Delta TM3

PNEUMATIC MODULE FOR LEAK TESTS
BY PRESSURE DROP

WITH USB INTERFACE AND RS485 SERIAL LINE

Module Delta TM3P

Model	Pressure range	Resolution
TM3PN	- 1000 mbar	0.1 Pa
TM3P05	500 mbar	0.1 Pa
TM3P2	2 bar	0.1 Pa
TM3P6	6 bar	1 Pa
TM3P10	10 bar	1 Pa
TM3P20	20 bar	1 Pa

Options	Description
-86	test pipe fittings 8x6
-64	test pipe fittings 6x4
-64H	Compression fitting at the output for pipe 6x4 (high pressures)
-R64H	remote reading of test pressure (high pressures)
-42	test pipe fittings 4x2.5
-42H	Compression fitting at the output for pipe 4x2.5 (high pressures)
-R42H	remote reading of test pressure (high pressures)
-RS	RS232 serial line for proportional valve driving
-2V	two external valves management 24V
-I3	addition of 3 digital inputs

INSTRUCTION MANUAL

Rev: 20190904

Revision	Description	Date
20181011	Issued	11/10/2018
20190715	Three-steps leak test update with external valve. Updating parameter **P_OFFSET_DP**	15/07/2019
20190904	Weight update	04/09/2019

DECLARATION OF CONFORMITY

We: **Tecna Srl**
Via Statale Sud 115, 41037 Mirandola (MO) Italy

declare that the product/s

Family: Delta TM3P
Model: TM3PN, TM3P05, TM3P2, TM3P6, TM3P10, TM3P20
Description: Microprocessor module for leak testing by pressure drop

complies with the following directives and standards:

SAFETY
Directive: **2014/35/UE "Low Voltage Directive (LVD)" dated 26/02/2014**
Standards: **CEI EN 61010-1:2013** "Safety requirements for electrical equipment for measurement, control, and laboratory use- Part 1 - general requirements"

ELECTROMAGNETIC COMPATIBILITY
Directive **2014/30/UE** "Electromagnetic compatibility (EMC)" dated 26/02/2014
Standards: **CEI EN 61326-1:2013** and subsequent amendments "Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1 - general requirements"

WASTE AND HAZARDOUS SUBSTANCES
Direttive **2012/19/UE** "Waste electrical and electronic equipment (WEEE)" dated 04/07/2012

Sergio Lodi

Ing. Sergio Lodi
President Tecna Srl

Mirandola, 01/02/2016

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1 SYMBOL LIST USED

! CAUTION: Safety rules for the operator, considering as operator any installer, user or present person.

WARNING: Instructions to be followed carefully for the correct operation of the equipment and to avoid any damage to the equipment or to the operator.

NOTE: Contains important prescriptions for the equipment maintenance.

NOTE: Contains important supplementary information or useful suggestions.

2 RISKS AND WARNINGS

! CAUTION: Compressed air risk: when the equipment is installed and used, the operator must be protected against any possible damage caused by the accidental detachment of parts under pressure. The tested product must conform with the mandatory requirements (e.g. “Pressure Equipment Directive”, PED 97/23/CEE)

! CAUTION: Electrical shock risk: class I equipment.
The electrical power supply requires mandatory a protective ground connection. Check regularly the protective earth connection of the power supply. Always keep the power supply cable in good conditions. Disconnect the power supply cable for any maintenance and before to clean the equipment housing.

! CAUTION: Moving parts risk: if the pneumatic or electrical outputs of the equipment are used to drive external moving parts, the operator must be protected applying all the safety rules of the Machinery Directive for moving parts.

! CAUTION: Before carrying out any maintenance operations, depressurize the pneumatic system and disconnect the power supply cable to the equipment.

WARNING: Clean the housing of the equipment with soft cloths and use only water with neutral detergents and disinfectants; never use alcohol or thinners.

WARNING: Do not pour fluids on the equipment: this could damage some of its parts permanently, especially those under voltage.

WARNING: Use the equipment only for the intended purposes, described in this manual; different uses can be unsafe for the operator and can damage the equipment.

WARNING: This manual must be read carefully before using the equipment of which it is integral part. Preserve with care.

WARNING: Do not use petrol or flammable solvents as detergents, but always use non-flammable and non-toxic commercial detergents authorized by current legislation.
Do not spray the detergent directly on the equipment.
Clean the outside of the equipment with a soft cloth moistened with a neutral detergent. Use screen-specific cleaning products to clean the screen.

3 GENERAL INFORMATIONS

3.1 PACKAGING AND TRANSPORTATION

The type of packaging is chosen according to the chosen transport medium, the quantity of appliances to be delivered and the place of destination.

Normally, every single appliance is contained within a cardboard box.

Keep the cardboard packing in order to use it when the device is shipped to authorized service centers or to the manufacturer for the required work.

If the original packaging has not been stored, use a cardboard box with appropriate dimensions and fill any blank spaces with soft material (paper, sponge, etc.) to prevent any movement of the appliance into the container.

Transport must be carried out at temperatures between -10 ° C and 50 ° C, with a maximum relative humidity of 50% and ambient pressure between 700 hPa and 1100 hPa.

3.2 STORAGE

In case of prolonged inactivity, store the appliance, possibly packaged, or otherwise protected in rooms with a temperature between 0 ° C and 50 ° C, maximum relative humidity 50%, ambient pressure between 700 hPa and 1100 hPa

3.3 DESCRIPTION

DELTA TM3P pneumatic modules are the best solution for any who wish to integrate one or more parallel testing station in their automated systems, with reliable and compact, high performance measuring instruments.

Delta TM3P modules have minimum footprint, allowing for easy installation on the machine, and include everything you need for managing tests:

- Pneumatic circuit complete with valves and pressure transducer
- PCB with microprocessor for managing tests
- Optoisolated USB device-to-PC communication interface
- Optoisolated RS485 communication interface with Modbus protocol
- USB slave interface with test data output in CSV format;
- Digital inputs and outputs for PLC management

The following is excluded and must be supplied by the installer:

- Air supply at service pressure for driving internal valves;
- An external pressure reducing valve, to adjust the test pressure of the air supply;
- 24 VDC, 1.0 A max power supply

An optional RS232 serial line interface can be used to drive an external proportional valve to regulate the test pressure.

Thanks to it's very small size, the module can be installed very close to the component under test, to shorten the pneumatic connections and minimize the test volume; by this way it is possible to increase the speed and sensitivity of the tests.

Using the standard Modbus RTU communication protocol, Delta TM3P pneumatic modules can be operated via programmable controllers (PLC), PC or from HMI/ SCADA terminals with touch screen.

3.3.1 HMI OPERATOR PANELS

Tecna srl can provide display and programming terminals which can handle up to 8 TM3P modules on a RS485 serial line with Modbus RTU communication protocol (e.g.: Weintek MT8050iE, 4.3” TFT touchscreen).

3.3.2 SERVICE SOFTWARE

Each TM3P instrument is provided with a USB pendrive containing:

- FTDI driver for managing communications between PC and TM3P on a USB port
- TM3P Configurator: PC software (Windows XP / Vista / Seven/8/10) which allows the programming of the RS485 serial port and update the internal program (firmware).
- SWM-TECNA version LITE: supervision software for the TM3 modules that allows the programming of the test and configuration parameters of the instrument, the calibration of the sensors, the management of the visualisation of the test in progress with pressure and flow graphs.

3.3.3 DATA COLLECTION SOFTWARE

Tecna srl can supply SWM-TECNA software in the FULL version which includes:

- The collection of data and graphs of each test stored on the database.
- Statistics in sigma 6 format stored on the database.
- User management.
- Management of barcode, qrcode and datamatrix.

3.3.4 LABVIEW

Tecna srl can supply the LabView driver for the Delta TM3 testing equipment. The LabView driver is a set of software routines that allow the management of a programmable equipment. Each driver procedure corresponds to a machine programming operation, For example configuration, read, write, start or reset.

3.4 FRONT PANEL

DIMENSIONS
Width 75 mm
Height 84 mm
Length 120 mm

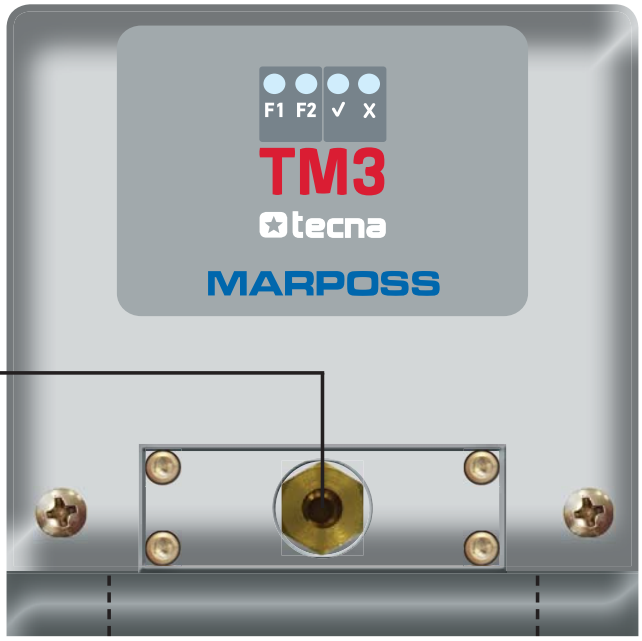
OUTLET with internal filter

DRILLING TEMPLATE
Width 60 mm
Depth 110 mm

FIXING HOLES X4
M4 screw from above
M5 screw from bellow

Mod. TM3PN - TM3P05-2-6-10

DIMENSIONS
Width 100 mm
Height 100 mm
Length 130 mm



OUTLET with internal filter

DRILLING TEMPLATE
Width 90 mm
Depth 110 mm

FIXING HOLES X4
M4 screw from above
M5 screw from bellow

Mod. TM3P20

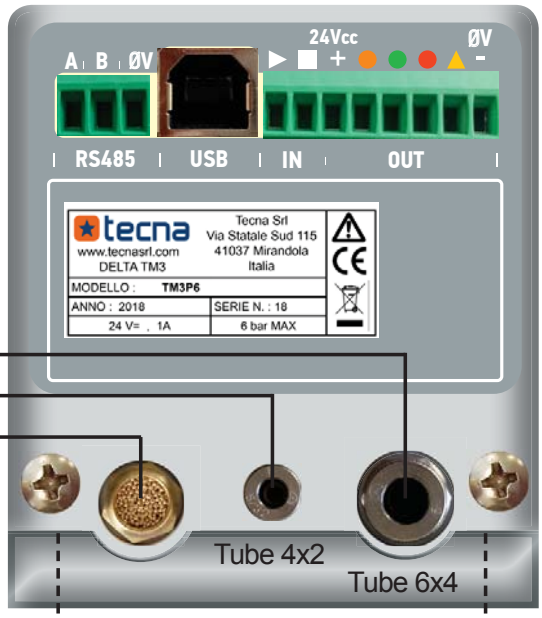
Model with double outlet

CYCLE PHASE	F1 Led: yellow	F2 Led: yellow	GREEN Led: green	RED Led: red
Waiting (power on / reset)	OFF	OFF	OFF	Blinking
Calibration procedure	Blinking	Blinking	OFF	Blinking
Test running, filling phase	ON	OFF	OFF	OFF
Test running, settling phase	ON	ON	OFF	OFF
Test running, measure phase	OFF	ON	OFF	OFF
Test result: PASSED	OFF	OFF	Blinking	OFF
Test result: FAILED	OFF	OFF	OFF	Blinking
Test result: ERROR	OFF	OFF	OFF	Blinking
Test result: FAILED RVP%	OFF	OFF	OFF	Blinking
Test result: FAILED VEXT	OFF	OFF	OFF	Blinking

Outlet with internal filter:
- tube fitting (6x4 mm tube or 4x2.5 mm) for connection to the test piece
- compression fitting (6x4 mm or 4x2.5 mm pipe) for connection to the product under test (TM3P20);
- protection filter on test outlet to reduce the risks of foreign objects entering the pneumatic circuit during filling/discharge.

3.5 REAR PANEL

DIMENSIONS
Width 75 mm
Height 84 mm
Length 120 mm

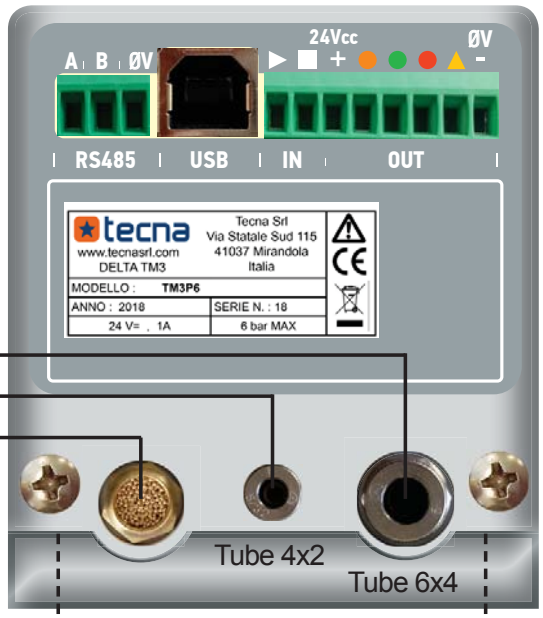


DRILLING TEMPLATE
Width 60 mm
Depth 110 mm

FIXING HOLES X4
M4 screw from above
M5 screw from bellow

Mod. TM3PN

DIMENSIONS
Width 75 mm
Height 84 mm
Length 120 mm

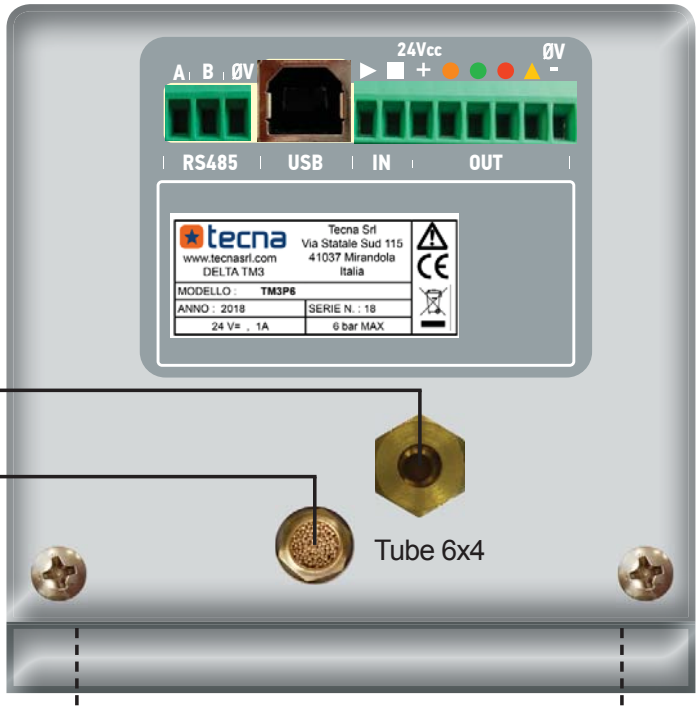


DRILLING TEMPLATE
Width 60 mm
Depth 110 mm

FIXING HOLES X4
M4 screw from above
M5 screw from bellow

Mod. TM3P05-2-6-10

DIMENSIONS
Width 100 mm
Height 100 mm
Length 130 mm



DRILLING TEMPLATE
Width 90 mm
Depth 110 mm

FIXING HOLES X4
M4 screw from above
M5 screw from bellow

Mod. TM3P20

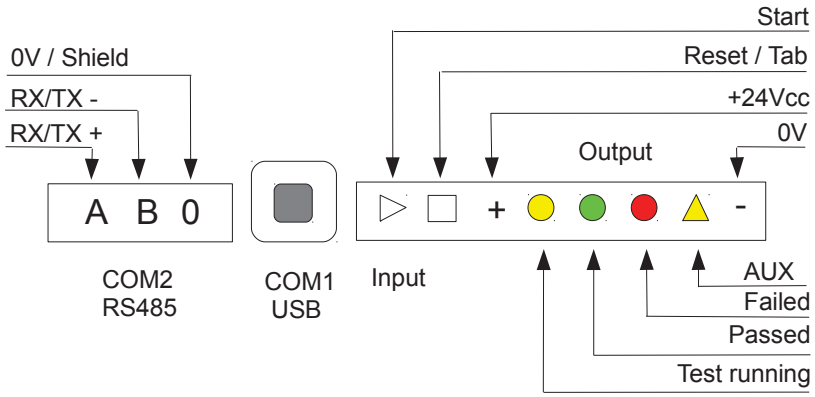
TEST PRESSURE
Air inlet at test pressure, regulated by an external pressure reducer, provided by the user, in the pressure transducer's measurement range.
Quick connector coupling for 6x4 mm tube for models TM3P05-2-6-10 and compression fitting for 6x4 mm tube for model TM3P20.

TEST VACUUM
Test vacuum input, regulated by an external generator, for example a Venturi nozzle, supplied by the user.
Quick connector coupling for 6x4 mm tube

PILOT PRESSURE FOR VALVES
Pilot air supply for driving valves, minimum pressure 2.5 bar, max pressure 10 bar; quick connector coupling for 4x2 mm tube.
(TM3PN - TM3P05-2-6-10)

DISCHARGE
Discharge outlet for compressed air from the component being tested, after testing, with silencer filter.

! **CAUTION:** **Do not apply pressure higher than the full scale of the instrument in order not to damage the internal components and not compromise their safety.**



COM2 RS485 serial port with Modbus RTU protocol.
3-pin connector, 3.5 pitch, movable socket, model Sauro CTF030M8.

COM1 USB serial line for PC connection.
The PC requires the FTDI interface driver for FT232RL converter, downloaded from the Internet or provided by Tecna srl with the configuration program for TM3P modules in the USB stick supplied.

INPUTS/OUTPUTS/POWER
8-pin connector, 3.5 pitch, movable socket, model Sauro CTF080M8.

INPUTS Digital inputs from PLC.
24VDC inputs, 5 mA max, opto-coupled.
- Start: Starts testing
- Reset/Tab:Function programmable through configuration parameters
- Reset: Stops a running test (outcome: REJECT)
- Tab: If active, enables the alternative test program

OUTPUTS Digital outputs to PLC

24VDC outputs, 0.7 A max, opto-coupled, short-circuit protection.

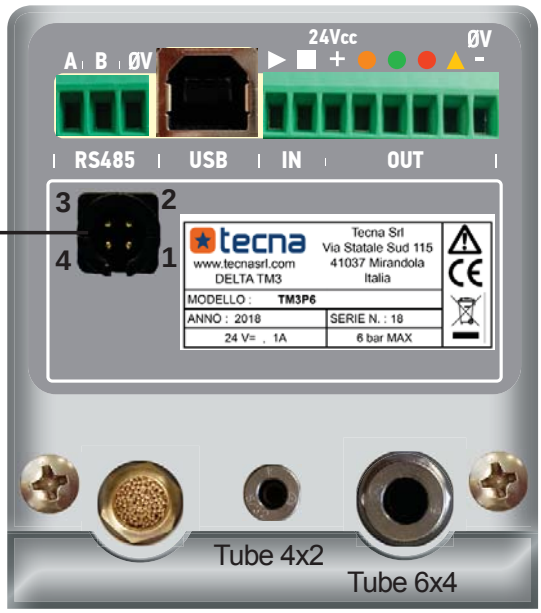
- Test running: Activates during test
- Pass: Activates after testing, with “Pass” outcome;
- Reject: Activates after testing, with “Reject”/”Error” outcome, and at power up;
- AUX: auxiliary output function, defined by the parameter CYCLE,
- *Alarm, Inverted output (active if no alarm is present);;
- VEXT, external valve (parameter CYCLE=2);
- Obstruction, for obstruction test (parameter CYCLE=3)
- Venturi: used to drive an external valve that activates a Venturi nozzle during the discharge phase, for the duration of time T1.

POWER SUPPLY Power supply to control PCB and digital outputs. 24Vcc, +/- 10%, power consumption 1A max (excluding digital outputs).

3.5.1 REAR PANEL WITH RS OPTION (OPTION) TM3P05-2-6-10

PROPORTIONAL VALVE CONNECTOR WITH RS232 INTERFACE
Connector type: M5, 4 pins, male
RS232 serial line signals: pin 1= TXD, pin 3= RXD, pin 4= 0V common.

Proportional valve connector
Type M5 4 poles male
Pin 1: TXD →
Pin 2: not used
Pin 3: RXD ←
Pin 4: 0V common

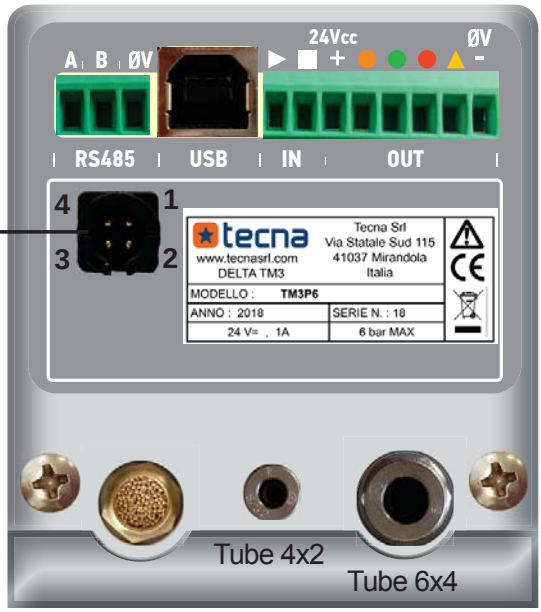


Mod. TM3P05-2-6-10

3.5.2 REAR PANEL WITH 2V OPTION (OPTION) TM3PN - TM3P05-2-6-10

PILOT CONNECTOR FOR TWO EXTERNAL VALVES
Connector type M5, 4 pins, female
Connection V1: pin 1= +24V, pin 2= 0V.
Connection V2: pin 4= 0V, pin 3= +24V.

Connector for 3 external valves
Type M5 4 pins female
Pin 1: +24V (VALVE 1)
Pin 2: 0V (VALVE 1)
Pin 3: +24V (VALVE 2)
Pin 4: 0V (VALVE 2)



Mod. TM3PN - TM3P05-2-6-10

After a start command, valve V1 is activated if the test program number is odd, otherwise valve V2 will be activated.
The valve activation signal remains active for the duration of the test cycle.

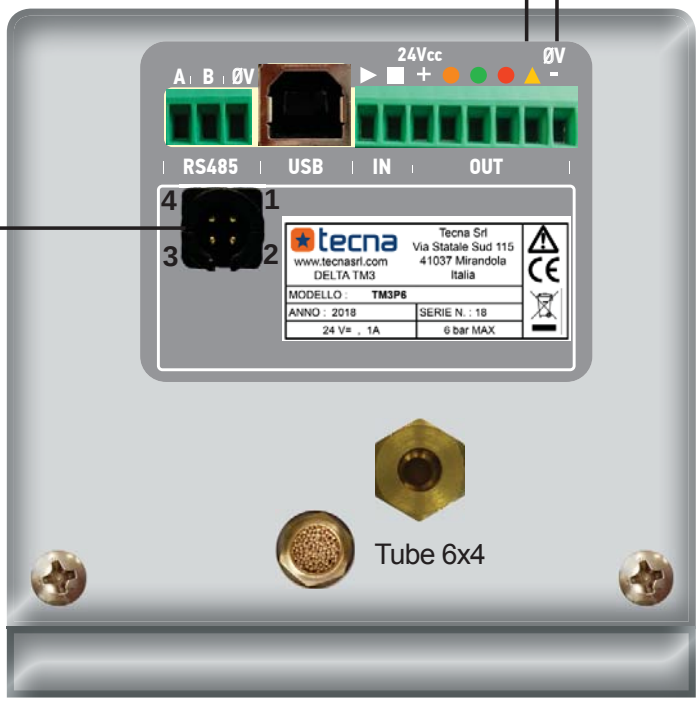
3.5.3 REAR PANEL WITH 2V OPTION (OPTION) TM3P20

The 2V option allows the management of two external valves to use two separate test channels. A valve is managed by connecting it to the connector on the back panel of the module, the other is managed with the digital output 4 normally used for the alarms. It is necessary to set the configuration parameter P_T_UD4 to the value 0 = EXTERNAL VALVE.

PILOTING OF TWO EXTERNAL VALVES
Connector type M5, 4 pins, female
Connection V1: digital output 4 (alarm) = +24V, 0V of power supply.
Connection V2: pin 4= 0V, pin 3= +24V.

Digital output 4 (ALARM) : +24V (VALVE 1)
0V of power supply : 0V (VALVE 1)

Connector for 1 external valve
Type M5, 4 pins, female
Pin 1: not used
Pin 2: not used
Pin 3: +24V (VALVE 2)
Pin 4: 0V (VALVE 2)



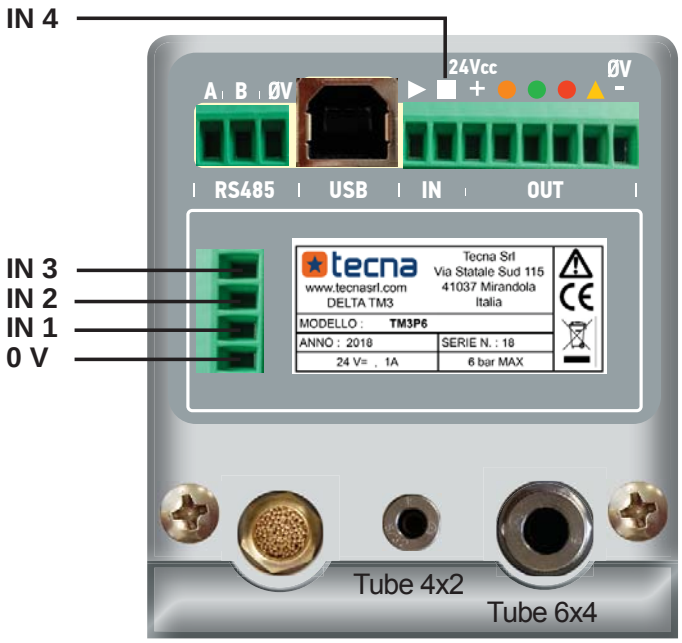
Mod. TM3P20

After a start command, valve V1 is activated if the test program number is odd, otherwise valve V2 will be activated.
The valve activation signal remains active for the duration of the test cycle.

3.5.4 REAR PANEL WITH I3 OPTION (OPTION) TM3P05-2-6-10-20 - TM3PN

CONNECTOR TO ADD 3 DIGITAL INPUTS
4-pin connector, 3.5 pitch, movable socket, model Sauro CTM040P8.

The I3 option adds 3 digital inputs to the TM3P pneumatic module, which added to the RESET / TAB input, allow to a PLC to select up to 16 different test programs. To enable the option it is necessary to set the general configuration parameter P_NTABX to a value greater than 0 (see section 6.1).



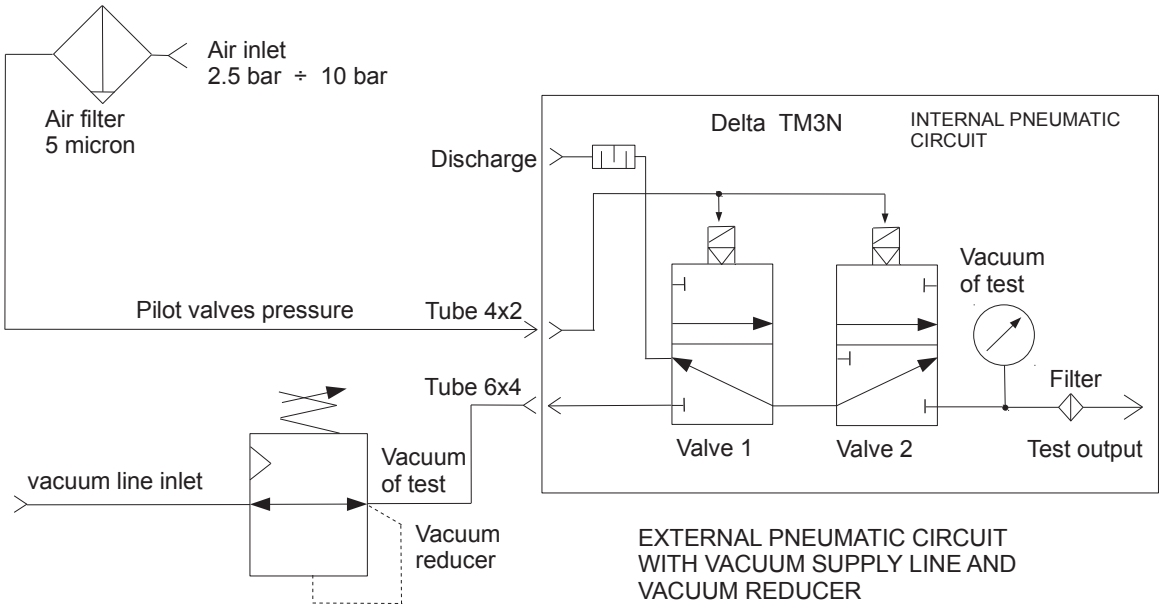
Mod. TM3P05-2-6-10-20 - TM3PN

Example of program selection from PLC:

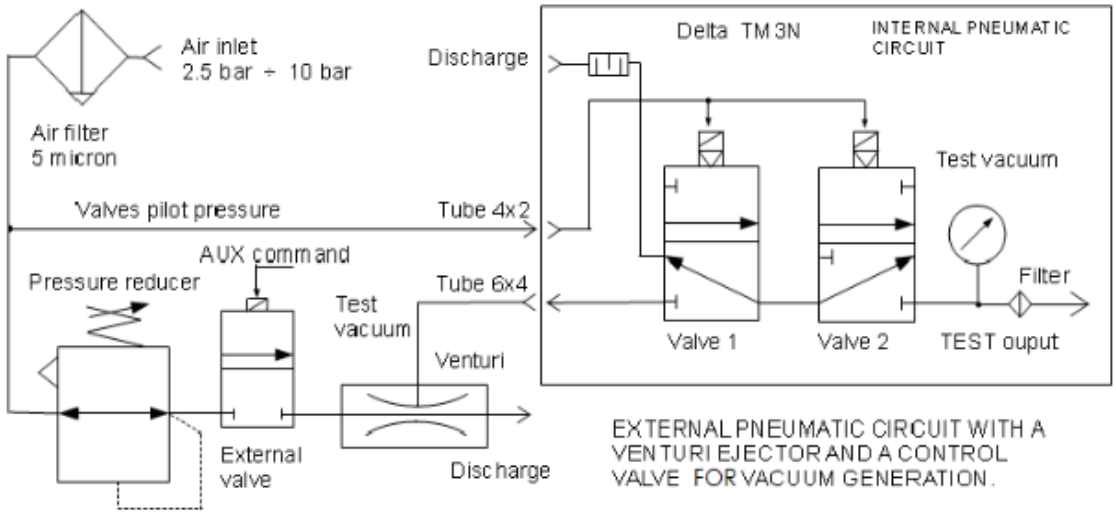
Parameter P_NTABX = greater than zero.

PROGRAM	INPUT 1 (IN 1)	INPUT 2 (IN 2)	INPUT 3 (IN 3)	INPUT 4 (IN 4)
1	0V	0V	0V	0V
7	24V	24V	24V	0V
10	0V	24V	0V	24V
16	24V	24V	24V	24V

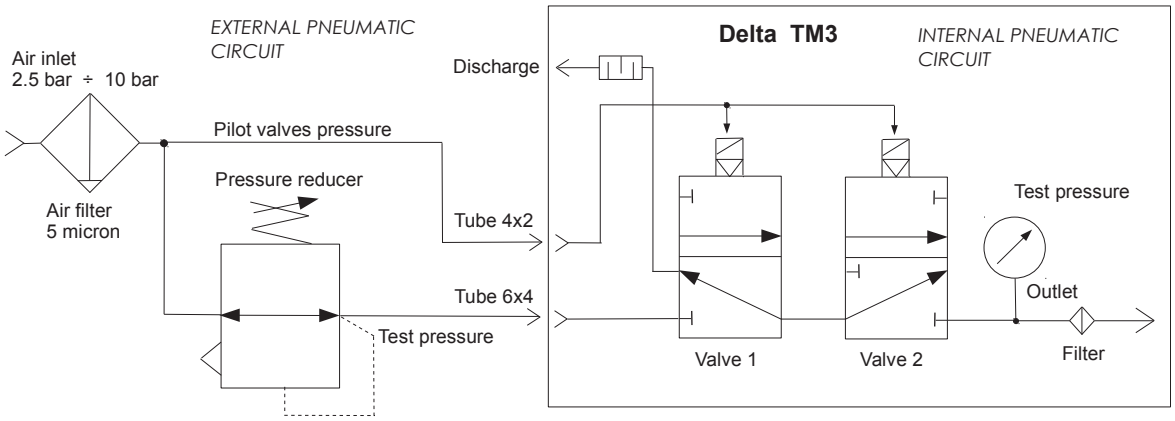
4 PNEUMATIC DIAGRAM



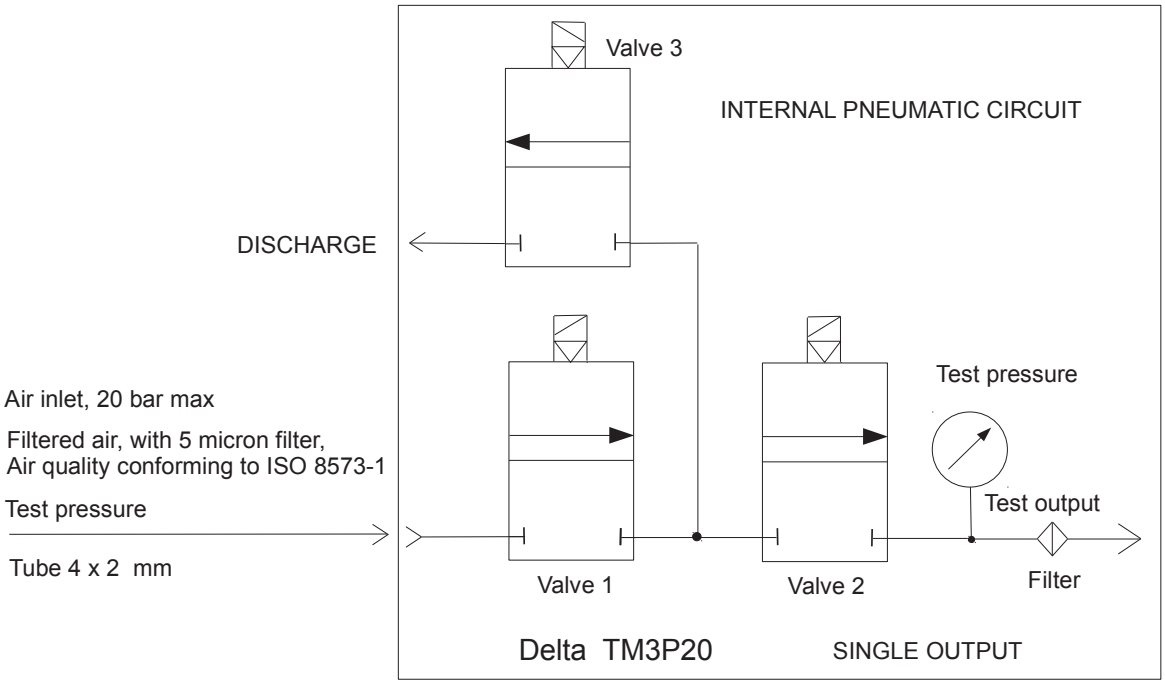
Delta TM3PN - Pneumatic diagram



Delta TM3PN - Pneumatic diagram with Venturi tube



Delta TM3P05-TM3P2-TM3P6-TM3P10 - Pneumatic diagram



Delta TM3P20 - single output - Pneumatic diagram

External pneumatic circuit
The operator must connect externally:

- compressed air supply line, with a 5 micron air filter , to drive the internal pilot valves (excluding TM3P20) and to generate the test pressure/vacuum;
- a pressure reducing valve to adjust the test pressure.

WARNING: Use only dry air, without condensate, filtered, not lubricated and free from explosive gases, conforming to ISO 8573-1 air quality.

WARNING: The pressure regulator's full scale adjustment must not exceed the pressure transducer's full scale value. In any case, do not adjust the pressure regulator at a pressure higher than instrument's full scale value to avoid damaging the internal pressure sensor.

Internal Pneumatic Circuit for models TM3PN - TM3P05-2-6-10
The pneumatic circuit of the instrument is simple but effective and safe, and consists of:

- two NC 3/2 way solenoid valves;
- a pressure transducer;
- an outlet connector with built-in filter;
- a discharge outlet with silencer filter.

Valves 1 and 2 are open (energized) only during filling/discharge, and are closed (not energized) during settling and pressure drop measurement/vacuum.
This way, the component being tested is connected to the pressure reducer only during filling/discharge, whereas, during settling and measurement, the component being tested is completely isolated from the pressure reducer, since the inlet of valve 2 is in fact connected to discharge.
A possible leakage or failure of valve 2 during testing can therefore only cause a loss of pressure/vacuum in the component being tested, not an increase in pressure/vacuum: the possibility that an error in the pneumatic circuit can hide a pressure loss/vacuum of a component to be rejected is therefore excluded.
Valves are supplied with 24 V DC, with low power absorption (< 2 W) and provide a 4 mm passage, suitable also for filling large volumes.
Both valves have a poppet and provide a superior seal; moreover, they are easy to access and inspect.
Pressure / vacuum transducers measure ambient pressure and are available with three full-scale values: -1 bar, 0.5 bar, 2 bar, 6 bar, 10 bar.

Internal Pneumatic Circuit for models TM3P20
The pneumatic circuit of the instrument is simple but effective and safe, and consists of:

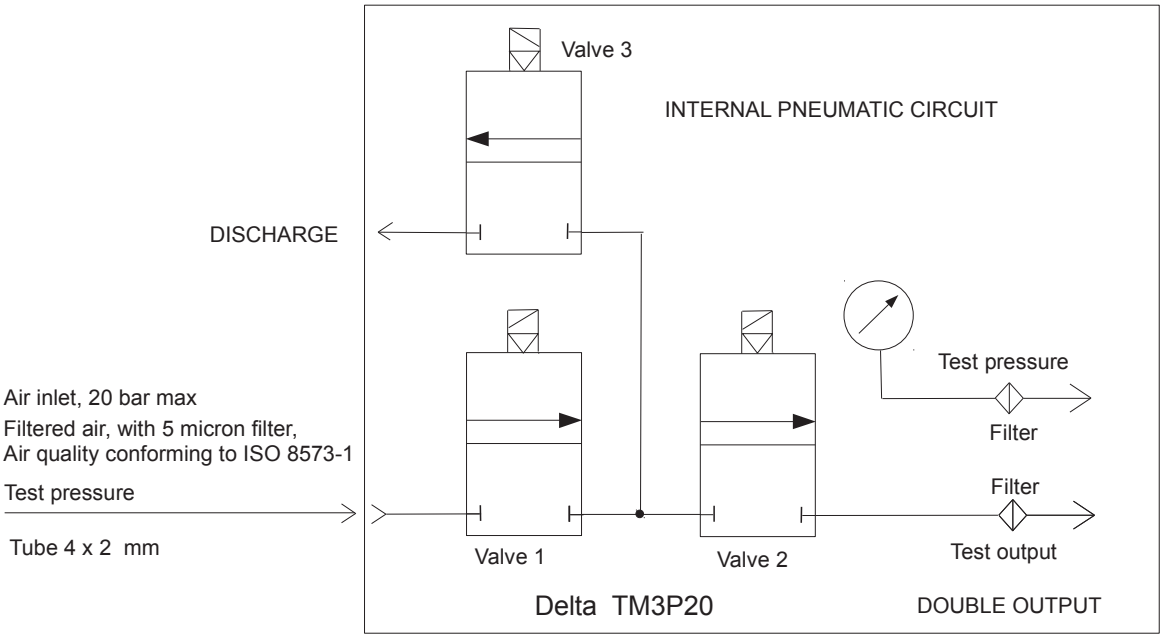
- Three NC 2 way solenoid valves
- A pressure transducer
- An outlet connector with built-in filter
- A discharge outlet with silencer filter

Valves 1 and 2 are open (energized) only during filling, and are closed (de-energized) during settling and pressure drop measurement.
This way, the component being tested is connected to the pressure inlet only during filling, whereas, during settling and measurement, the component being tested is completely isolated from the pressure inlet, since the inlet of valve 2 is in fact connected to discharge.
A possible leakage or failure of valve 2 during testing can therefore only cause a loss of pressure in the component being tested, not an increase in pressure: the possibility that an error in the pneumatic circuit can hide a pressure loss of a component to be rejected is therefore excluded.

Valves are supplied with 24 V DC, with low power absorption (< 3.8 W), with a 1.2 mm passage.
All valves have a poppet and provide a superior seal; moreover, they are easy to access and inspect.

The pressure transducer has a full scale value of 20 bar.
The test output connected to the pressure sensor includes a metallic filter housed inside a bracket.

Internal Pneumatic Circuit with double output



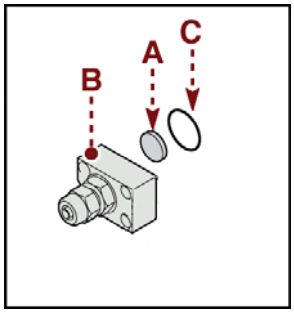
Delta TM3P20 - double output - Pneumatic diagram

If it is necessary to check the free passage of air through the product under test, to detect an internal obstruction, a Delta TM3P20 module with double output connections can be used.
The product under test is connected to the TM3P module at two access points, one at an inlet port and the second at an output port.
The inlet port of the product is connected to the test output port, the output port of the product is connected to the test pressure port.
In case of obstruction inside the product under test, the pressure transducer will not read the expected test pressure and the test will end with a reject outcome, due to test pressure fail.

NOTE: Regarding the type of high-pressure pneumatic connections, see APPENDIX B of this manual.

NOTA: After testing you should not discharge the pressure in the component being tested through internal valves, to prevent foreign objects being sucked in and affecting the tightness of the valves.
If for safety or practicality reasons you enable end-of-test pressure discharge, you should periodically check the status of the internal filter and clean or replace it if dirty.

NOTE: You should keep the connecting hoses to the component being tested as short as possible. Any volume added to the test circuit reduces the measurement's sensitivity. Tests should always be carried out with the same type of connection in order to have consistent results. Periodically check the integrity of the connection between the pneumatic module and the components to be tested.



The test output includes a metal filter housed inside a support on which a 6x4 mm tube or 4x2.7 mm hose connection is mounted for connecting the component under test.

NOTE: Check the filter periodically and clean or replace the filter if clogged.

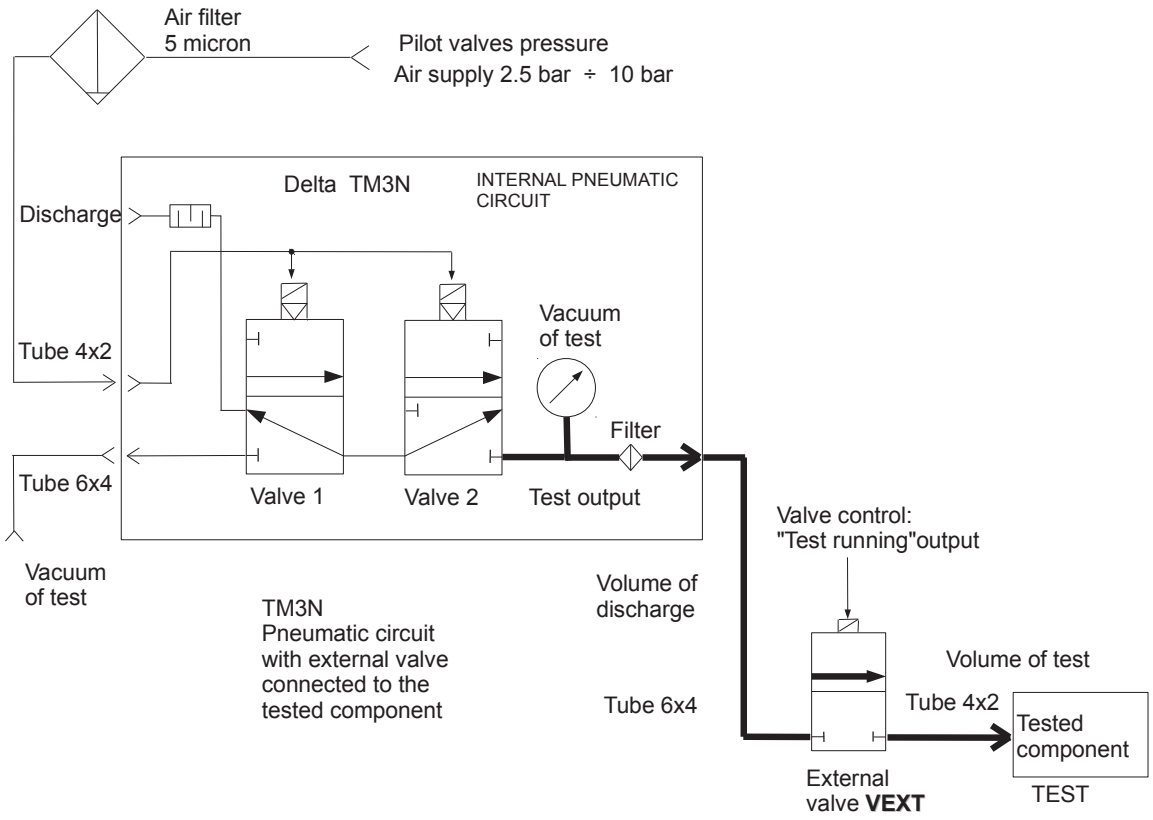
To check and replace the filter, do not unscrew the tube fitting port, but only the flange (B), fixed with 4 screws, to access the filter (A) under the flange, then replace the filter, making sure the sealing ring (C) is correctly mounted.

WARNING: The air filter prevents the infiltration of dust, filaments, waste, but it is not effective for oil or water.

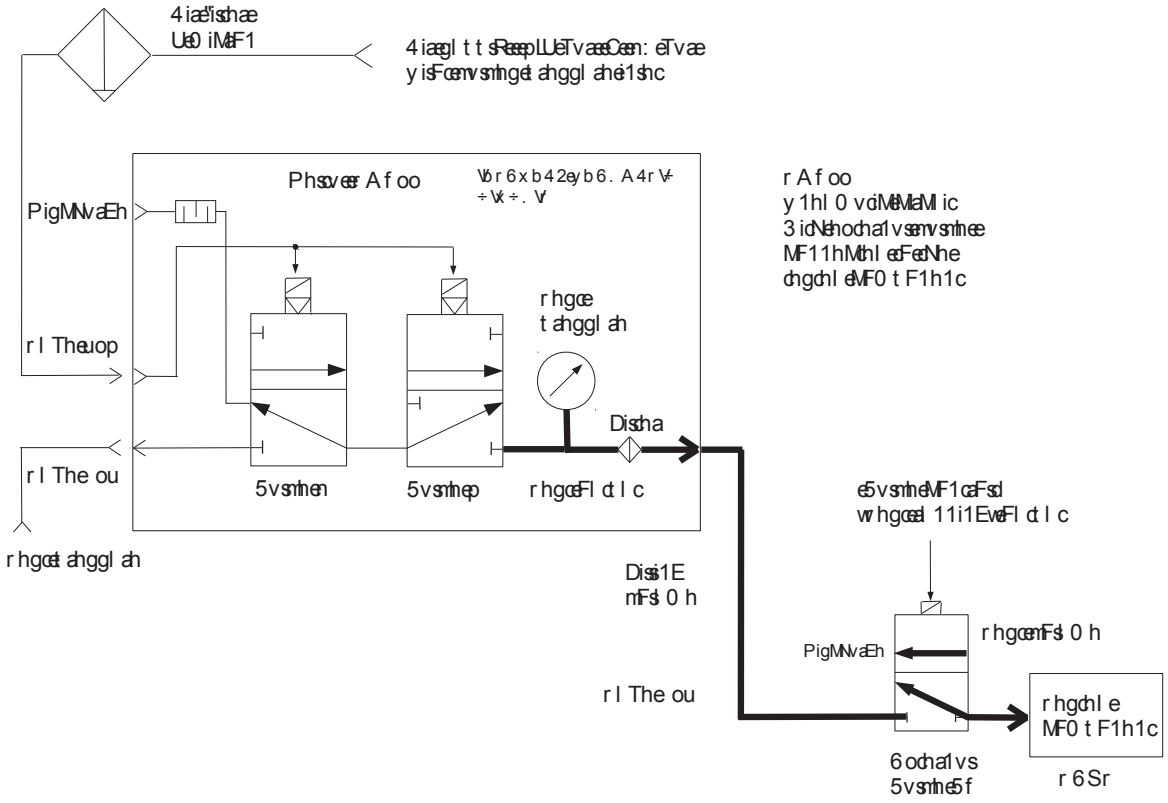
NOTA: The connecting tube to the component being tested should be as short as possible. Any volume added to the test circuit reduces the measurement's sensitivity. Tests should always be carried out with the same type of connection in order to have consistent results. Periodically check the integrity of the connection between the pneumatic module and the components to be tested.

4.1 PNEUMATIC DIAGRAM WITH EXTERNAL VALVE VEXT

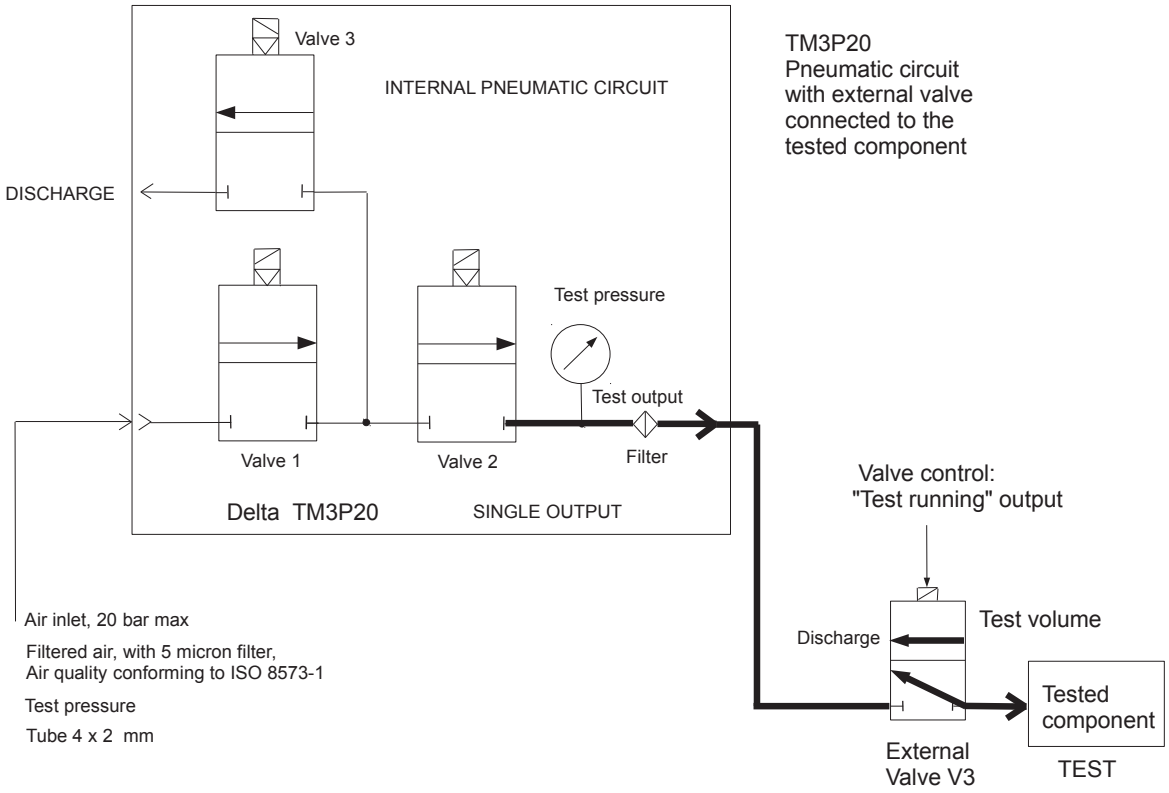
For fast tests on small volumes, an external valve VEXT is useful on the output test port.
The valve must be installed as close as possible to the tested component: the TM3P module can be installed remotely with a tube connected to valve VEXT.



Delta TM3PN - Pneumatic diagram with external valve



Delta TM3P05-TM3P2-TM3P6-TM3P10 - Pneumatic diagram with external valve



Delta TM3P20 - Pneumatic diagram with external valve

Test cycle with external valve VEXT with phases T2-T3 and phase T1 in waiting time:

- the option VEXT must be programmed in the test parameters of the active test program;
- the valve VEXT must be electrically connected to the output signal “Test running” on the rear connector of the module;
- the filling time T1 is used only during the wait phase, at the end of a test, before to start the next test, to fill the tube that connects to the external valve VEXT;
- when a new test is started, the connection tube is already filled at the test pressure; the internal valves V1 and V2 are already closed, the “Test running” signal opens the external valve VEXT; the test cycle actually starts with the settling time T2;

- the tested component is filled up to the test pressure using, as a reservoir of pressure, the connection tube between the TM3P module and the external valve VEXT;
- at Start, the instrument registers the initial pressure P1 at the output test port, on the connection tube to the valve VEXT;
- at the end of the settling time T2, the instrument registers the final pressure P2;
- the registered values P1 and P2 are used to calculate the volumetric ratio RVP% that indicates the ratio between the filling volume and the total test volume;
- the control of the volumetric ratio RVP% , with respect to the programmed limits, allows to verify the actual opening of the external valve VEXT.

Discharge/filling volume:
volume of the pneumatic circuit from the internal valve V2 to the external valve VEXT.

Test volume:
volume of the pneumatic circuit from the external valve VEXT to the tested component, including the internal volume of the tested component.

Total test volume:
discharge/filling volume + test volume.

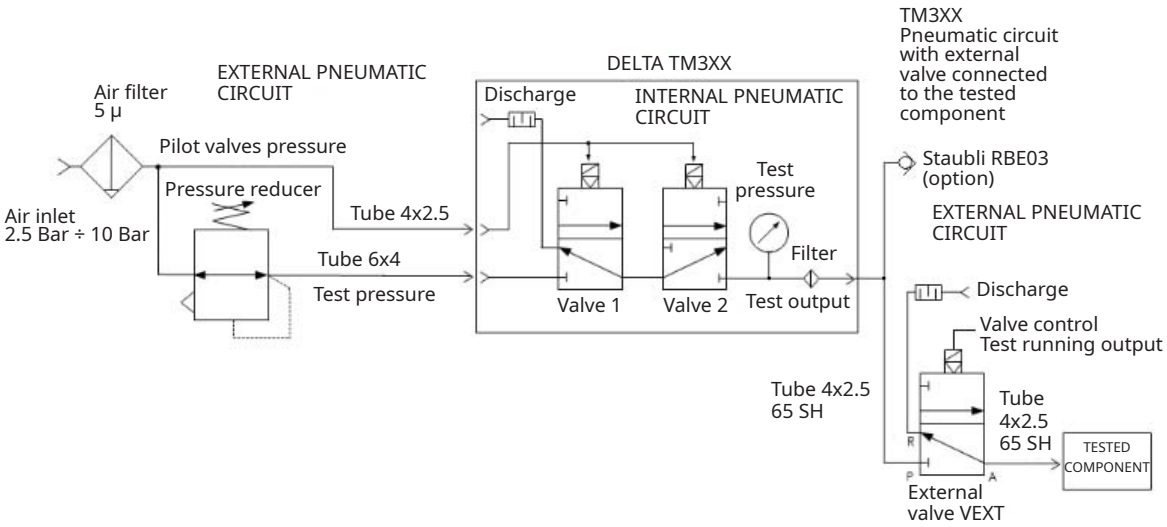
Volume/pressure ratio:
(P1 * discharge/filling volume) = (P2 * total test volume).

Volumetric ratio RVP% = (P1 * 100.00 / P2).

Advantages:

- the discharge/filling time T1 is counted in the waiting phase between the last test and the next one, therefore it can be included in the transfer part of the automation cycle, allowing to increment the time available for testing, since the test cycle is including only the settling time T2 and the measuring time T3;
- the discharge/filling volume is already filled before the test is started, therefore the settling time T2 can be reduced;
- controlling the volumetric ratio RVP% allows to verify the internal volume of the tested component, giving the possibility to test sealed components, closed inside a test chamber (bell jar).

Test cycle with external VEXT valve with phases T1-T2-T3



Delta TM3P - Pneumatic diagram with external 3-way valve.

the test cycle must be programmed with the VEXT / T1-T2-T3 option in the test table parameters;

- the VEXT valve must be electrically connected to the "Test in progress" output of the connector on the rear;
- the filling time T1 is used to check the opening of the external valve and to perform filling / discharge;
- at the Start, the connection pipe is already filled to the test pressure; the internal valves V1 and V2 remain closed, the external VEXT valve is opened with the “Test in progress” signal; if during the T1 phase a DELTA VEXT pressure drop is found higher than the value programmed in the PH parameter, the internal valves are opened for the duration of T1 otherwise the test ends with the result of the external valve opening rejection.
- the component under test is brought to the test pressure by using the connection pipe between the TM3P module and the VEXT valve as a tank;
- a reset command (serial line or PLC) opens the internal valves for the duration of time T1, allowing the circuit to be loaded.
- at the end of each test, the circuit recharging procedure is performed, which involves opening the internal valves until the pressure exceeds the Pr - Pr min% value, this procedure can have a maximum duration of 1 s.

Advantages:

- the filling / discharge volume is already under pressure before testing, so it is in practice already settled before testing, allowing to reduce the time T2;
- the component under test is filled with the test reducer, this allows to test components with volumes greater than 10 cm^3/min.

4.2 TESTING OF SEALED COMPONENTS INSIDE A TEST CHAMBER (BELL JAR)

With the aid of an external valve VEXT, the TM3P modules can perform leak tests on sealed components, that are components without an external access, but with an internal cavity, that might be filled in case of leaks on the body of the component.
To check for pressure leaks/vacuum, the sealed component must be inserted inside a test chamber (bell jar) and the leak test is performed on the interspace between the walls of the test chamber and the body of the sealed component; any pressure drop/vacuum of the interspace indicates a leak to the external ambient (a leak of the seals of the test chamber) or a leak to the internal cavity of the tested component (a leak of the body of the component).
This type of test requires the control of the volume of air which is introduced in the test chamber during the filling phase/discharge, because, in case of a large leak in the tested component, also the internal cavity would be filled/discharged at the test pressure, therefore it would not be possible
any longer to measure a pressure drop of the interspace to the internal cavity, during the next measure phase time T3.
The interspace of the test chamber must be connected to the output port of valve VEXT.
During the filling time/discharge T1, while waiting for a new test, only the volume between the valves V2 and VEXT is filled/discharged; the interspace of the test chamber is instead filled/discharged when a new test is started, and the valve VEXT is opened, at the beginning of time T2 and at the pressure/vacuum initial P1.
The total test volume includes the filling/discharge volume, from valve V2 to valve VEXT, plus the volume of the connection circuit to the test chamber and the interspace volume.
When the time T2 expires, the instrument registers the pressure/vacuum value P2 and calculates the volumetric ratio RVP% = (P1 * 100.00 / P2) between the filling volume and the total test volume; the calculated RVP% is then compared respect to the parameter RVP% and the parameter RVP%MAX (+/- % tolerance) of the test program.
In case of a large leak, with a volumetric ratio outside the limits RVP% +/- RVP%-MAX, at the end of time T2, the test outcome is FAILED RVP%.

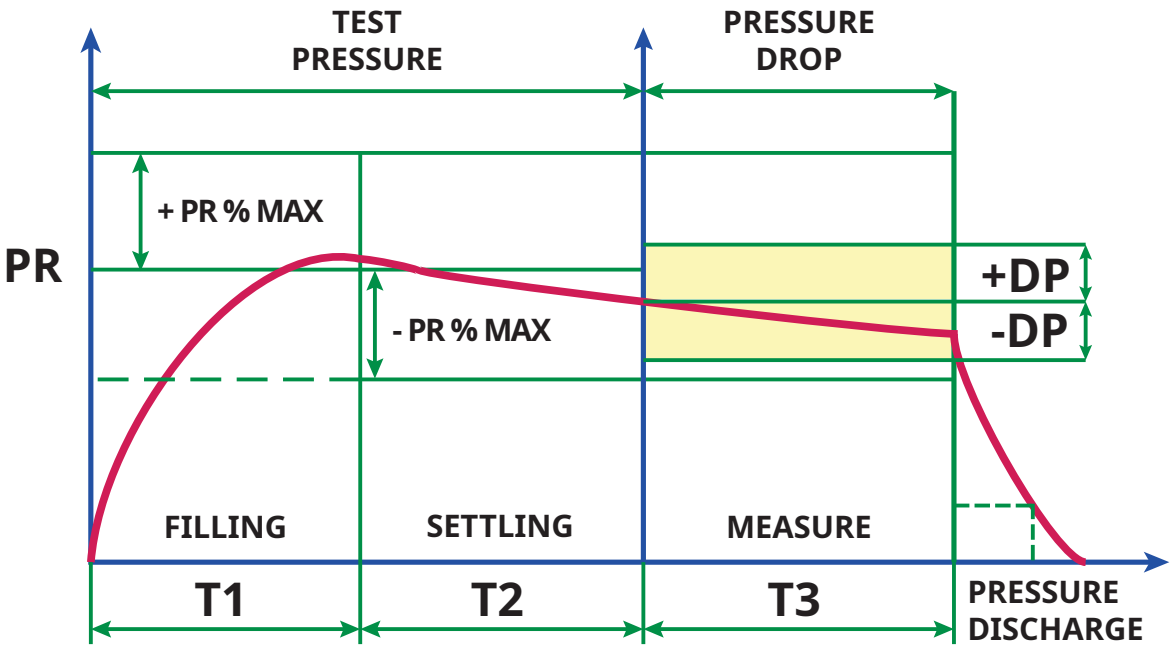
5 TEST CYCLE

! CAUTION: Compressed air risk: the equipment uses compressed air at the inlet and can supply compressed air at the outlet; when the equipment is installed and used, the operator must be protected against any possible damage caused by the accidental detachment of parts under pressure. The tested product must conform with the mandatory requirements (e.g. “Pressure Equipment Directive”, PED 97/23/CEE)

! CAUTION: The operator must ensure that the test pressure adjustment does not exceed the full scale of the equipment to avoid full scale alarms and the pressure transducer breakage.

5.1 THREE-STEPS LEAK TEST

The testing cycle starts after receiving a START command.



Delta TM3P - Three-step pressure leak test

The three-step pressure leak test is based on the following programmable parameters for each test program.

T1 Filling time/discharge

The filling phase/discharge begins after a START command and proceeds for time T1: the air flows out the output connector to fill/discharge the piece being tested at test pressure/vacuum Pr, regulated by the external pressure reducer.
You can stop the filling process/discharge after achieving test pressure/vacuum Pr, without waiting for the end of time T1, selecting in the configuration parameters the three-step test type with the Pr/T1 option.
If during the filling phase/discharge the test pressure/vacuum exceeds the programmed value Pr beyond the threshold %Pr_MAX, the test ends with outcome Reject with Max pressure/vacuum error.
If the test requires external filling/discharge of the piece being tested, time T1 can be programmed to 0 (zero): in this case, when receiving the START the equipment skips filling step/discharge, and without opening the valves, begins the test directly from time T2. With nominal test pressure Pr=0, valves are not energized.
If the module has the option RS (paragraph 3.5.1) for connecting a proportional valve, setting the parameter NT = 300, it is possible to fill in linear ramp mode. The pressure regulation starts from zero and at the end of the time T1 reaches the value of the nominal test pressure. The regulation value of the pressure supplied by the proportional valve is updated every 200 ms.

T2 Settling time

After T2, if pressure/vacuum inside the piece being tested is within percentage limits %Pr_MAX and %Pr_MIN set in the configuration parameters, and it is also greater than the programmed leak limit Dp, the test continues with phase T3; the pressure value/vacuum is stored as a reference point for controlling leak limit Dp in time T3.
If the test pressure/vacuum exceeds the programmed value Pr beyond limit %Pr_MAX, the test ends with outcome Reject for Max pressure/vacuum error.
If however, during settling time T2 and measure time T3, test pressure/vacuum falls below the programmed value Pr beyond limit %Pr_MIN, the test ends with outcome Reject for Min pressure/vacuum error.
With rated test pressure/vacuum Pr=0, no control is performed on percentage limits and Dp after T2.
If the parameter T2 is set to zero, the measurement time T3 is automatically set to zero and the module should be programmed for an obstruction test.

T3 Measurement time

The variation (delta) of pressure/vacuum within the work piece being tested is measured and compared to the value stored at the end of time T2, with a minus sign in case of pressure drop/vacuum (leak).
After time T3 the equipment stores the pressure variation/measured vacuum: the test's outcome is Pass if pressure variation does not exceed in absolute value, without a sign, the programmed limit Dp.
Also during time T3 test pressure/vacuum must be within percentage limits %Pr_ MAX and %Pr_MIN as in time T2.
If the parameter T3 = 0, the test ends in T2 with the result evaluated based on the percentage limits% Pr_MAX and% Pr_MIN.

Pr Pressure/ rated test vacuum

This is the pressure value/vacuum at which the air leak test should be executed, with programmed percentage tolerances %Pr_MAX and %Pr_MIN.
Percentage tolerance limits %Pr_MAX and %Pr_MIN for pressure/ rated test vacuum Pr are programmed in the configuration menu.
With pressure/rated test vacuum Pr=0, valves are not energized.

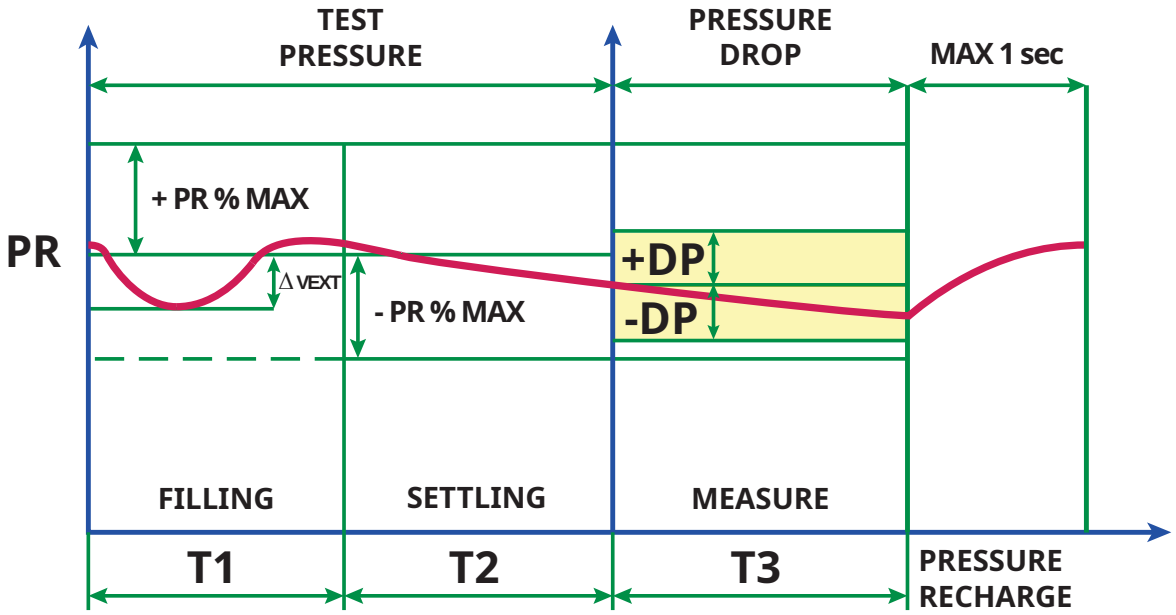
Dp Pressure delta

This is the maximum allowed pressure/vacuum increase or decrease during time T3.
Pressure drop/vacuum is shown with a negative sign, any increase in pressure/vacuum is shown with a positive sign.

NOTE: The accuracy of test pressure depends on the physical characteristics of the pressure reducer, the stability of the external supply pressure, and temperature.
The accuracy of the test vacuum depends on the physical characteristics of the external vacuum generator.
Programmed tolerance limits %Pr_MAX and %Pr_MIN must be compatible with actual operating conditions.

5.2 THREE-STEPS LEAK TEST WITH EXTERNAL VALVE (VEXT)

The test cycle begins after receiving a START command.



Delta TM3P - Three-steps pressure leak test with external valve

The three-steps leak test with external VEXT valve is based on the following programmable parameters for each test table.

T1 Filling / discharge time

The pneumatic circuit that goes from the internal valves of the module to the external valve, must be preloaded to the test pressure before receiving a test start command. A reset command (serial line or PLC) opens the internal valves, leaving the external valve closed, for the duration of time T1, in this case the circuit is charged to the test pressure. When a start command is received, the internal valves of the module remain closed and the external valve is opened.
After opening the external valve, if a pressure drop higher than the DELTA VEXT is detected, the internal valves of the module open up to the end of the programmed time T1. If during the T1 phase a pressure drop higher than DELTA VEXT is not detected, the test ends with the result of the external valve opening rejection.
If, during filling / discharge, the test pressure / vacuum exceeds the programmed value Pr over the% Pr_MAX limit, the test ends with a result failed for max pressure/vacuum error.

T2 Settling time
The T2 test phase is the same as the three-steps test phase, described in the previous paragraph 5.1.

T3 Measurement time
The T3 test phase is the same as the three-steps test phase, described in the previous paragraph 5.1.

At the end of the test the circuit pressure recharge procedure (internal valves up to the external valve) is performed at the nominal test pressure. The valves close again when the threshold defined by PR +% Pr_MIN is exceeded; the internal valves can remain open for a maximum time of 1 s.

NOTE: The accuracy of the test pressure depends on the physical characteristics of the external pressure regulator, the stability of the supply pressure of the external network and the temperature. The accuracy of the test vacuum depends on the physical characteristics of the external vacuum generator. The programmed tolerance limits % Pr_MAX and% Pr_MIN must be compatible with the actual operating conditions.

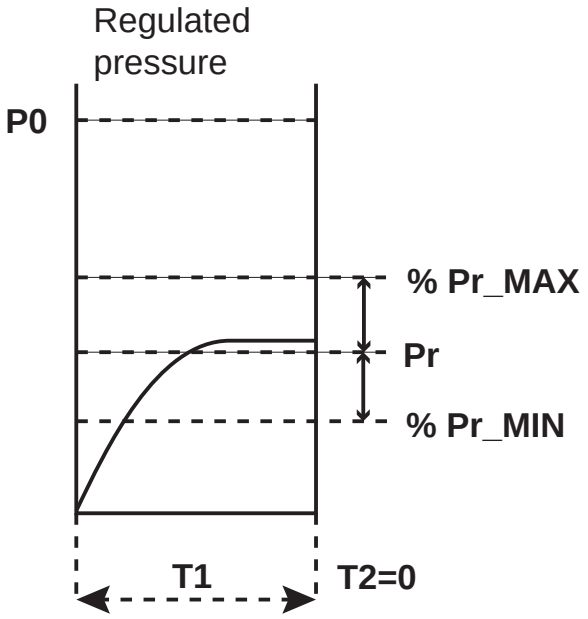
5.3 TESTING IN RECOVERY (FOR INTERCEPTION) MOD.TM3PN

This test mode can be used for components with two or more chambers that must be sealed separately.
For example, for testing a closed valve, the seal between the inlet chamber and the outlet chamber of the valve can be tested by leading to the positive test pressure of the inlet chamber and testing the vacuum seal of the outlet chamber. : any leakage of the valve will be identified as a leak of test vacuum.
The same method can be used for testing a component in a test chamber (bell jar); the component is filled to the positive test pressure and is closed inside the test chamber; the vacuum test of the interspace of the test chamber allows to identify a leak in the component under test.
The positive test pressure can be controlled by an independent external system or by another TM3 module for tests in pressure.

Note: Testing in recovery or in a test chamber (bell jar) could also be performed at positive pressure, but, for safety reasons, vacuum testing is preferable; in fact, a leak of seal, of the pad that closes the test chamber or of the gaskets of the bell jar, towards the external environment, could hide a leak of the component under test; instead, during the vacuum test, any leakage of the test chamber or of the test bell jar towards the external environment.

5.4 OBSTRUCTION TEST

5.4.1 OBSTRUCTION TEST ON FILLING PHASE T1



If T2=0, the measuring time T3 is automatically zeroed and the test cycle terminates immediately at end of time T1: this mode can be used for obstruction tests on the tested component.

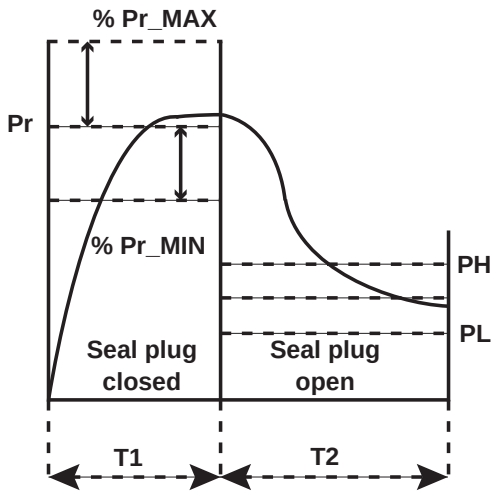
While waiting for a new test, the valves are closed, the output flow is null and the pressure/ inlet vacuum is regulated at the value P0, that must be higher than the pressure/ rated test vacuum Pr.

If the air flow is free without obstructions, through the component under test, then the back pressure/vacuum, which is developed on the output port at end of time T1, shall be within the programmed limits respect to at the nominal value Pr.
Any obstruction increases the back pressure/vacuum and the test result is FAILED if the measured back pressure/vacuum is above the % limit Pr + Pr * Pr_MAX /100.
If the flow rate is instead too high through the component under test or the component itself is not connected, the test result is FAILED if the measured back pressure/vacuum is lower than the % limit Pr - Pr * Pr_MIN/100. By setting the general configuration parameter P_T1_EOST = 1, the test result is evaluated using the parameters PH and PL, expressed not in% of Pr but in numerical value.

By selecting the parameter of the CYCLE = 6 test program, the control of the minimum peak pressure is enabled; this function verifies that at least one pressure reading during the test is lower than the limit programmed in the PL parameter. This function allows you to check that the pressure has been discharged at the end of the previous test.

5.4.2 OBSTRUCTION TEST WITH EXTERNAL SEAL PLUG

The test cycle can be explicitly defined as an obstruction test by setting the parameter CYCLE = 3 in the test program; in this case, the parameters PH (maximum pressure limit) and PL (minimum pressure limit) are enabled; the test cycle include only the times T1 and T2.



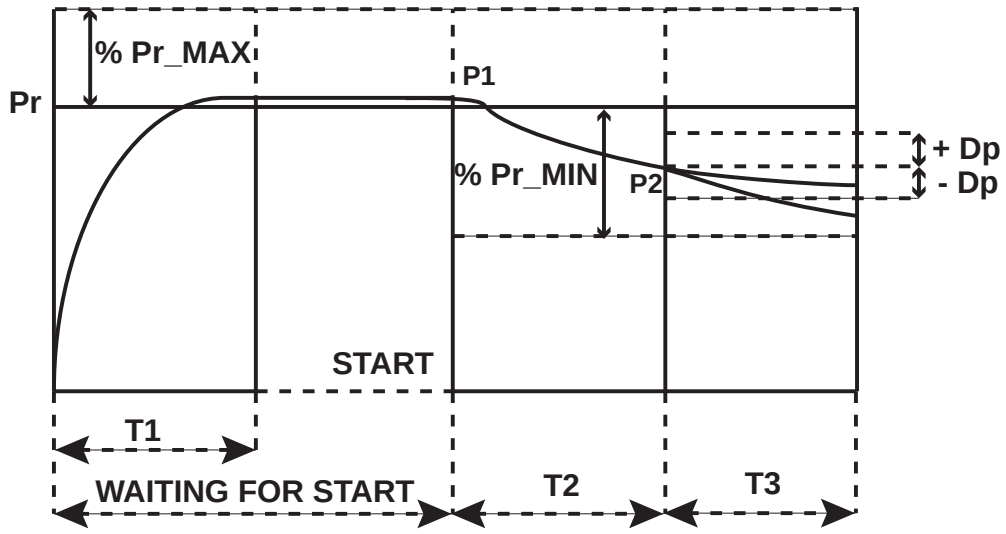
The internal valves are open during time T1 and T2; the component under test must be closed by a plug (zero flow rate) during the filling phase T1; the plug must be instead open during the phase time T2, in order to measure the back pressure developed by the air flow through the component. This method allows to verify the initial pressure Pr, regulated by the pressure reducer, that must be within the maximum limit % Pr_MAX and the minimum limit % Pr_MIN, at the end of T1,with the seal plug closed and zero output flow; otherwise the test is FAILED.

At end of T2, the outcome of the test is FAILED if the back pressure measured is not within the limits PH (maximum pressure) and PL (minimum pressure); the test is PASSED if the pressure is within the limits. The external seal plug can be controlled by an electro valve driven by the signal AUX of the TM3P module.

The test cycle can be programmed as an obstruction test, with the parameter CYCLE = 4 in the test program; in this case during the phase time T2 the internal valves of the equipment are closed.

5.5 LEAK TEST WITH EXTERNAL VALVE

When the configuration parameter VEXT is enabled (external valve connected to the output port) the time T1 is used to fill/discharge the pneumatic circuit up to the external valve VEXT, during the wait time, before the start of a new test.
The pneumatic diagram with an external valve VEXT is described in chapter (2.1).
During time T1, the internal valves are open, while the external valve VEXT is instead closed; then the internal valves are closed at end of T1.
The external valve VEXT is actually opened only when a new start command is received for a new test, that starts directly with the phase time T2.
By selecting the VEXT PH PL option, the test ends in phase T2, the test will end with a PASSED result if the pressure is within the limits programmed in the PH and PL parameters.



Delta TM3P - Pressure leak test with the external valve VEXT

5.6 LEAK TEST WITH VOLUME CONTROL

If an external valve is used, for example the VEXT valve, to separate the filling / discharge volume from the test volume, it is possible to program the test cycle in order to check the volume of the test circuit; this function is useful, for example, to test sealed components inside a test chamber (bell jar).
The pneumatic diagram with external valve VEXT is described in chapter (4.1), the test cycle is described in the previous chapter (5.4).
The volume of the test circuit can be controlled during the settling time T2, measuring the ratio between the pressure/vacuum P1, at the beginning of phase time T2, and the pressure/vacuum P2, at the end of phase time T2.
The volumetric ratio RVP% is calculated as RVP% = (P1/P2)*100; if the calculated RVP% ratio is within the limits programmed in the test program, that is within the range RVP% ± RVP%_MAX, the test cycle proceeds to the phase time T3, otherwise the test cycle terminates with the outcome FAILED RVP %.
If the parameter RVP%_MAX is set to zero, the control of the volumetric ratio at end of T2 is skipped.

5.7 LEAK TEST OF BALL VALVES

The test cycle with control of the volume can be used to test ball valves.
The test cycle starts with the ball valve closed; the inlet chamber of the valve and the output chamber, connected together by an external circuit, are filled/discharged during the phase time T1; if the seats of the ball are leaking, the internal volume of the ball is also filled/discharged, partially or completely.
Subsequently, during the phase time T2, the ball valve is turned open to fill/discharge the internal volume of the ball.
The volumetric ratio RVP%, between the pressure/vacuum P1 measured at the beginning of time T2 (ball valve closed) and the pressure/vacuum P2 measured at end of time T2 (ball valve turned open), allows to check the tightness of the seats of the ball: actually, if the internal volume of the ball was partially or completely filled/discharged during the phase time T1, the ratio RVP% will be less than the programmed value.

Note: For this test, the external valve VEXT is not used and the settling phase T2 is immediately following the filling/discharge phase T1; but closing the internal valves at end of T1 may disturb the measure of pressure/vacuum P1 and therefore also the measure of the volumetric ratio RVP%; for this reason, the measure of the pressure/vacuum P1 is not taken right at the beginning of time T2, but after 0.5 s; the ball valve must stay closed at the beginning of time T2 for at least 0.5 s.

5.8 TEST SEQUENCES

It is possible to create a test sequence by programming the NT table parameter or sending a list to the module directly, up to 12 tables to be executed consecutively.
In both cases, to perform the tests, the start command must be given to the pneumatic module.

5.8.1 NT TABLE PARAMETER

The test table NT parameter can be used to set, at the end of a test, the number of the next test table.
In this way, the operator can program freely a sequence of tests, which will be executed after receiving the start command; the last test of the sequence will be executed with a test table with the parameter NT = 0 or NT = the first table of the sequence.
The NT test table parameter is stored in the module's internal memory and is not lost when the instrument is turned off.

5.8.2 SEQUENCE PROGRAMMING

By writing 13 registers from address 601 of the modbus protocol, up to 12 test tables can be sent to the module in order to create a sequence of tests; register number 13 is used to set sequence options. Each test is performed after receiving a start command and at the end of the last test, the first test table indicated by the sequence is automatically set; this also happens after receiving a reset command from PLC or serial line. At the end of each test, 10 variables containing the test data in the modbus protocol logs starting from 701 (sequencing status variables) are copied, which allows you to always have the results of all the tests in the sequence. Upon receipt of the first start command to start a new sequence, the variables are copied into the registers modbus starting from 901 (last sequence status variables executed) and subsequently reset. Sequence status registers are described in section A2.1. When the module is switched on, all the registers are set to zero and the sequence is disabled. To enable the sequence, you must always write at least once with the modbus 16 and 13 registers.

Sample sequence with 6 test tables without options:

Register	Table number to be executed
601	1
602	5
603	8
604	5
605	125
606	7
607	0
608	0
609	0
610	0
611	0
612	0
613	0 = all disabled options

Sample sequence with 9 test tables with all active options:

Register	Table number to be executed
601	116
602	55
603	235
604	22
605	55
606	88
607	88
608	88
609	12
610	0
611	0
612	0
613	31 : all enabled options

5.8.3 SEQUENCE PROGRAMMING: OPTIONS

Discharge at the end of sequence
By setting the bit 0x0001 of log 613 to one, it is possible to enable forced discharge at the end of the sequence, without evaluating the parameter P_DISCHARGE of the next test table.

Discharge at the end of test with FAILED result
By setting the bit 0x0002 of log 613 to one, it is possible to enable the forced discharge at the end of a FAILED test, without evaluating the parameter P_DISCHARGE of the next test table.

Discharge at the end of the test with PASSED results
By setting one, bit 0x0010 of log 613, you can enable the forced discharge at the end of a PASSED test, without evaluating the P_DISCHARGE parameter of the next test table.

Test table setting in T2 phase

In the case of test pressure setting with proportional valves, you can enable the function to set up the next test table during phase T2, so the proportional valve can set in advance the required pressure value for the next test.
Set one, bit 0x0008 of register 613 to enable option.

Continue the sequence after a failed test

In the case of test systems with more than one instrument involving the use of a single proportional valve to generate test pressure, the instrument connected to the device (PLC, HMI or personal computer) that controls the pressure setting , it is always synchronized with the instruments that are not directly connected to the pressure control system.
Generally in a test sequence, if a test ends FAILED before the end of the sequence, it is interrupted, and then no start commands are given to the instrument. If this occurs on the instrument that controls the pressure regulation, it will no longer be possible to adjust the pressure.
By setting one, bit 0x0004 of register 613, you can enable the function to accept the start command performing a dummy test (only recharging the test times without internal valve movement); in this way it is possible to proceed with the execution of the sequence and with the adjustment of the test pressure in synchrony with the other instruments connected to the test system.

5.9 ALARMS: CAUSES AND REMEDIES

In case of alarm, Start commands are not executed and the test is cancelled with outcome Reject.
Alarms are stored in the FALL variable (register 52 of Modbus protocol).

ATABP Memory error in the selected test program parameters.
Reprogram all parameters in the test program.

APGEN Memory error in the configuration parameters.
Reprogram all configuration parameters.

APCAL Memory error in the pressure transducer calibration parameters.
Perform pressure/vacuum calibration

APFS Pressure out of scale alarm.
Test pressure exceeds 5% above the pressure transducer full scale.Discharge outgoing pressure by disconnecting the component being tested.
If the alarm persists, service is needed.

ACVP Proportional valve alarm.
The proportional valve is configured but the communication is not active. Check the electrical connections.

WARNING: The operator must ensure that test pressure adjustment does not exceed the instrument's full scale value, in order to avoid full scale alarms and damage to the pressure transducer.

6 TEST PROGRAMS

The instrument features 300 test programs; each test program contains the following parameters for the test cycles.

Test program in running
At the start command of each test, the enabled test program is extracted from the program file and is copied to a service program together with some general configuration parameters (test program number, test phase type, vacuum scale, test time scale); the service program remains unchanged for all the testing in running.

T1 **Filling/discharge time**
Programming range: 0.0 ÷ 2999.9 s, resolution: 0.1 s.
If T1=0, filling/discharge is external and testing begins directly from the settling phase.

T2 **Settling time**
Programming range: 0.0 ÷ 2999.9 s, resolution: 0.1 s.
If T2 = 0, also T3 is assumed equal to zero (obstruction test).

T3 **Measurement time**
Programming range: 0.0 ÷ 2999.9 s, resolution: 0.1 s.

Pr **Pressure / nominal test vacuum**
Test pressure can be programmed within the pressure transducer full scale.
The external pressure reducer must be adjusted to the programmed test pressure; the scale for parameters and pressure measurements is set in the configuration parameters; programming range:

The external vacuum generator must be adjusted to the programmed test vacuum; the measurement scale for the vacuum reading and for the test parameters is set in the configuration parameters; programming range:

	TM3PN
cmH2O	0 ÷ 1020
mbar	0 ÷ 1000
kPa	0.0 ÷ 100.0
mmHg	0 ÷ 750
PSI	0.0 ÷ 14.5
inH2O	0 ÷ 401

	TM3P05 (500 mbar f.s.)	TM3P2 (2 bar f.s.)	TM3P6 (6 bar f.s.)	TM3P10 (10 bar f.s.)
	0 ÷ 509.89 (mmH2O)	0 ÷ 2040 (cmH2O)	0 ÷ 6119 (cmH2O)	0 ÷ 10198 (cmH2O)
mbar	0 ÷ 500.00	0 ÷ 2000	0 ÷ 6000	0 ÷ 10000
kPa	0.0 ÷ 50.000	0.0 ÷ 200.0	0.0 ÷ 600.0	0.0 ÷ 1000.0
mmHg	0 ÷ 375.00	0 ÷ 1500	0 ÷ 4500	0 ÷ 7500
PSI	0.0 ÷ 7.250	0.0 ÷ 29.0	0.0 ÷ 87.0	0.0 ÷ 145.0
inH2O	0 ÷ 20.07	0 ÷ 802	0 ÷ 2408	0 ÷ 4014

	TM3P20 (20 bar f.s.)
cmH2O	0 ÷ 20395
mbar	0 ÷ 20000
kPa	0.0 ÷ 2000.0
mmHg	0 ÷ 15000
PSI	0.0 ÷ 290.0
inH2O	0 ÷ 8028

Dp **Leak limit**

Maximum pressure / vacuum difference acceptable for measuring time T3. This parameter is unsigned and applied as an absolute value both for pressure/vacuum drops (leaks), with negative sign, and pressure/vacuum increases (anomalies), with positive sign.The scale for parameters and pressure/vacuum measurements is set in the configuration parameters; programming range:

	TM3PN risolution 1 Pascal	TM3PN risolution 0.1 Pascal
mmH2O	0.0 ÷ 1999.9	0.00 ÷ 199.99
mbar	0.00 ÷ 196.12	0.000 ÷ 19.612
kPa	0.000 ÷ 19.612	0.0000 ÷ 1.9612
mmHg	0.00 ÷ 147.09	0.000 ÷ 14.709
PSI	0.000 ÷ 2.844	0.0000 ÷ 0.2844
inH2O	0.00 ÷ 78.73	0.000 ÷ 7.873

	TM3P05 (0.5 bar f.s.) risolution 0.1 Pascal	**TM3P2 (2bar f.s.) risolution 1 Pascal**	**TM3P2 (2bar f.s.) risolution 0.1 Pascal**	**TM3P6 (6 bar f.s.) risolution 1 Pascal**	**TM3P10 (10 bar f.s.) risolution 1 Pascal**
mmH2O	0.00÷199.99	0.0 ÷1999.9	0.00 ÷199.99	0.0÷1999.9	0 ÷1999.9
mbar	0.000÷19.612	0.00 ÷196.12	0.000÷19.612	0.00÷196.12	0.0÷196.12
kPa	0.0000÷1.9612	0.000÷19.612	0.0000÷1.9612	0.000÷19.612	0.00 ÷19.612
mmHg	0.000÷14.709	0.00÷147.09	0.000÷14.709	0.00÷147.09	0.0 ÷147.09
PSI	0.0000÷0.2844	0.000÷2.844	0.0000÷0.2844	0.000÷2.844	0.00÷2.844
inH2O	0.000 ÷7.873	0.00 ÷78.73	0.000 ÷7.873	0.00 ÷78.73	0.0÷78.73

	TM3P20 (20 bar f.s.) risolution 1 Pascal
mmH2O	0.0 ÷ 1999.9
mbar	0.00 ÷ 196.12
kPa	0.000 ÷ 19.612
mmHg	0.00 ÷ 147.09
PSI	0.000 ÷ 2.844
inH2O	0.00 ÷ 78.73

Pr_MAX **Maximum test pressure tolerance % limit**
Programming range: 0:99 % (TM3P05-2-6-10)
Programming range: 1:99 % (TM3PN - TM3P20)
If the pressure / vacuum exceeds the value of the nominal pressure / vacuum Pr beyond the tolerance limit%, the test ends in failed for Max. Pressure / vacuum error. If the parameter is set to 0, limit control is disabled.

Pr_MIN **Minimum test pressure tolerance % limit**
Programming range: 0:99 % (TM3P05-2-6-10)
Programming range: 1:99 % (TM3PN - TM3P20)
If during settling time T2 or measurement time T3 pressure/vacuum drops below the programmed nominal pressure Pr by more than tolerance limit % , the test ends with outcome FAILED specifying Min pressure/vacuum error.
If the parameter is set to 0, limit control is disabled.

RVP% **Volumetric coefficient,** for the ratio% between the volumes of the pneumatic test circuit; Programming range: 100.0 : 649.99 %.
RVP% = (filling/discharge volume + test volume)/ filling/discharge volume.
In the filling / discharge phase T1, the pressure/vacuum of filling/ discharge must correspond to the value P = PR * (RVP% / 100).
Example: PR= 1000 mbar, RVP%=140.00; the regulated pressure for the filling phase T1 is P= 1000 * (140.00/100) = 1400 mbar.
The filling pressure is limited to the full scale value of the instrument, therefore, if the volumetric ratio is very unfavorable, and the test pressure PR is high, it may happen that the filling pressure is limited to the full scale.
Example: at 2 bar full scale range and RVP%=400.00, it must be PR < 500 mbar.
To stay within the full scale limit, the filling volume should be increased (adding a volume on the TEST output port, for example by increasing the length or the diameter of the tube between the output TEST port and the external valve VEXT).

Example: PR = -200 mbar, RVP% = 140.00; vacuum expected in discharge in phase T1: P = -200 * (140.00 / 100) = -280 mbar.
If the volumetric ratio is very high, and also the test vacuum PR is high, it may happen that the vacuum required in discharge is greater than the vacuum actually available from the external supply.

Example: with RVP% = 400.00, PR = -250 mbar, the vacuum available from the external power supply must be -1000 mbar.
To reduce the vacuum required at the external supply, it is necessary to increase the discharge volume (add a volume to the test output, for example by increasing the length or diameter of the tube between the test output and the external VEXT valve).

RVP%MAX **Maximum tolerance +/-%,** on the RVP% coefficient:
range 0.00 : 50.00 %.
If the parameter RVP%MAX is null, the volumetric control at end of T2 is skipped.
The volumetric ratio RVP% is calculated at every test at the end of the settling phase time T2, as the ratio between the pressure/ vacuum P1 measured at the beginning of the phase, and the pressure/vacuum P2 measured at end of phase.
The calculated coefficient RVP% = (P1 / P2) * 100 must be within the tolerance limits RVP% +/- RVP% MAX.
The test ends with the result RVP% failed if the calculated coefficient does not remain within the tolerance limit RVP% MAX with respect to the programmed value; the test continues to the measurement phase T3 if the volume control is passed.

CYCLE **Test cycle phases**
0 =T1-T2-T3, the filling/discharge phase is terminated at the end of time T1;
1 =Pr/T1-T2-T3, the filling/discharge phase is terminated as soon as the nominal test pressure/vacuum PR is reached or at the end of time T1;
2 = VEXT, external valve, test cycle with phases T2-T3; the filling / discharge of the pneumatic circuit up to the external VEXT valve is carried out while waiting for START (internal valves open for the programmed time T1 waiting for the next test);
3= OBSTRUCTION, obstruction test, with external seal plug.
4 = VC OBSTRUCTION, obstruction test with valves closed in T2.
5 = VEXT PH-PL, external valve, test cycle with phase T2; the filling / discharge of the pneumatic circuit up to the external VEXT valve is performed in the START waiting phase (internal valves open for the programmed time T1 waiting for the next test); the test result is evaluated based on the parameters PH ePL.
6 = MIN CP OBSTRUCTION, obstruction test with minimum pressure control; at least one pressure reading must be below the minimum PH limit.
(Test steps 3-4-5-6 not available for TM3PN)

7 = VEXT / T1-T2-T3, three-teps leak test with external 3-way valve. When the start command is received, the internal valves remain closed until the pressure drop due to the opening of the external valve is detected, higher than the value programmed in PH.

CV **Volumetric coefficient for the leak flow rate Q**
If the volumetric coefficient CV is programmed, different from zero, the instrument calculates the leak flow rate Q, expressed as cm3/min, that corresponds to the pressure decay measured during the T3 time.

DISCHARGE Discharge valve opening at the end of the test
0 = NO, the internal valves are not opened to discharge pressure at end of test;
1 = SI, the internal valves are opened to discharge pressure at end of test (energized for 10 s.);
2 = Manual discharge (only for TM3PN, TM3P05,TM3P2 and TM3P6).
3 = Always, the valves open in discharge at the end of the test and are always energized (TM3P05,TM3P2, TM3P6, TM3P10);
If Phase = 7, the parameter is not evaluated and the discharge is never performed.

PH **Obstruction test with external plug: maximum pressure limit**
Programming range: as the parameter Pr (test pressure).
If the back pressure developed at the end of time T2 by the air flow through the component under test is higher than the limit PH, the test ends up with an outcome FAILED and the indication Max pressure error.
If Phase = 7, its meaning is the DELTA VEXT limit to detect the opening of the external valve.

PL **Obstruction test with external plug: minimum pressure limit**
Programming range: as the parameter Pr (test pressure).
If the back pressure developed at the end of time T2 by the air flow through the component under test is lower than the limit PL, the test ends up with an outcome FAILED and the indication Min. pressure error.

NT **Next test program**:
Programming range: 0-300.
At the end of the test, the NT value is saved in the P_NTAB configuration parameter: in this way it is possible to automatically change the test program for the next test and to execute programmed test sequences.
If NT = 0, the configuration parameter P_NTAB is not updated and the same test program will always be executed at the next start command.
If NT = 300 and the module has the option RS (for connection to a proportional valve), the filling in phase T1 will be executed in linear ramp mode.

NOTE: Manual discharge
The Manual discharge option is useful to reduce the possibility of an error by an operator who manually connects the components to be tested and disconnects the components already tested.
If the instrument keeps the result Passed of the last test, when the operator disconnects the tested component the green light Passed remains on. Subsequently, if the operator connects a new component to be tested, but does not immediately give a new Start command and is distracted, it can then be misled, considering the component that sees connected to the instrument as already tested with a Passed result.
In manual discharge, on the other hand, the valves open in discharge at the end of the test only if the result is failed, but remain closed if the result is passed; subsequently, when the operator removes the component under test and the pressure is discharged below 50% of the final test pressure / vacuum, the valves open in the discharge and the instrument goes into Standby phase, with failed output.

In this way, the operator can connect a new component, still to be tested, only with red light on and active failed output.

NOTE: Program of the last test performed
At the end of the test, the service program is saved together with the test results and is available for data collection of the last test performed.

NOTE: Program of the last test performed
At the start command of each test, the enabled test program is extracted from the program file archive and is copied to a service program together with some general configuration parameters (test program number, test phase type, pressure scale, test time scale).
The service program remains unchanged for all the testing in progress.

7 CONFIGURATION

7.1 CONFIGURATION PARAMETERS OF THE TEST CYCLE

The following configuration parameters are applied to all tests for each test program. At the start of each test, some parameters (test program number, test phases type, pressure/vacuum scale, test time scale) are copied into a service program together with the test parameters program.

P_QOUT	Digital output activation mode: 0=PLC; 1=Semaphore In PLC mode, active outputs are fixed; in Semaphore mode, Passed/Failed/Alarm (Buzzer) outputs are intermittent.
P_NTAB	Test program number selection, range: 1-300
P_NTABX	0 = not used, RESET/TAB input used as reset; 1:300 = alternative test program selected with RESET/TAB input active.
P_SCALA	Pressure/vacuum unit: 0=mmH2O, 1=mbar, 2=kPa, 3=mmHg, 4=PSI, 5=inH2O
P_SCALA_F	leak flow rate unit (fixed): 0=cm³/min
P_TP_MODBUS	Type of Modbus protocol on the RS485 serial line. This parameter is available only for TM3P2 and TM3P6 modules and can be configured only using the USB serial port. 0 = TM3P, standard Modbus protocol for the TM3P modules. 1 = Delta Rack, Modbus protocol emulation of Delta Rack Plus modules

P_TP_TARA	0 = MANUAL, tare executed by the operator by command on a serial line from the operator panel, Personal Computer or PLC; the parameter P_SCARICO must be enabled; the tare is accepted only for values within max. ± 10 mbar (TM3PN - TM3P2-6-10 - TM3P20) and ± 5 mbar (TM3P05). 1 = AUTOMATIC, tare automatically performed by the module when not in test; the parameter P_SCARICO must be enabled; the drain valve is always activated; the tare is accepted only for values within max. ± 10 mbar for models TM3PN, TM3P2-6-10, TM3P20 and max ± 5 mbar for model TM3P05. If the test table parameter Phase = 7, the tare is never executed.
P_TIPO_VP	Proportional valve model connected to the module: 0 = NOT USED, 1 = SMC ITV1050, 2 = SMC ITV1010, 3 = MW REGT 10B
P_RP%	Pressure regulation coefficient : Regulated pressure = (Pr * P_RP %) / 100.0 . Programming range = 50.0 : 150.0 %
P_RIS_PRESS	Pressure resolution (model TM3P2 only): 0 = 1 Pascal; 1 = 0.1 Pascal
P_T1_TOLLMAX	Enables or disables control of the maximum tolerance limit% max during the T1 filling phase. 0 = DISABLE 1 = ENABLE
P_T1_EOST	Type of parameter to use for evaluate result of the obstruction test in the only T1 phase. 0 = Tolerances % 1 = Parameters PH and PL, in numerical value.
P_T_UD4	Type of the digital output 4. 0 = ESTERNAL VALVE. 1 = ALLARM.
P_RIS_CV	Resolution with which to calculate the volumetric CV coefficient and conversion of the leak in flow. 0 = low; from 0.01 to 600.00 cm^3/min; 1 = high; from 0.001 to 60.000 cm^3/min;
P_OFFSET_DP	Value to be applied to the delta measured during the T3 measurement phase.

7.2 PRESSURE/VACUUM TARE

The tare of pressure removes the reading drifts at zero pressure (offset), after power on the equipment.
The tare must be executed only at true zero pressure, with the output test port free in ambient air; the command for a new tare is accepted only if no test is running and if the pressure offset is within +/- 10 mbar (+/- 5 mbar for TM3P05 model); larger offsets can only be calibrated in the calibration adjustment menu.

NOTE: To perform the tare command, the configuration parameter P_SCARICO must be enabled.

7.3 COMMUNICATION LINES

Delta TM3P modules have two serial communication lines: USB and RS485; both lines use the same Modbus RTU for data exchange.

7.3.1 COM1: USB SERIAL LINE

Configuration parameters for USB serial line connection.

P_ILSER1	COM1, address of serial line node 1 (USB) preset address = 33; the module answers to address 33 and also to the address programmed for RS485 serial line COM 2. To connect a PC to several modules in parallel, use a USB hub.
P_TLS1	COM1, serial line 1 type, preset = 0 (interface: USB)
P_PRT1	COM1, serial line 1 communication protocol. 0 = Modbus RTU; 1 = Modbus RTU + Sending data for testing in CSV format at the end of the test (See the manual TM3PXX_CSV_ENG.pdf included in the USB pendrive)
P_BR1	COM1, serial line 1 baud rate, preset = 115200;
P_PRT1	COM1, serial line 1 parity (USB), preset = 0, not used;
P_SB1	COM1, serial line 1 stop bit (USB), preset = 1;

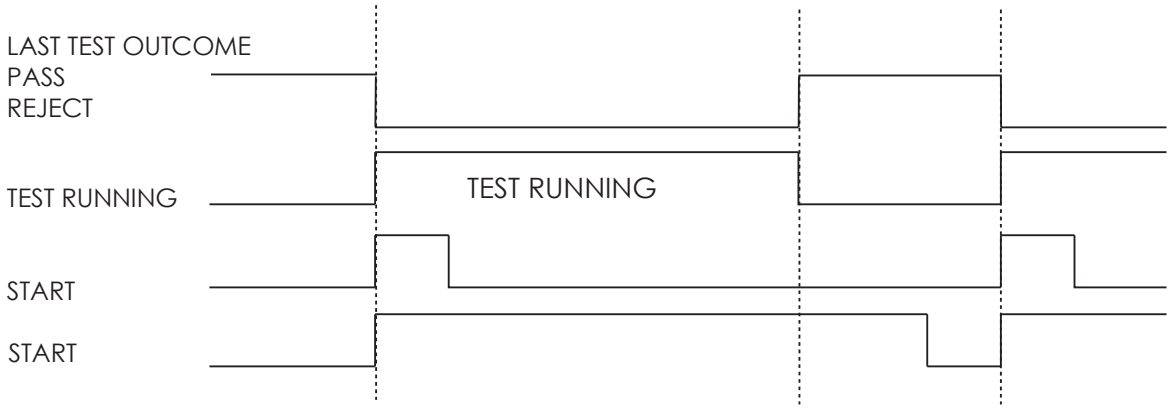
7.3.2 COM 2: RS485 SERIAL LINE

Connection configuration parameters for RS485 serial line.

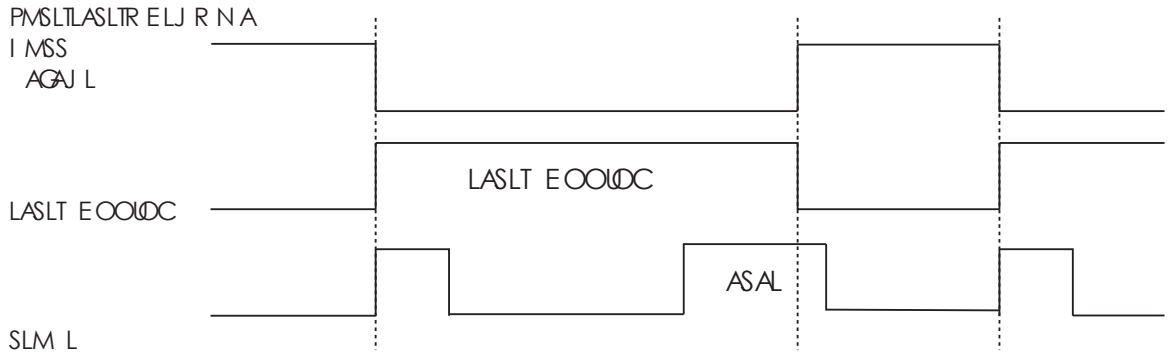
P_ILSER2	COM2, address of serial line node 2 (RS485), programmable, range 1-16 16 modules can be connected on the same serial line. If you do not know the address of the COM2 line, you can use the line COM1 (USB) to read or modify module parameters, including the address of the COM2 line.
P_TLS2	COM2, serial line 2 type, preset = 1 (RS485);
P_PRT2	COM2, serial line 2 communication protocol, preset = 0 (Modbus RTU);
P_BR2	COM2, serial line 2 baud rate, programmable: 0=4800, 1=9600, 2=19200, 3=38400, 4=56000, 5=57600, 6=115200
P_PRT2	COM2, serial line 2 parity (RS485), programmable: 0=none, 1=odd, 2=even
P_SB2	COM2, serial line 2 stop bit (RS485), programmable: 0=0.5 stop bits, 1, 2, 3=1.5 stop bits

8 START/RESET PLC CONTROLS

PLC signal sequence



A new “START” command is accepted only if the former has been switched to low state. In the graph, the second START pulse is maintained for the duration of the test, but is performed only after being set low and then high again.



The current test run may be cancelled directly with the RESET/TAB input, if enabled as Reset function, or by repeating the START command with a pulse of at least 1 second.

9 LEAK FLOW RATE Q (cm3/min)

The test results, PASSED or FAILED, are calculated with respect to the pressure/ vacuum variation measured during the phase time T3, compared with the programmed leak limit DP of the selected test program.
It is generally preferable, and in some cases expressly required, that the leak flow rate is programmed and measured in flow units of measure cm³/min or cm³/h.
The leak flow rate equivalent to a pressure variation can be calculated knowing the volume of the pneumatic test circuit, which includes the volume of the component under test, the internal volume of the instrument and the volume of the connecting pipes.
The leak flow rate Q is calculated using a formula which is based on the known physical laws for perfect gases, considering the pressure change(ΔP) during the phase time T3 and the volume of the test circuit, at the nominal temperature of 27 °C (about 300 °K).

$$Q_{cm^3/min} = \frac{0.27}{Temperature_{\,°K}} * \frac{\Delta P_{mbar} * Volume_{cm^3}}{TimeT3_{\,min}}$$

Example, for a test temperature of 27 °C (about 300 °K):
pressure drop (ΔP) = 35 Pa (0.35 mbar), volume 31.2 cm3, T3 = 5 s = 5/60 minutes,
Q= (0.27/ 300) * (0.35 * 31.2) * 60/ 5 = (1/ 1111) * (0.35 * 31.2) * 60/5 = 0.11 cm³/min.

For a standard test temperature of 0 °C (273.15 K), the result is instead:
pressure drop (ΔP) = 35 Pa (0.35 mbar), volume 31.7 cm³, T3 = 5 s = 5/60 minutes,
Q= (0.27/ 273.15) * (0.35 * 31.2) * 60/ 5 = (1/ 1013) * (0.35 * 31.2) * 60/5 = 0.13 cm³/min.

While the formula is for perfect gases, at a specified temperature, the actual relationship between pressure variations and leak rates is influenced by many physical factors, mainly the mechanical dilatations and temperatures changes of the air inside the test circuit.
For this reason, the correct value that should be used for the calculus is not the geometrical real volume of the test circuit but an equivalent volumetric coefficient, that can be programmed as a parameter in the test program (parameter CV).
It is preferable to experimentally determine the value of the CV volumetric coefficient using a calibrated sample leak, to be connected to the test circuit.

The picture shoes a leak master , with STAUBLI coupling, type RBE 03.
Quick couplings, with valve seals, are available to be mounted on the external pneumatic test circuit, for the quick insertion of a leak master.
A leak master must always be certified for a specified leak flow rate Q (cm³/min) at a specified test pressure.

In order to determine the volumetric coefficient CV, the test must be performed on a good component, without leaks, with a specified leak master inserted in the test circuit, for example on the connection tube, with a quick coupling.
The procedure can be management by the operator terminal or PC, with Modbus protocol commands on serial line:

- write to the register 112 the value 2, enables the calculation function without the leak master inserted;
- start a test;
- at the end of the test, the TM3P module measures and stores the value of the pressure leak;
- write to the register 113 the value Q of the leak master (cm³/min);
- write to the register 112 the value 1 (enables the calculation and updating function of the CV parameter at the end of the test);
- start a test;
- at the end of the test, the TM3P module automatically calculates and updates the CV parameter of the active test program, using for the calculation the measured leak (pressure drop ΔPmbar = ΔPmbar second test - ΔPmbar first test), the Q value of the leak master, the phase time T3 of the test program
- write to the register 112 the value 0 (disable the function).
  The volumetric coefficient CV is calculated with the previous formula, exchanging the terms:

$$CV = Volume_{cm^3} = \frac{Temperature_{°K}}{0.27} * \frac{Q_{cm^3/min} * TimeT3_{min}}{\Delta P_{mbar}}$$

The temperature is by default assumed to be about 27 °C (300 °K).
The volume calculated with the formula can be used as the volumetric coefficient CV, but only for tests performed on components of the same type and tested with the same test program.
When the volumetric coefficient has been updated, repeat a test with the leak master to check the correspondence between the the nominal value of the leak master and the outcome of the test.

If the parameter CV is not zero, the instrument will automatically calculate, at the end of each test, the leak flow rate Q which is equivalent to the measured pressure drop (ΔP) in the test time T3; the calculated leak flow rate will be available to the operator terminal on the serial line (register 60 of the Modbus protocol).

WARNING: If the test program is changed, modifying the parameter pressure/vacuum of test Pr or the phase times T1,T2,T3, the volumetric coefficient CV must be measured again and updated.

NOTE: The procedure to measure and update the volumetric coefficient CV with serial line commands is available on the operator terminals offered by Tecna Srl.

NOTE: Leak simulator LTC (Leak tester control).
A leak master is certified for a single flow rate value at a single specified test pressure; for general applications, it is preferable to use a leak simulator, for example the model Leak Tester Control (LTC) by Tecna srl, which allows to simulate leaks with adjustable flow and pressure / vacuum values

NOTE The same formula, in reverse mode, can be used to calculate the pressure drop (ΔP) which is equivalent to a given leak flow rate Q.

$$\Delta P_{mbar} = \frac{Temperature_{°K}}{0.27} * \frac{Q_{cm^3/min} * TimeT3_{min}}{Volume^3_{cm}}$$

10 PRESSURE CALIBRATION

Delta TM3P modules have serial line controls for zero calibration and pressure transducer gain.

WARNING: A wrong calibration of the pressure transducer can compromise the operation of the instrument and the validity of test results.
Verify the correct calibration of the pressure sensor at least once a year, repeating the calibration procedure if necessary.
Calibration of the pressure sensor should only be performed by qualified personnel with certified calibration instruments.

Tecna srl provides a scheduled calibration service.

Enabling the calibration procedure
Calibration cannot be performed while testing.
To enable calibration, send value 1 to register 120 via serial line.

Connection to a certified reference pressure gauge and to a stable pressure source.
Connect to the outlet fitting an accuracy-certified digital pressure gauge with at least 0.1% accuracy of the pressure transducer full scale.
During the calibration procedure, pneumatic valves are closed, so you cannot use the pressure regulator/vacuum generator in inlet for pressure/vacuum of test
Connect a controlled source of compressed air / vacuum to the outlet fitting, parallel to the digital pressure gauge.
To generate sample pressure/vacuum, we recommend using a hand pump with fine adjustment screw, but you can also use a precision adjustable pressure regulator/vacuum generator connected to the compressed air line, as long as it is stable.

WARNING: During sensor calibration, do not apply a pressure higher than equipment full scale, to avoid damaging the sensor.

NOTE: After starting up the instrument, wait about 10 minutes to stabilize thermal drift, before calibrating the equipment.

Zero calibration
The transducer zero refers to the ambient pressure.
Let the outlet connector free, at ambient pressure.
Send value 1 to register 121 via serial line (zero calibration command).
The reading of the A/D converter is stored as a zero calibration parameter, which can be read from the serial line at registers 251 and 252.

Gain calibration
The gain of the pressure transducer refers to a sample value / vacuum, which must be sent to register 124.
With the compressed air source, generate on the outlet fitting the desired reference pressure/vacuum, normally about 2/3 of full scale.
Read on the certified digital pressure gauge the generated sample pressure/vacuum and send the value to register 124.

Send value 1 to register 122 via serial line (gain calibration command).
Zero calibration value is subtracted from the A/D converter reading and the difference is stored as gain calibration parameter, which can be read via serial line on registers 253 and 254.

Disabling the calibration procedure
Calibration is disabled by sending value 0 to register 120 via serial line.
A Start command for a new test or a Reset command disable calibration.

11 TECHNICAL SPECIFICATIONS

Power Supply	24Vcc, +/- 10%, 1A max
Fuse	Internal self resetting fuse, 1A; PLC outputs protected against short circuits.
Compressed air line	20 bar max, dry air, without condensate, filtered, not lubricated and free from explosive gases, conforming to ISO 8573-1 air quality; TM3PN - TM3P05-2-6-10 tube connector 4x2 mm for pilot valve driving; tube connector 6x4 mm for test pressure. TM3P20 connection with compression fitting for 6x4 mm pipe.
Environment	Temperature 5 ÷ 50 °C Relative humidity 80% RH max Ambient pressure 700 hPa ÷ 1100 hPa
Sensor calibration	Guided procedure with external master instruments
A/D converter	24 bit
Test pressure	Regulated by an pressure reducer/external vacuum generator, with 6x4 mm tube fitting. **TM3PN**: full scale - 1000 mbar class 0.5 % FS, resolution up to 0.01 mmH2O (0.001 mbar, 0.1Pa); **TM3P05**: full scale 500 mbar, class 0.5 %FS, resolution 0.01 mmH2O (0.001 mbar, 0.1Pa); **TM3P2**: full scale 2 bar, class 0.5 % FS, programmable resolution: minimum: 0.1 mmH2O (0.01 mbar, 1Pa); maximum: 0.01 mmH2O (0.001 mbar, 0.1Pa). **TM3P6**: full scale 6 bar, class 0.5 % FS, resolution 0.1 mmH2O (0.01 mbar, 1Pa); **TM3P10**: full scale 10 bar, class 0.5 % FS, resolution 0.1 mmH2O (0.01 mbar, 1Pa). **TM3P20**: full scale 20 bar, class 0.5 % FS, resolution 0.1 mmH2O (0.01 mbar, 1Pa).

Indicators	Two yellow Leds (test cycle phases), green LED, red LED
Test programs	300 test programs, with parameters in non-volatile memory
Test counter	PASSED and FAILED counts, in non-volatile memory
Clock/calendar	Accessible through serial line, available for data collection with test time/date indication Back power with a supercapacitor, for 7 days autonomy.
PLC connections	2 PNP photocoupled inputs, 5 mA max START: test start RESET/TAB: test reset or select second test program 4 PNP photocoupled outputs, 0.7 A max PASSED, FAILED, TEST RUNNING, *ALARM
Serial lines	COM1, USB device, serial, optoisolated, Modbus RTU protocol COM2, RS485 serial, optoisolated, Modbus RTU protocol
Housing	Aluminium
Protection class	IP40
Dimensions	TM3PN-TM3P05-2-6-10 L 75 x H 80 x P 120 mm TM3P20 L 100 x H 100 x P 130 mm
Weight	TM3PN-TM3P05-2-6-10 kg 1,0 TM3P20 Kg 1,50

PACKING LIST

The package of the TM3P pneumatic module contains:

1x TM3P instrument;

1x Operator's manual;

1x Pressure sensor calibration certificate;

1x USB pendrive with communication drivers and configuration program for PC (Windows XP/Vista/Seven/8/10) for connecting to your TM3P module;

1x USB cable for connecting to a PC;

1x Extractable connector, 8 pins, 3.5 pitch, for connecting to PLC input/ output/power supply (see chapter 3.2);

1x Extractable connector, 3 pins, 3.5 pitch, for connecting to RS485 serial line (see chapter 3.2);

WARRANTY TECNA SRL

This warranty is valid for contracts between Tecna Srl and companies and/or professionals holding VAT number (B2B) and only for the Client to whom the transport document (DDT or accompanying invoice) is issued by Tecna Srl.
Tecna Srl warrants its products for12 (twelve) months from the date of delivery against manufacturing defects and defective components. The delivery date shall be that of the transport document (DDT or the accompanying invoice) issued by Tecna Srl at the time of delivery to the customer or to the carrier in-charge for the delivery. The terms of this warranty do NOT apply to the sale of the spare parts and/or consumables which are subject to wear and tear.
The initial time period of the warranty of the whole instrument implies the end of the warranty even for all the parts eventually replaced during the warranty period, regardless of the time of implementation.
Only Tecna Srl is authorized to perform repairs on the instruments under warranty: intervention by an unauthorized personnel, as well as tampering to the warranty seal, shall terminate the said warranty.
Warranty repairs shall be carried out in the Headquarters of Tecna Srl.
Any requests for repairs on the customer's site shall be evaluated by Tecna Srl each time, and, in case of acceptance of the request, the transfer expenses (travel hour tariff, travel costs and out of office costs, call fee) shall be invoiced according to the current pricelist.
During the warranty period, parts and/or components that are not correctly functioning due to manufacturing defects, defective components and/or improper assembly of parts shall be replaced or repaired free of charge.
The evaluation on whether to proceed with a replacement or a repair is the sole responsibility of Tecna Srl.
The hours of work required for warranty service will also be provided free of charge.

The customer, following a written authorization by Tecna Srl, will have to deliver the equipment properly packed in its original packaging, to the courier sent by Tecna Srl for pick-up. The freight will be paid by Tecna Srl but will be charged back to the customer, if the necessary maintenance does not fall within the terms of this warranty.

The following are always excluded from the warranty:
- consumable parts that are subject to wear and tear or which may require replacement due to the normal use of the instrument during the warranty period such as, but not limited to: valves and/or their valve stems, pressure and/or flux sensors, dirt filters, printer ribbons, batteries etc.;

- damages caused by transport, due to wrong or improper installation, improper handling, carelessness or incapability to use, tampering by unauthorized persons and any other cause not dependent on Tecna Srl;
- damages arising from the use of the instrument in environmental conditions outside the specifications indicated;
- damages arising from the use of unfiltered, moist and not deoiled compressed air (where required);
- damages arising from the use of the instrument without the air filter (where required) mounted at the entrance of the compressed air, or with a dirty and/or worn-out filter;
- damages arising due to accidents or unforeseeable incidents, such as, but not limited to: fire, flood, earthquake, weather events (e.g. lightning), strikes, acts of vandalism, riots, unrests, thefts etc.;
- damages or malfunctions due to irregularities or anomalies in the mains supply (blackouts, power surges interference, etc.) or any other local power equipment;
- damages resulting from the misuse, repairs or maintenance activities performed by unauthorized personnel or use of non-original materials, damages due to use of corrosive materials for cleaning or otherwise that may damage the mechanical, electrical or electronic parts;
- damages or malfunctions caused by the installation of programs, software or operating systems or parts thereof or virus attacks that may damage or interfere with the operation of the operating system and software management of the instrument, in particular but not limited to installation via USB sticks, ethernet network or through other interconnecting systems;
- in general, all the damages that may be caused by the Customer or personnel authorized by him to operate the instrument, that is due to incorrect use of the instrument and/or against the instructions received or written in the instruction manual supplied with the instrument.

In all the above cases, the warranty does not apply and the repairs arising from such damages shall be quantified and billed according to the current tariffs. The applicability or otherwise of the warranty is the sole responsibility of Tecna Srl. Tecna Srl is not liable for eventual costs or damages caused by the machine downtime and is not liable for any direct or indirect damages resulting from the incorrect functioning of the supplied products or their use.
For any dispute that should arise in connection with the execution or interpretation of this warranty the court of Modena shall be exclusively competent. The applicable law shall be the Italian law.

Rev. 01/01/2015

Tecna Srl

USER INFORMATION EUROPEAN DIRECTIVE 2012/19/UE

This product conforms to European Directive 2012/19/UE.
This appliance bears the symbol of the barred waste bin. This indicates that, at the end of its useful life, it must not be disposed of as domestic waste, but must be taken to a collection center for waste electrical and electronic equipment, or returned to a retailer on purchase of a replacement.
It is the user's responsibility to dispose of this appliance through the appropriate channels at the end of its useful life.
Proper differential collection, and the subsequent recycling, processing and environmentally compatible disposal of waste equipment avoids unnecessary damage to the environment and possible related health risks, and also promotes recycling of the materials used in the appliance.