ANALYT MESSTECHNIK



OPERATING MANUAL

Aalborg DPC Digital Mass Flow Controller

Installation, wiring, operation, alarms, totalisers, serial commands and maintenance of the Aalborg DPC digital mass flow controller.

AMTC-MN-0009

Rev. 2 · October 2026

About this manual

This manual is for everyone who installs, operates or maintains an Aalborg DPC digital mass flow controller: plumbing and wiring it, giving set points, selecting the gas, setting up alarms and totalisers, controlling it from a computer or programmable logic controller (PLC), and keeping it in calibration.

If the controller is new to you, read Safety (p. 7), Installation (p. 12) and Electrical connections (p. 14) first, then follow First power-up (p. 18). If you control the controller over its serial interface, Communication (p. 33) lists every command.

The display with joystick, the Modbus interface and the interface type are options recorded with your order. Sections that apply only to an option or to some models say so.

Keep this manual for the lifetime of the product. The current revision is on the product page at analyt-mtc.com.

Conventions in this manual:

- Keys, buttons and menu entries are printed like this: **Esc**.
- A menu path such as **General Settings** › **Valve Parameters** › **Set Point Source** means that you open each entry in turn.
- Commands you send and replies the device returns are set in monospace type, for example `Z`, `N`.

Abbreviations

Abbreviation	Meaning
ADC	Analogue-to-digital converter
ASCII	American Standard Code for Information Interchange
AWG	American Wire Gauge, the US wire size scale
CPU	Central processing unit
CRC	Cyclic redundancy check
EEPROM	Electrically erasable programmable read-only memory
FKM	Fluoroelastomer
LPG	Liquefied petroleum gas
NPT	National Pipe Taper, the US tapered pipe thread
NTP	Normal temperature and pressure (normal conditions)
OLED	Organic light-emitting diode
PI	Process information (display screens)
PID	Proportional, integral, derivative (control)
RTS	Request to send, a serial handshake line
RTU	Remote terminal unit (Modbus transmission mode)
sccs	Standard cubic centimetres per second, a leak rate unit
SPST	Single-pole, single-throw (one make contact)
STP	Standard temperature and pressure (standard conditions)
TD	Transmit data, a serial line
UART	Universal asynchronous receiver-transmitter, the serial interface chip

Abbreviation	Meaning
UNC	Unified National Coarse, the US coarse screw thread
UNF	Unified National Fine, the US fine screw thread

Safety notices in this manual

⚠ WARNING

A hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

A hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Practices not related to personal injury — damage to the product, the process or the sample.

Note
Information that helps understanding; never a hazard.

Document information

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CHAPTER 1

Safety

Read this chapter before you connect gas or power. Each point is repeated, with its context, in the section where it applies. Warranty conditions are those of Analyt-MTC.

Intended use

The DPC measures and controls the mass flow of clean, dry gases within the pressure and temperature limits in Specifications (p. 43). All models are for non-corrosive gases; only the corrosion-resistant models (DPC08, DPC18, DPC38, DPC48, DPC58, DPC68 and DPC78) also support the gas groups Pure corrosives and Refrigerants (Appendix B (p. 52)). It also measures volumetric flow, absolute pressure and temperature. It does not work with liquids. Selecting a gas or a gas mixture only changes the gas data the controller calculates with; it does not mix gases.

⚠ WARNING

The DPC is not designed for life-support applications. There, a malfunction of the controller could injure people. Do not use the DPC in life-support applications: whoever uses or sells it for one does so at their own risk.

Rules that protect people and the instrument

NOTICE

Pressure. A line (common-mode) pressure above the maximum of your model — 8.3 bar g for the DPC07 to DPC77, 3.44 bar g for the DPC04 and DPC14 — or a differential pressure across the open controller above 0.83 bar (DPC04 and DPC14: 0.67 bar) damages the differential pressure sensor permanently. Pressure transients and opening the valve against a high pressure difference do the same (see Pressure limits, p. 12). Never exceed these limits.

⚠ WARNING

Oxygen. A DPC that has not been specially cleaned and prepared for oxygen service can cause damage or personal injury when it is used with oxygen. Do not use the DPC with oxygen unless it has been specially cleaned and prepared for oxygen service.

NOTICE

Gas compatibility. Corrosion resistance is not guaranteed: a gas that is not compatible with the wetted materials can corrode the controller. Check that your gas is compatible with the wetted materials (see Specifications, p. 45). If you are not sure, ask Analyt-MTC before you use the controller.

NOTICE

Power. More than 26 V DC, or power through the power jack and the Mini-DIN connector at the same time, can damage the controller or make it malfunction. Never apply more than 26 V DC, and never power the controller through both at the same time. Switch the power off before you connect or disconnect any cable.

NOTICE

Signals. The 4–20 mA output is self-powered, and the analogue set point input accepts at most 12 V DC. An external voltage on the output, or a loop-powered source on the input, can damage these circuits. Never connect the output to an external voltage source or a loop-powered system. Never apply more than 12 V DC to the analogue set point input, and never connect it to a loop-powered source.

NOTICE

Sealants. Pipe grease or sealant on the process connections contaminates the narrow channels of the laminar flow element and can damage the controller permanently. Do not use pipe grease or sealant on the process connections.

NOTICE

Static electricity. Some electronic components are sensitive to electrostatic discharge, which can damage them. Wear a grounded wrist strap when you adjust or service the controller.

Situations that make the valve hot or open it fully

Set point above zero in **`Auto`** with no or too little pressure difference	The control loop drives the valve at maximum power trying to reach the flow; the valve can become very hot.
Valve mode **`Open`**	The valve opens fully whatever the set point, and a large uncontrolled flow results. It also heats the valve: leave it open for 15 minutes at most. Do not select it with more than 0.69 bar g at the inlet (DPC04 and DPC14: 0.67 bar g) and the outlet open to atmosphere.
Analogue set point input left open	With the analogue set point source selected, an unconnected input can produce random flows.
Changed control (PID) parameters	The control loop can become unstable. Change them only with Analyt-MTC support (see Tuning the control loop (p. 23)).

See Valve modes, p. 21, and Set point input, p. 15.

CHAPTER 2

Product description

The DPC is a digital mass flow controller for gases. It derives the flow from the pressure drop across a laminar flow element, corrects it for the gas, its pressure and its temperature, and adjusts a built-in proportional valve until the flow matches the set point.

Models and flow ranges

The model number sets the flow range, the process connections and the pressure ratings. The DPC04 and DPC14 are low-pressure-drop versions (named "Breeze" by the manufacturer) for applications that can spare only a few millibar across the controller. The DPC08, DPC18, DPC38, DPC48, DPC58, DPC68 and DPC78 are corrosion-resistant versions; only they support the gas groups Pure corrosives and Refrigerants (Appendix B (p. 52)).

Table 2-1 Models (flows at standard conditions, 21.11 °C, 1013.25 mbar)

Model	Full-scale flow	Pressure drop at full scale	Process connections
STANDARD MODELS			
DPC07	0.5–50 smL/min	69 mbar (1.0 psid)	10-32 female thread
DPC17	51 smL/min – 20 sL/min	69–1379 mbar (1.0–20.0 psid)	1/8" NPT female
DPC37	21–50 sL/min	621 mbar (9.0 psid)	1/4" NPT female
DPC47	51–100 sL/min	1034 mbar (15.0 psid)	1/4" NPT female
DPC57	250 sL/min	172 mbar (2.5 psid)	1/2" NPT female
DPC67	500 sL/min	476 mbar (6.9 psid)	3/4" NPT female
DPC77	1000 sL/min	1034 mbar (15.0 psid)	3/4" NPT female
CORROSION-RESISTANT MODELS (AIR)			
DPC08	0.5–50 smL/min	69 mbar (1.0 psid)	10-32 female thread
DPC18	51 smL/min – 20 sL/min	69–1379 mbar (1.0–20.0 psid)	1/8" NPT female
DPC38	21–50 sL/min	621 mbar (9.0 psid)	1/4" NPT female
DPC48	51–100 sL/min	1034 mbar (15.0 psid)	1/4" NPT female
DPC58	101–250 sL/min	172 mbar (2.5 psid)	1/2" NPT female
DPC68	251–500 sL/min	476 mbar (6.9 psid)	3/4" NPT female
DPC78	501–1000 sL/min	1034 mbar (15.0 psid)	3/4" NPT female
LOW-PRESSURE-DROP MODELS (AIR)			
DPC04	0.5–20 smL/min	5.5 mbar (0.08 psid)	10-32 female thread
DPC14	21 smL/min – 2 sL/min	13.1 mbar (0.19 psid)	1/8" NPT female

smL/min and sL/min: millilitres and litres per minute at the standard conditions of the controller (see Reference conditions, p. 23). The maximum pressure drop at intermediate flows is in Table 10-3, p. 44.

The interface cable supplied with an RS-232 or RS-485 controller is described in Digital interface (p. 16); cables and other accessories are listed in Accessories (p. 46).

Parts of the controller

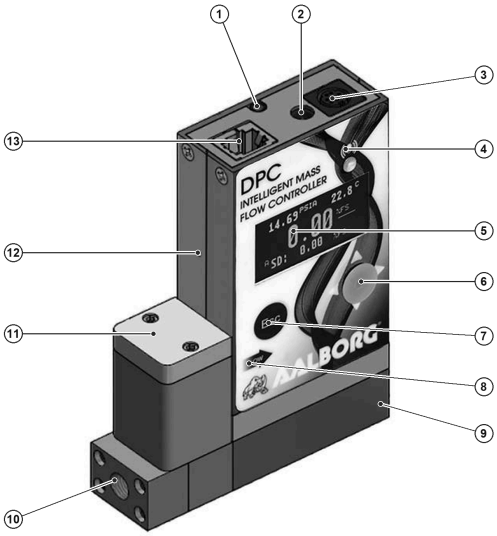


Figure 2-1. DPC with the valve upstream of the flow body (upstream valve configuration).

#	Part
1	Digital interface connector, RS-232 or RS-485 (3.5 mm stereo jack)
2	Power jack
3	8-pin Mini-DIN connector: power, analogue signals, relay
4	Status LED
5	Display (option)
6	Joystick (with the display option only)
7	**Esc** button (with the display option only)
8	Flow-direction arrow
9	Outlet port, on the right-hand end
10	Inlet port
11	Control valve
12	Multi-function push button, behind a small hole in the left side
13	Modbus RJ45 connector (option)

On a controller with the downstream valve configuration the valve sits at the outlet end. The DPC57, DPC58, DPC67, DPC68, DPC77 and DPC78 have a cylindrical valve that must stand upright.

How the DPC measures and controls

The gas passes through a restrictor flow element built so that the flow stays laminar over the whole operating range, from zero up to 133 % of full scale. In laminar flow the pressure drop across the element is proportional to the volumetric flow. A high-resolution differential pressure sensor measures that drop; an absolute pressure sensor and a temperature sensor measure the state of the gas.

From these three readings and the properties of the selected gas, stored in the controller's gas database, the microcontroller calculates the volumetric flow and the mass flow. Mass flow, volumetric flow, pressure and temperature are available on the display and over the digital interface; the mass flow is also available as an analogue signal (0–5 V DC, 0–10 V DC or 4–20 mA, selectable). The normally closed proportional valve is driven by a control loop that holds the mass flow at the set point.

Functions

- More than 100 selectable gases and up to 20 gas mixtures of your own (Appendix B (p. 52)).
- Set point from one of four sources: the display and joystick, the analogue input, the digital interface or a stored program of up to 16 steps.
- Standard, normal and true-mass flow units, volumetric flow units and a unit you define yourself (Appendix A (p. 50)).
- Two totalisers with batch functions, and a pulse output proportional to the mass flow.
- Flow, pressure and temperature alarms; one solid-state relay that can switch on any of 16 events.
- Automatic zero of the flow sensor and tare of the absolute pressure sensor; self-diagnostics.
- RS-232 or RS-485 interface (selectable), Modbus RTU over an isolated RS-485 transceiver as an option.

Circuit board

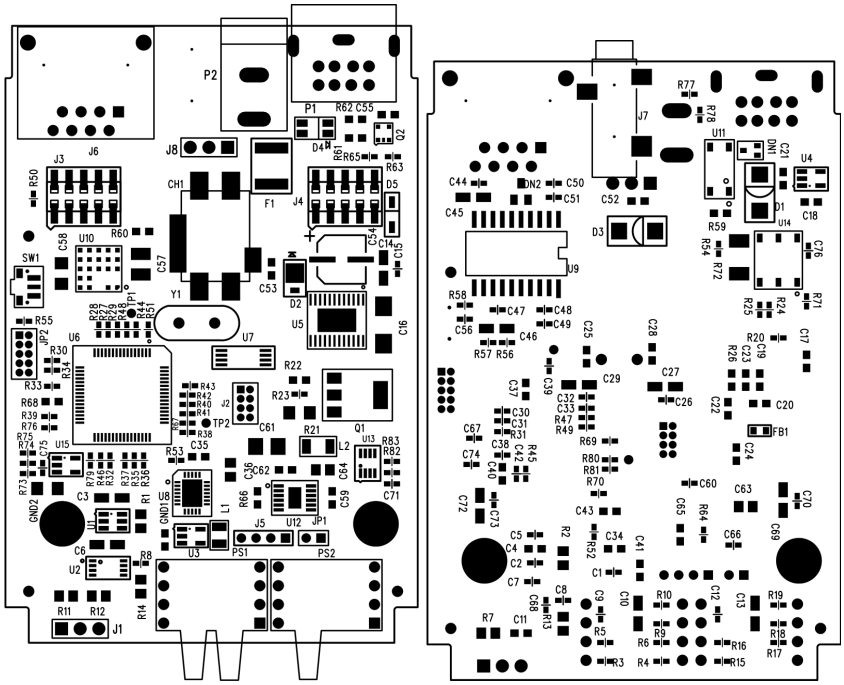


Figure 2-2. Circuit board, top component side (left) and bottom component side (right).

CHAPTER 3

Installation

Check the delivery, make sure the gas is clean enough, keep the pressures within the limits of your model, mount the controller and connect the gas line, then wire it as described in Electrical connections (p. 14).

Unpacking

1. Before you open the carton, look for external damage. If the carton is damaged, report it to the carrier at once.
2. Open the carton from the top and check the controller for hidden transport damage. Report any damage to the carrier and send Analyt-MTC a copy of the report.
3. Check the contents against the packing list and tell Analyt-MTC promptly about anything missing.

Gas quality and filters

The DPC works only with clean, dry gases: non-corrosive gases on every model, and the gas groups Pure corrosives and Refrigerants only on the corrosion-resistant DPC08, DPC18, DPC38, DPC48, DPC58, DPC68 and DPC78 (Appendix B (p. 52)). It does not work with liquids. The laminar flow element consists of narrow stainless-steel channels that particles or crystallising gas components can block. Filter any gas that may carry particles, and install an in-line particle filter upstream of the controller. Analyt-MTC recommends a filter with a pore size of at most 5 µm for the DPC04 and DPC07, 20 µm for the DPC14, DPC17, DPC37 and DPC47, and 50 µm for the DPC57, DPC67 and DPC77.

⚠ WARNING

A DPC that has not been specially cleaned and prepared for oxygen service can cause damage or personal injury when it is used with oxygen. Do not use the DPC with oxygen unless it has been specially cleaned and prepared for oxygen service.

Pressure limits

Two limits protect the differential pressure sensor: the *line* (common-mode) pressure inside the controller, and the *differential* pressure between inlet and outlet while the valve is open. A steady line pressure within the limit does no harm; pressure transients — sudden pressure changes at the inlet or outlet — can damage the sensor permanently even when the steady pressure is within the limit.

Table 3-1 Pressure ratings

Models	Max. line pressure	Max. differential pressure, valve open	Proof pressure
DPC07, DPC17, DPC37, DPC47, DPC57, DPC67, DPC77	8.3 bar g (120 psig)	0.83 bar (12 psid)	10.0 bar g (145 psig)
DPC04, DPC14	3.44 bar g (50 psig)	0.67 bar (9.75 psid)	3.44 bar g (50 psig)
DPC08, DPC18, DPC38, DPC48, DPC58, DPC68, DPC78	10.3 bar g (150 psig)	10 psid	175 psig

NOTICE

A line pressure above the limit damages the differential pressure sensor permanently. So does switching the valve to **Open**, or giving a set point, while the pressure difference across the controller is above the differential limit: the full difference reaches the sensor at once. Keep the line pressure and the pressure difference within the limits in the table above.

- If the supply pressure can exceed the line-pressure limit, install a pressure regulator upstream of the controller. This applies in particular to controllers with the valve downstream of the flow body.
- Install the controller only in lines within its pressure and temperature ratings, with a margin for pressure spikes and surges; in high-pressure applications fit relief valves or burst discs.

NOTICE

On the corrosion-resistant DPC08, DPC18, DPC38, DPC48, DPC58, DPC68 and DPC78, a line pressure above 10.3 bar g (150 psig) damages the differential pressure sensor permanently; pressure transients at the inlet or outlet can damage it even within that limit. A differential pressure above 10 psid with the valve open can damage the controller permanently. Do not switch the valve to **Open** while the pressure difference across the controller is above 10 psid.

Maximum operating pressure of the valve

For controllers with the valve upstream of the flow body, the valve is rated for the operating pressures below. The line-pressure limit in Table 3-1 applies as well; the lower of the two values counts.

Models and range (sL/min at 21.11 °C, 1013.25 mbar)	Max. valve operating pressure
DPC04, DPC07, DPC08, DPC17, DPC18 below 2 sL/min	10.3 bar g (150 psig)
DPC17, DPC18, 2–5 sL/min	6.9 bar g (100 psig)
DPC17, DPC18, 5–20 sL/min	3.4 bar g (50 psig)
DPC37, DPC38, DPC47, DPC48	3.4 bar g (50 psig)
DPC57, DPC58, DPC67, DPC68, DPC77, DPC78	3.4 bar g (50 psig)

Mounting

The DPC needs no straight pipe runs upstream or downstream. Choose a stable environment, free of frequent and sudden temperature changes, high humidity and draughts, and away from vibration, hot corrosive atmospheres and strong radio-frequency or magnetic fields.

The **DPC04 to DPC48** can be mounted in any position; the **DPC57, DPC58, DPC67, DPC68, DPC77 and DPC78** must be mounted with the valve cylinder vertical and upright.

Threaded mounting holes in the bottom of the body fix the controller to a flat panel: 6-32 UNC on the DPC04, DPC07, DPC08, DPC14, DPC17 and DPC18, 8-32 UNC on the DPC37, DPC38, DPC47, DPC48, DPC57, DPC58, DPC67, DPC68, DPC77 and DPC78. The hole pattern and the thread of each model are in the dimension drawings in Appendix C (p. 56).

Connecting the gas line

The ports have female threads for your own fittings: 10-32 on the DPC04, DPC07 and DPC08, 1/8" NPT on the DPC14, DPC17 and DPC18, 1/4" NPT on the DPC37, DPC38, DPC47 and DPC48, 1/2" NPT on the DPC57 and DPC58 and 3/4" NPT on the DPC67, DPC68, DPC77 and DPC78. Matching tube fittings are listed on the product page of the DPC; ask Analyt-MTC if you need help choosing.

NOTICE

Pipe grease or sealant on the process connections contaminates the narrow channels of the laminar flow element. It can damage the controller permanently. Do not use pipe grease or sealant on the process connections.

1. Inspect every part of the piping — tubes, ferrules and fittings — for dust and other contamination, and clean it before you connect it.
2. Note the flow arrow on the front of the controller. Connect the supply to the inlet so that the gas flows in the direction of the arrow.
3. Push the tube into each compression fitting until its end sits flush against the shoulder of the fitting.
4. Tighten the compression fittings by 1¼ turns, or as the maker of the fitting specifies. Do not overtighten: that can damage the fitting seriously.

Electrical connections

Power, analogue signals and the relay share the 8-pin Mini-DIN connector on top of the controller; the digital interface has its own 3.5 mm jack. Wire everything with the power off, then check wiring and polarity before you switch on.

Before you wire

- Switch the power off before you connect or disconnect any cable or wire.
- Wear a grounded wrist strap: some components are sensitive to electrostatic discharge.
- Do not exceed the rated values of the inputs and outputs (see Specifications (p. 43)). Wrong wiring or reversed polarity can damage the controller or the connected equipment, or cause faulty operation.
- To keep noise out of the signals, run the power, digital interface and analogue signal lines through separate cable entries.

8-pin Mini-DIN connector



Figure 3-1. Pin numbering of the Mini-DIN connector on the controller, seen from the front of the connector with the key notch at the bottom.

Table 3-2 Mini-DIN pin assignment

Pin	Function
1	Relay contact 1 (solid-state relay, normally open)
2	Relay contact 2. Max. 48 V (AC peak or DC), 400 mA
3	Analogue set point input (+): 0–5 V DC, 0–10 V DC or 4–20 mA
4	Analogue common (–) for pins 3 and 6
5	Factory use only — do not connect anything
6	Analogue output (+): 0–5 V DC, 0–10 V DC or 4–20 mA
7	Power supply (+)
8	Power supply common (–)

NOTICE

Most Mini-DIN plugs follow the standard numbering, but some do not, so the numbers on your mating plug may not match Figure 3-1. A cable wired by those numbers connects signals to the wrong pins, and the controller does not work correctly. Wire by the pin positions shown here, not by the numbers printed on the plug.

Power supply

Models	Supply voltage	Supply rated for at least	Resettable fuse
DPC04, DPC07, DPC08, DPC14, DPC17, DPC18, DPC37, DPC38, DPC47, DPC48	12–26 V DC	350 mA	300 mA
DPC57, DPC58, DPC67, DPC68, DPC77, DPC78	24–26 V DC	650 mA	750 mA

Use a unipolar DC supply with a ripple below 150 mV peak to peak. A controller with the 4–20 mA output needs at least 14 V DC. When several controllers share one supply, size it for their combined current.

NOTICE

Power through the power jack and the Mini-DIN connector at the same time, or more than 26 V DC, can damage the controller or make it malfunction. Never apply power through both at the same time, and never apply more than 26 V DC.

Connect the supply either to the power jack or to the Mini-DIN connector: (+) to pin 7 and (−) to pin 8.

Both power inputs are protected by a resettable fuse with medium time lag, and the circuit board is protected against reversed polarity. If a short circuit or reversed polarity trips the fuse, disconnect the power, correct the fault and reconnect.

Analogue set point input

The analogue set point input accepts 0–5 V DC, 0–10 V DC or 4–20 mA; the signal range corresponds linearly to 0–100 % of full scale. Select the signal type on the display or over the digital interface (see Analogue input, p. 31), and select the analogue set point source (see Set point source, p. 21) — otherwise the controller ignores the input.

NOTICE

With the analogue set point source selected and nothing connected to pin 3, the controller may produce random flows. Do not leave pin 3 open while the analogue set point source is selected. Drive a voltage input from a low-impedance source.

NOTICE

More than 12 V DC on pin 3 destroys the input circuit, and loop-powered signal sources are usually supplied with more than 12 V. Never apply more than 12 V DC to pin 3. Never connect the input to a loop-powered signal source.

Connect the signal (+) to pin 3 and (−) to pin 4. On a voltage range the input impedance is about 100 kΩ; on 4–20 mA the controller sinks the current through about 250 Ω.

Analogue output

The analogue output carries the mass flow as 0–5 V DC, 0–10 V DC or 4–20 mA, linear over 0–100 % of full scale; select the type on the display or over the digital interface (see Analogue output, p. 30).

Output	Load
0–5 V DC	at least 5 kΩ
0–10 V DC	at least 5000 Ω
4–20 mA	at most 500 Ω loop resistance

NOTICE

The 4–20 mA output is self-powered (sourcing, not isolated), and an external voltage source on it can damage the circuit. A load below 5 kΩ on a voltage output can damage the circuit, and a load above 500 Ω on the current output makes it non-linear. Never connect an external voltage source to the output, for example a loop-powered input. Always check which output type is configured before you connect a load, and keep the load at 5 kΩ or more on a voltage output and at 500 Ω or less on the current output.

Connect the load (+) to pin 6 and (−) to pin 4.

Relay output

Pins 1 and 2 are the contacts of a normally open solid-state relay (SPST). It closes when the event assigned to it occurs — an alarm, a totaliser limit, the pulse output or a manual command (see Relay assignment, p. 25). Do not exceed 48 V (AC peak or DC) and 400 mA.

Digital interface

The digital interface works as RS-232 or RS-485 and gives access to all readings and settings. Both use the 3.5 mm stereo jack on top of the controller. The default settings are 9600 baud, 8 data bits, 1 stop bit, no parity and no flow control.

NOTICE

Connecting the controller to a computer or PLC that uses another interface type can damage it or make it malfunction. Check which interface your controller is set to before you connect it. A controller with display shows the interface type for about two seconds at power-up. Without display, press the multi-function push button briefly and count the amber flashes of the status LED: one = interface disabled, two = RS-232, three = RS-485 (see Push-button functions, p. 31).

RS-232

The connection to the computer must be crossed over. Controllers ordered with RS-232 come with a crossover cable of about 1.5 ft, from a 9-pin D-sub socket to a 3.5 mm stereo plug. To make a longer cable, wire it like this:

Computer, 9-pin D-sub	Controller, 3.5 mm plug
Pin 2, RX (receive)	Ring (contact 3), TX (+)
Pin 3, TX (transmit)	Tip (contact 2), RX (−)
Pin 5, signal ground	Sleeve (contact 1), ground

RS-485

Up to 64 controllers can share one RS-485 segment of up to 2000 ft. Set the RS-232/RS-485 converter or adapter for multidrop, two-wire, half-duplex operation. Its transmitter must be enabled by TD or RTS, whichever the converter offers, and its receiver set to follow the transmitter so that there is no echo. Each controller ordered with RS-485 comes with a cable of about 3 ft, from a 3.5 mm plug to stripped wires.

RS-485 line	Controller, 3.5 mm plug	Wire colour
A, T(−) or R(−)	Tip (contact 2), RX (−)	white
B, T(+) or R(+)	Ring (contact 3), TX (+)	red
Ground, if available	Sleeve (contact 1)	shield

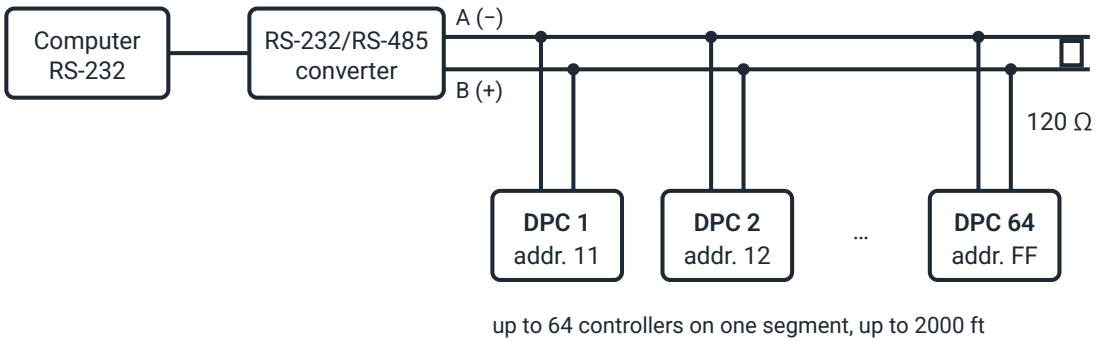


Figure 3-2. RS-485 network: every controller has its own address; the last controller on a long segment is terminated with 120 Ω between A and B.

Give every controller on the bus a different address (see Communication port, p. 29). When a controller is the last device on a long segment, connect a 120 Ω termination resistor between its (+) and (−) lines within 6 ft of the controller. The controller has a switchable internal 120 Ω resistor for this purpose; it is disabled on delivery.

CHAPTER 4

Commissioning

First power-up

After power-up the valve stays closed, whatever the set point, until you set the valve mode to **`Auto`** — unless *local set point auto start* has been enabled. The set point source in use before power-down is restored.

1. With the gas line connected and leak-tested, switch on the power. Check on the power-up screens that the interface and the address are what you expect.
2. Bring the line to its operating pressure, keeping within the pressure limits of your model (see Pressure limits, p. 12).
3. Check the selected gas on PI screen 5; change it if necessary (see Selecting the gas, p. 22).
4. Select the set point source and give a set point (see Set point source (p. 21)).
5. Set the valve mode to **`Auto`**. The controller now controls the flow to the set point.

CHAPTER 5

Operation

Controllers with the display option show their readings on a monochrome OLED screen and are set up with a five-way joystick and an **Esc** button. Controllers without display are set up over the digital interface, which reaches the same parameters (Chapter 6 (p. 33)). This chapter also covers the set point, the valve modes and the gas selection, the control loop, alarms and totalisers, the interface and display settings, the push button and the diagnostic screens.

Power-up screens

When you switch the controller on, it shows a banner screen for two seconds, then an information screen for another two seconds:

Line 1	Firmware version (`Fw`) and gas database version (`Tbl`)
Line 2	Interface type (`COM:` `RS232` or `RS485`) and RS-485 address, hexadecimal
Line 3	Baud rate
Line 4	Modbus hardware installed (`Y`/`N`) and Modbus address, decimal

Then the main screen appears. About five seconds after power-up the status LED turns steady green: the controller is ready to control.

The main screen

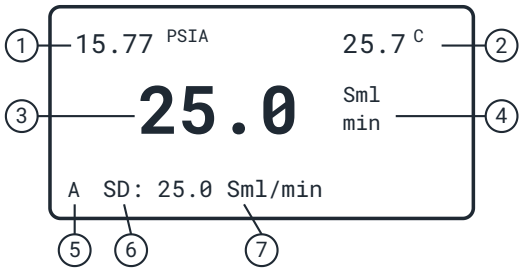


Figure 5-1. Main screen (process information screen 1). The exact content depends on model and configuration.

#	Field
1	Absolute pressure and its unit
2	Gas temperature
3	Mass flow (large digits)
4	Mass flow unit
5	Valve mode: `C` closed, `A` auto, `O` open
6	Set point source after the `S`: `A` analogue, `L` local, `D` digital interface, `P` program table
7	Set point and its unit

A flashing reading is outside the range of its sensor and cannot be relied on (see Swamping, p. 22). An active alarm alternates the unit with an alert such as `Hi!` or `Lo!`.

Process information screens

Move the joystick up or down on the main screen to page through up to eight process information (PI) screens; after the last one the display returns to the first. Screens you do not need can be hidden, and the screens can also cycle automatically (see Display settings, p. 31).

Screen	Shows
1	Pressure, temperature, mass flow, set point, set point source and valve mode (main screen)
2	Pressure, temperature, mass flow and totaliser 1 (`T1`)

Screen	Shows
3	Pressure, temperature, mass flow and totaliser 2 (T2)
4	Pressure, temperature, mass flow and volumetric flow (V)
5	Selected gas, full-scale range, interface type and address, Modbus hardware (MB:Y/N), analogue input and output type
6	Events: hours since power-up, relay assignment, status of the flow, pressure and temperature alarms (Alm), totalisers (T1, T2), pulse output (P0), alarm and diagnostic event registers (AE, DE)
7	Program set point: current flow, current set point and elapsed time of the step, step number, program mode, loop and run status (see Program set point, p. 28)
8	Diagnostics: raw sensor counts, differential pressure in mbar and psid, gas temperature

Joystick and menus

The joystick moves **up**, **down**, **left** and **right**; pressing it towards the front panel is **Enter**. **Esc** switches between the PI screens and the menus and takes you one menu level up. In a menu, move up or down to highlight an item and press Enter to open it; the list wraps around at both ends. This manual names a setting by its menu path, for example **General Settings › Valve Parameters › Set Point Source**.

Table 5-1 Main menu

Menu	Contents	See
Program Protection	Unlock the protected settings	p. 20
Change PP Password	Set the protection password	p. 20
Device Information	Read-only: device ID and full scale, interfaces, firmware and database versions, alarm, totaliser, pulse output, LED and general settings	
Units of Measure	Mass flow, volumetric flow, pressure and temperature units; user-defined unit	p. 22
Select Gas	Recent gases; standard, bioreactor, breathing, chromatography, fuel, laser, O_2 concentrator, stack and welding gases; user-defined mixtures	p. 22
Alarm Settings	Gas flow, gas pressure and gas temperature alarms	p. 24
Totalizers Settings	Totaliser 1, totaliser 2, pulse output	p. 27
General Settings	Valve parameters, STP/NTP conditions, display and PI screens, communication port, Modbus interface, relay assignment, analogue output, analogue input, status LED, signal conditioner, program set point	p. 29
Sensor Zero Calibr.	Start auto zero, start absolute-pressure tare, view zero parameters, background auto tare	p. 38
Alarm & Diagnostic	Alarm and diagnostic event registers; diagnostic screens	p. 26

The **Valve Parameters** menu holds the set point source, the local and digital set point merge, local set point auto start, and the control loop settings: auto-tune valve delay, loop type, P, I and D terms, valve bias, KmP coefficient, restore factory values, auto-tune oscillation criterion and start auto tune.

Program protection

All configuration settings are protected by a password of up to three digits, and the protection switches itself on again every time the controller is powered up. On delivery the password is 0, which means no password is needed.

1. Press **Esc** and open **Program Protection**.
2. If a password has been set, enter it (see Entering values below).

3. Select **Disabled** and press Enter. The settings stay unlocked until the controller is next switched off.

To change the password, unlock the protection, open **Change PP Password**, enter the old password and then the new one; the controller confirms the change. If you have lost the password, contact Analyt-MTC.

Entering values

- **Numbers:** move up or down to change the digit under the cursor (0–9, and the decimal point where allowed), left or right to move to another digit, and press Enter to save the value.
- **Choices:** move up or down to highlight an option and press Enter.

The controller checks every value it receives. A value outside the permitted range is rejected with a message, and the old value remains.

Operation

This section covers everyday use: where the set point comes from, how the valve modes work, and how to select the gas, the units and the reference conditions.

Set point source

The set point comes from one of four sources. Select it under **General Settings** › **Valve Parameters** › **Set Point Source**; the letter after the S on the main screen shows the active source.

Analog	The analogue set point input on pin 3 (see Analogue set point input, p. 15).
Digital	The SP command over RS-232, RS-485 or Modbus (see Chapter 6 (p. 33)).
Local	The display and joystick.
PSP	The stored program of up to 16 steps (see Program set point, p. 28).

Two further options in the same menu change how the local set point behaves. **Loc & Dig SP Merge** lets a computer change the set point even while the source is **Local**. **Local SP Auto Start** sets the valve mode to **Auto** at power-up and starts controlling at the last saved local set point, provided the source is **Local**.

Giving a local set point

1. With the source set to **Local**, press the joystick on the main screen. The set point replaces the large flow reading, with a flashing cursor.
2. Move up or down to change the digit or decimal point under the cursor, left or right to move the cursor.
3. Press Enter. The set point is saved and shown at the bottom of the screen, and the flow reading returns.

The controller executes the set point only in valve mode **Auto**. It can control up to 125 % of full scale; the specified operating range is 0.5 to 100 % of full scale.

Valve modes

Close	The valve stays closed, whatever the set point. This is the mode after power-up.
Auto	Normal operation: the controller follows the set point from the selected source.
Open	The valve opens fully at maximum drive current, whatever the set point. The flow is limited only by the pressure difference across the controller.

⚠ CAUTION

In **Open** mode a large, uncontrolled flow passes and the valve heats up, so touching it can burn you. When the valve opens, the pressure step can also exceed the differential limit of the sensor and damage it (see Pressure limits, p. 12). Do not touch the valve while it is open, and leave it open for 15 minutes at most. Before you select **Open**, check the inlet pressure. Never select **Open** with more than 0.69 bar g at the inlet (DPC04 and DPC14: 0.67 bar g) while the outlet is open to atmosphere.

⚠ CAUTION

With a set point above zero in **Auto** and no pressure difference across the controller, or too little to reach the flow, the control loop drives the valve at maximum power. The valve can then become very hot and burn you if you touch it. Do not leave a set point above zero in **Auto** in this situation.

To change the mode, move the joystick right on PI screen 1, 2, 3 or 4, highlight the mode and press Enter.

Flow above the range: swamping

The flow element is designed for laminar flow up to 133 % of full scale. Above that the controller is "swamped". The flow reading flashes, and it is then neither accurate nor linear. Reduce the flow below 133 % of full scale; once the flow is back within the calibrated range, the reading is valid again.

Selecting the gas

The gases are arranged in groups. Open **Select Gas**, choose the group, highlight the gas and press Enter. For example, nitrogen is under **Select Gas** › **Standard Gases** › **Nitrogen**. The group **Recent Gases** keeps the last 16 gases you selected. All gases and their numbers are listed in Appendix B (p. 52); over the digital interface, use the G command.

Defining a gas mixture

You can store up to 20 mixtures of your own, each of two to five gases from the gas list. No mixtures are stored on delivery.

1. Open **Select Gas** › **User Defined Mixture**. The first line shows how many places are free. Press Enter on it.
2. Enter a name: a flashing A appears. Move up or down to change the character, right to go to the next position, left to switch between upper and lower case. Press Enter to save the name.
3. The component list G1 to G5 appears. Press Enter on G1, highlight its gas in the list and press Enter.
4. Move right to the ratio, press Enter, enter the percentage and press Enter. Move left or right to switch between gas and ratio, and up or down to go to the next component.
5. Repeat for the other components. The ratios must add up to exactly 100 %; the total is shown at the top of the screen.
6. Move left to save the mixture and confirm the message with any button. The mixture now appears in the **User Defined Mixture** list and can be selected like any other gas.

To edit a saved mixture — its name, its gases or its ratios — highlight it, move left and answer **YES**. A mixture that does not add up to 100 % is not saved; an error message appears.

Units of measure

Under **Units of Measure** you select the units for mass flow, volumetric flow, pressure and temperature. They apply everywhere: on all PI screens and over the digital interface. Select the units

first, because other settings — alarm limits, totaliser volumes — are entered in them. The totalisers follow the flow unit automatically. The available units are listed in Appendix A (p. 50).

User-defined unit

If none of the listed units fits, define your own under **`Units of Measure › User Defined Unit`** with three parameters:

`UD Unit K-Factor`	Size of your unit in litres (default 1.00 L)
`UD Unit Time Base`	Time base of the unit: second, minute, hour or day
`UD Unit Use Density`	Whether the unit is based on density (a mass unit) or not

Reference conditions (STP and NTP)

Mass flow is expressed as the volume the gas would occupy at reference conditions. Units starting with `S` use the standard conditions (STP), units starting with `N` the normal conditions (NTP).

	Temperature	Pressure
Standard conditions (factory setting)	21.11 °C	1013.25 mbar
Normal conditions (factory setting)	0 °C	1013.25 mbar

> **Note**
> Changing the reference conditions changes the mass flow readings on the display, over the digital interface and on the analogue output. When two flow instruments in one line disagree, check first that they use the same reference conditions.

Both can be changed under **`General Settings › STP/NTP Units Cond`**: select the temperature or pressure unit first, then enter the value.

Tuning the control loop

The control loop decides how fast and how steadily the valve follows a set point change. It was tuned at the factory for the conditions in your order and suits most applications. Retune only when the flow is unstable, oscillates or responds too slowly.

> **Note**
> Change the control parameters only when Analyt-MTC support asks you to. If the controller shows problems with stability or response time, or your application needs different settings, contact Analyt-MTC first. The factory values can always be restored with **`Restore Valve PID`**.

Loop types and terms

The loop has a proportional (P), an integral (I) and a derivative (D) term; together they set the control speed, the stability of the valve and how much the flow overshoots, undershoots or oscillates. Three loop types are available under **`General Settings › Valve Parameters › Valve PID Loop Type`**:

PD	Default on most controllers; works for most applications and a wide range of pressure differences. The integral term is not used.
PID	Proportional, integral and derivative.
PIDD	Third algorithm, for special applications. Select PID or PIDD only on Analyt-MTC's advice.

After a change of loop type the terms usually need adjusting as well. The valve bias and the KmP coefficient belong to the individual valve and were set at the factory; do not change them.

Automatic tuning

Auto tune searches for the terms that give the most stable valve response — not necessarily the fastest. Use it as a starting point, for example after a valve has been replaced, and fine-tune manually afterwards if you need a faster response.

1. Apply the normal inlet pressure to the controller.
2. Under **`Valve Parameters`**, set **`Auto Tune Vlv Delay`**: the time, in steps of 100 ms, between a set point step and the start of the stability evaluation, also used between iterations. Controllers with a full scale below 50 smL/min respond slowly; give them 500 to 2000 ms.
3. Set **`AT Oscill. Criteria`**: the peak-to-peak flow variation, in % of full scale, that counts as oscillation. 2.0 % is a good starting value.
4. Select **`Start PID Auto Tune`** and enter the target set point in % of full scale; 50 to 90 % suits most applications.
5. Wait until the controller reports the result — between half a minute and three minutes. During the run it shows the terms being tried. If the run succeeds, the new terms are saved automatically.

Manual tuning

To make the controller faster, or to adapt its response to a special application, find the terms by hand: the aim is the quickest response with the least oscillation. Watch the analogue output (0–5 or 0–10 V DC) on a digital oscilloscope while you change the set point; this is the only practical way to tune for response times of 100 to 200 ms. The manufacturer's PC configuration utility has a tuning screen that sets the set point and the individual terms; ask Analyt-MTC for it. Fine tuning can be difficult; Analyt-MTC is glad to help.

Signal conditioner

The signal conditioner settings (**`General Settings`** › **`Signal Conditioner`**) filter and damp the flow, pressure and temperature signals and the display reading. They were set at the factory for the best performance.

> **Note**
> Change the signal conditioner settings only when Analyt-MTC support asks you to.

Alarms, relay and status LED

The controller watches the flow, the pressure and the temperature against limits you set. An alarm shows on the display and the status LED, can switch the relay and, for the flow alarm, can close the valve. Two event registers record what has happened.

Flow alarm

The flow alarm compares the flow with the *set point*: it is triggered when the difference between flow and set point reaches the low limit (flow below the set point) or the high limit (flow above the set point). The display then alternates the flow unit with `Lo!` or `Hi!` every second. Set it up under **`Alarm Settings`** › **`Gas Flow Alarm`**:

Setting	Range	Default
Flow Alarm Mode	**Enabled** or **Disabled**	**Disabled**
Low Flow Alarm	0–110.0 % of full scale, in steps of 0.1 %	
High Flow Alarm	0–110.0 % of full scale, in steps of 0.1 %	
Flow Alarm Delay	0–3600 s that the condition must last before the alarm acts; 2–10 s filters out short spikes	0 s
FA Power Up Delay	0–3600 s after power-up before the alarm is active	0 s
Flow Alarm Latch	**Enabled**: the relay stays switched after the condition ends. **Disabled**: it follows the condition	**Disabled**
Valve Close Action	**Disabled**, **High Alarm** or **Low Alarm**: the valve closes when the selected alarm is active	**Disabled**

Pressure alarm

The pressure alarm is triggered when the absolute pressure falls below the low limit or rises above the high limit; the display alternates the pressure unit with `LOW!` or `HIGH!`. The limits are entered in the current pressure unit, in steps of 0.1 % of the pressure sensor range: low limit 0.0 to 99.9 %, high limit 0.1 to 100 %. The low limit must be below the high limit. Mode, delay, power-up delay and latch work as for the flow alarm (defaults: disabled, 0 s, 0 s, not latched).

Temperature alarm

The temperature alarm is triggered when the gas temperature falls below the low limit or rises above the high limit; the display alternates the temperature unit with `L` or `H`. Limits are entered in the current temperature unit, in steps of 0.1 degree: low limit −20.0 to 69.9 °C, high limit −19.9 to 70.0 °C. The low limit must be below the high limit. Mode, delay, power-up delay and latch work as for the flow alarm.

Relay assignment

The solid-state relay on pins 1 and 2 (see Relay output, p. 16) closes its contact when the event you assign to it occurs. Assign it under **General Settings › Relay Assignment**. The display shows the assignment on PI screen 6.

Assignment	The relay closes when
Disabled (default)	never; the relay is not energised
Low / High flow alarm	the low or high flow alarm is active
Flow range H–L	the flow is between the high and low flow alarm limits
Low / High pressure alarm	the low or high pressure alarm is active
Pressure range H–L	the pressure is between the high and low pressure limits
Low / High temperature alarm	the low or high temperature alarm is active
Temperature range H–L	the temperature is between the high and low temperature limits
Totalizer 1 / 2 event	the totaliser has exceeded its action volume
Pulse output	the relay carries the pulse output (see Pulse output, p. 28)
Alarm events	one or more alarm events are active
Diagnostic events	one or more diagnostic events are active
Manual	always, whatever the alarms and totalisers

Status LED

The status LED lights red, green or amber in different patterns. Under **`General Settings`** › **`Status LED Settings`** you choose which events it reports:

Mode	Indication
`Default events`	Steady red: auto zero failed, or fatal error (the controller must be reset). Steady amber for 1–3 s: warm-up after power-up. Special patterns during push-button entries (up to 35 s).
`Flow alarm and totalizer events` (default setting)	Red/off every second: high flow alarm. Green/off: low flow alarm. Amber/off: totaliser 1 or totaliser 2 event. Red/amber or green/amber: a flow alarm together with a totaliser event (every second for totaliser 1, every 2 s for totaliser 2). Amber 3 s, off 1 s: both totaliser events. Amber 3 s, red or green 1 s: high or low flow alarm with both totaliser events.
`Alarm events`	Green/off every second while any alarm event is active.
`Diagnostic events`	Red/off every second while any diagnostic event is active.
`Main communication interface`	A short red flash (about 200 ms) for each message received, a short green flash for each message sent.
`Modbus interface` (option)	As above, for the Modbus interface.

Event registers

The controller records events in two registers, available on the display (**`Alarm & Diagnostic`**) and over the digital interface (`AE` and `DE` commands). The **alarm event register** collects non-critical events related to settings and process values; the **diagnostic event register** collects critical events related to the instrument and its hardware. Each register comes in three parts:

- **Status** (read-only): the events that are active, or have been latched. The display shows how many are active and lists them; with more than seven, scroll up or down.
- **Mask**: which events are monitored at all. A masked event is neither processed nor shown, even if its condition occurs. Toggle an event with the joystick moving right (an asterisk marks it enabled) and save with Enter.
- **Latch**: which events stay in the status register after their condition has ended. An event that is not latched shows only while it lasts.

Latched events remain until you reset the status register (**`Reset Alarm Events Reg`** or **`Reset DiagEvents Reg`**, answer **`YES`**) or the power is switched off — the status registers are not kept.

Table 5-2 Alarm events

Code	Event
0	High flow alarm
1	Low flow alarm
2	Flow between high and low limits
3	Totaliser 1 exceeded its action volume
4	Totaliser 2 exceeded its action volume
5	High pressure alarm
6	Low pressure alarm
7	Pressure between high and low limits
8	High temperature alarm
9	Low temperature alarm
A	Temperature between high and low limits
B	Pulse output queue overflow
C	Password event (attempt to change the password)
D	Power-on event (power-on delay above 0)

On delivery only the power-on event (D) is enabled in the mask; no event is latched.

Table 5-3 Diagnostic events

Code	Event
0	CPU temperature too high
1	Differential pressure sensor initialisation error
2	Absolute pressure sensor initialisation error
3	2.5 V DC reference out of range
4	Flow out of permissible range
5	Absolute pressure out of permissible range
6	Gas temperature out of range
7	Analogue output alarm
8	Serial (UART) communication error
9	Modbus communication error
A	EEPROM read/write error
B	Auto zero failure
C	Absolute pressure tare failure
D	Differential pressure sensor reading invalid
E	Absolute pressure sensor reading invalid
F	Fatal error

On delivery only event 0 is enabled in the mask; no event is latched.

Totalisers, pulse output and programmed set points

Two totalisers add up the gas that has passed; with an action volume they dispense batches. The pulse output turns the flow into pulses for an external counter, and the program set point runs a sequence of up to 16 set points by itself.

Totalisers

Each totaliser integrates the mass flow over time and counts upwards. Its reading is saved in non-volatile memory every second, so it survives a power interruption, and a backup copy is written to a separate memory area every six minutes; the reading can be restored from it with the command T , 1 , B or T , 2 , B. Set the totalisers up under **`Totalizers Settings`** › **`Totalizer #1`** or **`Totalizer #2`**:

Setting	Function	Default
`Totalizer Mode`	**`Enabled`** or **`Disabled`**	**`Disabled`**
`Flow Start`	The totaliser counts only while the flow is at or above this value: 0–100 % of full scale, in steps of 0.1 %	
`Action Volume`	Volume, in the current totaliser unit, at which the totaliser event occurs (relay, LED, valve close, auto reset). 0 = no event	0
`Power On Delay`	0–3600 s after power-up before the totaliser starts, so that the readings have settled	0 s
`Auto Reset`	Resets the totaliser to zero when it reaches the action volume — for dispensing the same batch again and again	**`Disabled`**
`Auto Reset Delay`	0–3600 s pause after an auto reset before the next batch	0 s
`Reset Totalizer`	Resets the reading after a confirmation (**`YES`**)	
`DP Precision`	Removes 0–5 decimal places from the reading, leaving more digits in front of the decimal point; the field has 10 digits	0

Setting	Function	Default
Over Limit Action	**Valve Close**: the valve closes when the totaliser reaches the action volume. **Disabled**: no effect on the valve	**Disabled**

> **Note**
> Configure all settings before you enable a totaliser. Flow start, action volume and readings are in the units currently selected; the totaliser unit follows the flow unit. On a controller without display, reset the totalisers with the push button (see Push-button functions, p. 31).

Locking the reset

If a totaliser must never be reset — for example because its reading has to be kept for the life of the controller — its reset can be locked with the command T , 1 , L , 1 or T , 2 , L , 1. The lock can be set only over the digital interface; on delivery the reset is not locked.

Pulse output

The pulse output works independently of the totalisers and delivers a pulse frequency proportional to the mass flow. The pulses are switched by the solid-state relay, so first assign the relay to **Pulse Output** (see Relay assignment, p. 25). Then set up **Totalizers Settings › Pulse Output**:

PulseOutput Mode	**Enabled** or **Disabled** (default)
Pulse Flow Start	Pulses are produced only at or above this flow: 0.0–100.0 % of full scale
[Unit]/Pulse	Quantity per pulse, in the current unit (not a time-based unit)
Pulse Active Time	Time the relay stays closed per pulse: 50–6553 ms

The relay closes for at least 50 ms per pulse and cannot pulse faster than once every 100 ms. A good rule is to set the quantity per pulse to the maximum flow per second: the output then never pulses faster than once a second. For example, at a maximum flow of 120 g/min (2 g/s), 120 g per pulse gives one pulse a minute and 2 g per pulse one pulse a second.

If the flow calls for pulses faster than the relay can produce, the extra pulses wait in a queue and are sent when the flow decreases. Rather than relying on the queue, increase the quantity per pulse.

Program set point

The program set point (PSP) runs a sequence of up to 16 steps. Each step has a set point in % of full scale and a time in seconds: the time the set point takes to move linearly from its previous value to the step's value. A step with time zero jumps; equal set points in consecutive steps hold the flow. With these elements you can program ramps, pulses and rising or falling flow profiles. Set the program up under **General Settings › Program Set Point**:

PSP Mode	**Enabled** or **Disabled** (default)
PSP Loop Mode	**Enabled**: after the last step the program starts again at the first enabled step. **Disabled** (default): it stops
PSP Steps Mask	Enables or skips each step (asterisk = enabled; toggle with the joystick moving right, save with Enter). All steps are enabled on delivery
PSP Steps Settings	Set point and time of each step: select the step, press Enter, edit the flashing value and press Enter

Table 5-4 Example program

Step	Set point	Time	Effect
S01	0.0 %	0 s	start at zero
S02	0.0 %	10 s	hold zero for 10 s

Step	Set point	Time	Effect
S03	25.0 %	25 s	ramp to 25 % in 25 s
S04	25.0 %	10 s	hold 25 % for 10 s
S05	50.0 %	25 s	ramp to 50 % in 25 s
S06	50.0 %	10 s	hold 50 % for 10 s
S07	25.0 %	30 s	ramp down to 25 % in 30 s

To run the program:

1. Enter the steps and enable **PSP Mode**.
2. Set the set point source to **PSP** (see Set point source, p. 21) and the valve mode to **Auto**.
3. Set **PSP Loop Mode** as required.
4. Go to PI screen 7 and move the joystick left to switch the run status to S: On. The screen shows the flow, the current set point, the step number and the time elapsed in the step.

Moving the joystick left again sets the run status to off: the program pauses and the set point stays at its current value until you switch it on again. Over the digital interface, use the PS command.

Interface and display settings

The settings in this section, all under **General Settings**, adapt the controller to the system around it: the serial and Modbus interfaces, the analogue signals and the display.

Communication port

Under **General Settings** › **Communication Port** you set up the main digital interface. It is configured on delivery to match your order.

Setting	Range	Default
UART Transceiver Mode	**Disabled**, RS-232 or RS-485	as ordered
Baud Rate Settings	1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200 baud; must match the computer or PLC	9600
RS-485 Bus Address	01–FF (two hexadecimal characters); RS-485 only	11
RS-485 Termination	Connects the internal 120 Ω resistor between the RS-485 lines	**Disabled**

NOTICE

Connecting the controller to a computer or PLC that uses another interface type can damage it or make it malfunction. Before you change the interface type, make sure the computer or PLC uses the same type.

Every controller on an RS-485 bus needs its own address. Address 00 is the global address: all controllers execute a command sent to it, but none replies. Never assign 00 to a controller, and never give two controllers on one bus the same address — the messages collide and communication fails.

NOTICE

Enabling the termination while the interface is set to RS-232 damages the controller or disturbs communication. Never enable the termination while the interface is set to RS-232.

Reflections at the ends of a long RS-485 cable disturb communication, so each end of the bus needs a line termination. If the controller is the last device on a line of more than 100 m, enable **RS-485 Termination**.

Modbus interface (option)

Controllers with the Modbus option communicate over Modbus RTU on an isolated RS-485 transceiver with its own RJ45 connector; a PLC or computer reads and writes the controller's parameters directly in registers. For the register description, contact Analyt-MTC. Under **`General Settings`** › **`ModBus Interface`**:

Setting	Range	Default
`Dev. ModBus Address`	1–247 (decimal); unique on the segment	11
`Baud Rate Settings`	2400, 4800, 9600, 19200, 38400, 57600 or 115200 baud	9600
`ModBus Com. Parity`	**`None`**, **`Odd`** or **`Even`**	**`None`**
`ModBus Com. StopBit`	1 or 2	2

Set baud rate, parity and stop bits to the values the Modbus master uses; all devices on the master need the same settings.

Analogue output

Under **`General Settings`** › **`Analog Output`**:

NOTICE

During the output test the analogue output does not represent the flow, so any device reading it receives a wrong value. Use the test only for troubleshooting, when Analyt-MTC support asks for it.

`Analog Output Mode`	0–5 V DC (load at least 5 kΩ), 0–10 V DC (at least 5000 Ω) or 4–20 mA (sourcing, loop at most 500 Ω). Check the load before you change the mode; a load outside these limits can damage the output or give wrong readings.
`Analog Output Cal.`	Recalibrates the output (see below).
`Analog Output Test`	Sets the output to a value you enter, 0.0–110.0 % of full scale, for troubleshooting. Enter the value and press Enter; **`Esc`** ends the test and the output returns to the actual flow.

NOTICE

The 4–20 mA output is self-powered (sourcing, not isolated), and an external voltage source on it can damage the circuit. Never connect an external voltage source to it (see Analogue output, p. 15).

Calibrating the analogue output

The output was calibrated at the factory. Recalibrate it only if components of the output circuit have been replaced or Analyt-MTC support asks you to. The calibration stores scale (and, for 4–20 mA, offset) values from two points, 0 and 100 % of full scale.

NOTICE

Changing the stored scaling values invalidates the factory calibration supplied with the controller. Recalibrate the analogue output only if components of the output circuit have been replaced or Analyt-MTC support asks you to.

1. Let the controller run for at least 30 minutes, and note which output mode is set.
2. Connect a voltmeter (voltage modes) or an ammeter (4–20 mA) to pin 6 (+) and pin 4 (−) of the Mini-DIN connector.
3. Start **`Analog Output Cal.`** and follow the prompts: adjust each calibration point with the joystick until the meter reads the requested value. **`Esc`** aborts.

4. At the end the controller shows the new offset and span. Press Enter to save them, or **Esc** to leave without saving. A message confirms the result.

Analogue input

Under **General Settings** › **Analog Input** select the set point input type: 0–5 V DC or 0–10 V DC (input impedance 100 kΩ) or 4–20 mA (250 Ω). **Analog Input Test** shows the input signal in % of full scale, for troubleshooting. Over the digital interface the input can also be damped (`AI,D`, 0 to 100; default 0, no averaging).

The input was calibrated at the factory; recalibrate it only after a repair of the input circuit or when Analyt-MTC support asks you to — changing the stored values invalidates the factory calibration.

NOTICE

More than 12 V DC on the analogue input damages the input circuit or gives wrong readings. Never apply more than 12 V DC to the analogue input.

1. Let the controller run for at least 30 minutes.
2. Connect a reference voltage or current source to pin 3 (+) and pin 4 (−) of the Mini-DIN connector.
3. Start **Analog Input Cal.**, apply the requested signal levels and confirm each with Enter.
4. Save the new offset and span with Enter, or leave without saving with **Esc**.

Display settings

Under **General Settings** › **Display & PI Screens**:

Setting	Function	Default
Display Oper. Mode	**Static**: page through the PI screens with the joystick. **Dynamic**: the screens change automatically	Static
Screen Cycle Time	Time each screen is shown in dynamic mode: 1–3600 s	
PI Screens Config.	Shows or hides each PI screen (asterisk = shown; toggle with the joystick moving right, save with Enter). Hidden screens are skipped; screen 1 cannot be hidden	all shown
OLED Brightness	Brightness in normal operation, 256 levels; 127 suits room temperature (20 °C)	127
Screen Saver Mode	**Disabled**, **Low Brightness**, **Vertical Scrolling** or **OLED Off**	**Vertical Scrolling**
OLED SS Time Out	Seconds without using **Esc** or the joystick before the screen saver starts	900 s
OLED SS Brightness	Brightness in the **Low Brightness** screen saver, 127 levels	
Flow Rate Precision	**Normal**: precision chosen automatically from unit and full scale. **Elevated**: one more decimal place	Normal

An OLED screen can keep a faint image of content that stays unchanged for long; the screen saver prevents this. Using **Esc** or the joystick restores normal brightness and restarts the time-out. A changed screen saver setting takes effect from the next screen saver cycle. If nobody reads the display — for example in a closed cabinet — select **OLED Off**. If the last digit keeps changing with the **Elevated** setting, return to **Normal**.

Push-button functions

All DPC models have a small push button behind a hole in the left side of the housing (Figure 2-1, item 12). It works whether the controller is set for analogue or digital operation, and is the only local control

on a controller without display. What it does depends on how long you hold it; the status LED tells you which window you are in.

Table 5-5 Push button

Hold for	Status LED	Released in this window, the controller
up to 6 s	amber flashes	shows its interface: 1 flash = interface disabled, 2 = RS-232, 3 = RS-485. Nothing else happens.
6–12 s	amber, on/off every 2 s	resets: the program restarts with a self-test, and all warnings and error messages are cleared.
12–18 s	green, on/off every 2 s	starts auto zero. Make sure there is no flow and the controller has been powered for at least 15 minutes.
18–24 s	steady red	opens a 14-second window for a totaliser reset or an interface change (below).

In the 14-second window, press the button the number of times for the action you want. Hold each press until the green LED has come on and gone off again (about 2 seconds); when you release it, the red LED comes back on, ready for the next press.

Presses	Action
1	Reset totaliser 1
2	Reset totaliser 2
3	Reset both totalisers
4	Switch the interface one step: disabled → RS-232 → RS-485 → disabled

If you do not press within the window, or release a press too early, nothing happens: the button returns to its normal state and the green LED comes on.

Diagnostic screens

Under **`Alarm & Diagnostic`** five read-only screens show internal values. They are meant for troubleshooting together with Analyt-MTC support, who will tell you what to read out; their content depends on model, configuration and operating state.

`Sensors ADC Reading`	Raw and averaged converter counts of the differential and absolute pressure sensors
`Temperature Sensors`	Counts and values of the gas temperature, the sensor temperatures and the CPU temperature
`AnalogOut & PO Queue`	Analogue output mode and converter counts; number of pulses waiting in the pulse output queue
`Sol. Valve Parameters`	Control loop terms and valve parameters
`Miscellaneous Param.`	The 2.5 V reference voltage and values of the temperature and pressure compensation

CHAPTER 6

Communication

Over RS-232 or RS-485 a computer or PLC reads every value of the controller and changes every setting with short ASCII commands. A terminal program is enough to try them out. Connection and wiring are described in Digital interface (p. 16); interface settings in Communication port (p. 29).

Command structure

All characters are printable ASCII. A command is a command code followed by up to four comma-separated arguments and a carriage return (**<CR>**); line feeds are ignored. On RS-485 every command starts with `!` and the two-character hexadecimal address of the controller; on RS-232 both are left out.

Interface	Structure	Example: read the flow
RS-232	`Cmd,Arg1,Arg2,Arg3,Arg4`**<CR>**	`F`**<CR>**
RS-485	`!Addr,Cmd,Arg1,Arg2,Arg3,Arg4`**<CR>**	`!11,F`**<CR>**

Note

On RS-232, omit the start character and the address: they are used only on RS-485. On RS-485, address 00 reaches all controllers at once and none of them replies, so do not assign it to a controller.

Examples

For a controller at RS-485 address 12 (hexadecimal):

Task	Command	Reply
Read the selected gas	`!12,G`	`!12,G:0,AIR` — gas 0, air
Read the flow alarm status	`!12,FA,R`	`!12,FAR:N` — no alarm
Read mass and volumetric flow	`!12,F`	`!12,50.0,50.3`
Set the set point to 100.0	`!12,SP,100.0`	`!12,SP:100.0`
Set flow alarm limits to 90 % and 10 %	`!12,FA,C,90.0,10.0`	`!12,90.00,10.00,`

Setting the address of an unknown controller

To give a controller without display a new RS-485 address when you do not know its current one, connect it as the only device on the bus and send `!00,MW,118,XX`**<CR>**, where `XX` is the new address, 01 to FF. From then on the controller answers to the new address.

Command reference

Commands are shown in RS-232 form; on RS-485 put `!Addr,` in front. Sent without its last argument, a setting command returns the current value. Values are in the currently selected units unless stated otherwise; % FS means percent of full scale. An asterisk (*) marks the factory setting.

Table 6-1 Readings and device information

Command	Function	Reply (example)
F	Mass flow and volumetric flow	`50.0,50.3`

Command	Function	Reply (example)
FM · FV	Mass flow only · volumetric flow only	50.0
GT · GP	Gas temperature · gas absolute pressure	24.51 · 14.66
PI	All process values: mass flow, volumetric flow, totaliser 1, totaliser 2, temperature, pressure, flow, temperature and pressure alarm status (D disabled, N no alarm, H high, L low), alarm and diagnostic event registers (hex)	25.4,23.2,354.2,0.0,24.8, 14.95,D,N,D,0x0,0x0
DI	Device information: gas number and name, full scale in L/min, mass and volumetric unit, totaliser 1 and 2 mode (E/D), analogue output mode (0 = 0–5 V, 1 = 0–10 V, 2 = 4–20 mA), Modbus hardware (0 = installed, 1 = not installed)	DI:5,Helium,0.200,Sml/min, ml/min,E,D,0,1

Table 6-2 Set point and valve

Command	Function	Reply (example)
SP,value	Set point, in the current mass flow unit; at most 125 % of full scale	SP:10.00
M,source	Set point source: A analogue, D digital, L local, P program	M:D
LS,S,value	Saved local set point. It is written to EEPROM: write it no more than once a minute	LSS:10.00
LS,M,E|D	Local and digital set point merge on/off	LSM:D
LS,A,E|D	Local set point auto start on/off	LSA:D
V,M,C|A|O	Valve mode: closed, auto, open. Before O, read the precautions in Valve modes, p. 21; leave the valve open for 15 minutes at most	VM:A
V,L,0–2	Loop type: 0 = PD*, 1 = PID, 2 = PIDD. Change only on Analyt-MTC's advice	VL:0
V,P,term,value	Control terms: P, I, D (0.0–5.0); valve bias B (0.0–0.8) and coefficient M (KmP, 0.0–9.99) belong to the valve — do not change them	VPP:0.08
V,P,R	Restore the factory control terms (P, I, D, bias, KmP)	VPR:0.08,0.009,0.16,0.128, 3.125
AT,value	Start auto tune at a set point of 2.0–100.0 % FS	AT:80.0
AT,S · AT,D	Auto tune status (I running, N not started, D done, F failed) with P, I, D · stop auto tune	ATS:D,0.108,0.054,0.2163
AT,V,1–99	Auto tune valve delay, in steps of 100 ms	ATV:3
AT,O,value	Auto tune oscillation criterion, 0.2–25.0 % FS	ATO:2.0
PS,C,R|S	Run or stop the program set point; PS,C,step,R starts at step 1–16	PSC:R,11 (running, step 11)
PS,M,E|D · PS,L,E|D	Program mode · program loop mode	PSM:D
PS,P,step,SP,time	Step 1–16: set point 0–100 % FS, time 0–86400 s. With the step number only: read the step	PSP02:50.0,25
PS,A,mask	Step mask, 0x0000–0xFFFF (all six characters); set bit = step enabled	PSA:0xFFFE

Table 6-3 Gas, units and reference conditions

Command	Function	Reply (example)
G,number	Select gas 0–128 on a controller configured for non-corrosive gases (gas numbers in Appendix B (p. 52)); without argument: read	G:5,He
CM	Number of stored mixtures (0–20)	CM:3
CM,index	Name and number of components of mixture 200–219	CM:200,4,MyMix1

Command	Function	Reply (example)
CM,index,C	Components (gas number, ratio) of mixture 200–219	CMC:200,2,0,65.0,4,35.0,MyMix2
CM,index,gases,ratios,name	Create mixture 200–219: gas numbers and ratios (0.01–99.99 %) separated by semicolons, same count, ratios adding up to 100 %; name up to 6 characters	CM:201,MyMix3,5
CM,D	Delete the mixture with the highest number	CMD:202
U,unit	Mass flow and totaliser unit (Appendix A (p. 50); %FS*)	U:SmL/min
U,USER,k,base,density	Define the user unit: factor (> 0), time base (0 s, 1 min, 2 h, 3 day), use density (0 no, 1 yes). U,USER selects it	U:USER,1.5,1,0
VU,unit	Volumetric flow unit (%FS*)	VU:mL/min
PU,unit	Pressure unit; %FS refers to the range of the absolute pressure sensor	PU:PSIA
TU,F|C|K|R	Temperature unit	TU:F
C,S,T,P · C,N,T,P	Standard · normal conditions, temperature in °F, pressure in psia (factory: 70.00 °F and 32.00 °F, 14.6959 psia)	CS:70.0,14.696
C,T · C,T,Z	Hours on the calibration/maintenance timer · reset it	CT:1024.2
C,P	Hours since power-up	CP:148.7

Table 6-4 Alarms, relay and events

Command	Function	Reply (example)
FA,C,high,low	Flow alarm limits, high 0.1–110.0 and low 0.0–109.9 % FS	FAC:40.10,20.50
FA,E · FA,D	Enable · disable* the flow alarm	FA:E
FA,R	Flow alarm status: N none, H high, L low	FAR:N
FA,A,s · FA,P,s	Action delay · power-up delay, 0–3600 s	FAA:5
FA,L,0|1	Latch off* / on	FAL:0
FA,V,0–2	Valve close action: 0 off*, 1 on high alarm, 2 on low alarm	FAV:0
FA,S	All flow alarm settings: mode, high, low, action delay, latch, power-up delay	FAS:E,40.00,20.00,2,0,8
TA, …	Temperature alarm, same arguments as FA without V; limits in kelvin, high 253.16–343.15, low 253.15–343.14	TAC:333.25,263.15
PA, …	Pressure alarm, same arguments as FA without V; limits in psia, high 0.1–100.00, low 0.0–90.99	PAC:60.00,10.00
R,code	Relay assignment: D* disabled, FL FH FR flow low/high/range, PL PH PR pressure, TL TH TR temperature, T1 T2 totaliser, PO pulse output, AE alarm events, DE diagnostic events, M manual on. R,S reads it	R:FH
AE · AE,R	Alarm event status register · reset it to 0	AE:0x0
AE,M,value · AE,L,value	Alarm event mask · latch register, one bit per event (see below), written with all six characters	AEM:0x11
DE, DE,R, DE,M, DE,L	Diagnostic event registers, as for AE (all six characters)	DEM:0x101
S,0–5	Status LED mode: 0 normal, 1 flow alarm and totalisers, 2 alarm events, 3 diagnostic events, 4 serial interface, 5 Modbus	S:1

In the event registers each event is one bit: event 0 = 0x0001, 1 = 0x0002, 2 = 0x0004 and so on up to event F = 0x8000. The events are listed in Table 5-2, p. 27, and Table 5-3, p. 27.

Table 6-5 Totalisers, pulse output and analogue signals

Command	Function	Reply (example)
`T,n,R`	Reading of totaliser `n` (1 or 2)	`T1R:354.2`
`T,n,Z`	Reset the totaliser to zero (not possible while locked)	`T1Z`
`T,n,E` · `T,n,D`	Enable · disable* the totaliser	`T1:E`
`T,n,C,start,volume`	Flow start (0.0–100.0 % FS) and action volume (0 = no event)	`T2C:2.0,20580.5`
`T,n,P,s`	Power-on delay, 0–3600 s	`T1P:10`
`T,n,A,0|1` · `T,n,I,s`	Auto reset off / on · auto reset delay, 0–3600 s	`T1A:0`
`T,n,O,D|V`	Over-limit action: none, or close the valve	`T1O:D`
`T,n,L,0|1`	Reset lock: 0 unlocked*, 1 locked	`T1L:0`
`T,n,B`	Restore the reading from the backup copy	`T1B`
`T,n,S`	Settings: mode, flow start, action volume, power-on delay, auto reset, auto reset delay	`T1S:E,0.5,2045.2,10,0,5`
`P,E` · `P,D`	Enable · disable* the pulse output	`P:E`
`P,U,value`	Quantity per pulse (not a time-based unit)	`PU:10`
`P,T,ms`	Pulse active time; at least 50 ms and at most half the pulse period	`PT:100`
`P,F,value`	Flow start, 0.0–100.0 % FS	`PF:1.0`
`P,Q` · `P,S`	Pulses waiting in the queue · settings (mode, flow start, quantity per pulse, active time)	`PS:E,1.0,1.666,100`
`AO,M,0–2`	Analogue output mode: 0 = 0–5 V, 1 = 0–10 V, 2 = 4–20 mA	`AOM:1`
`AO,S`	Analogue output alarm: `N` normal, `Y` fault detected	`AOS:N`
`AI,M,0–2`	Analogue input mode, as for the output	`AIM:0`
`AI,D,0–100`	Analogue input damping; 0* = no averaging	`AID:0`

NOTICE

Writing the EEPROM parameters with `MW` can make the controller malfunction. They were set at the factory for the best performance. Use `MW` only on the instruction of Analyt-MTC support. The one exception is the address change described above.

Table 6-6 Zero, display, signal conditioning and interfaces

Command	Function	Reply (example)
`Z,N`	Start auto zero now — only with no flow, after at least 15 minutes of power	`ZN`
`Z,S` · `Z,V`	Auto zero status: tare value, converter value, `N` not started, `I` in progress, `F` failed, `D` done · current zero value	`ZS:7492,70581,N`
`Z,A,pressure`	Tare the absolute pressure sensor to the reference pressure, 13.1–15.99 psia — no flow, ports open to atmosphere. `Z,A` alone returns the tare status	`ZA`
`Z,B,0|1`	Background auto tare off / on	`AB:0`
`L`	Display installed: `Y` or `N`	`L:Y`
`L,M,S|D` · `L,T,s`	Display mode static or dynamic · screen cycle time 1–3600 s	`LM:S`
`L,S,mask`	PI screens shown: bit `0x01` screen 1 (always on), `0x02` 2, `0x04` 3, `0x08` 4, `0x10` 5, `0x40` 7, `0x80` 8 (all six characters)	`LS:0x3F`
`L,B,1–255` · `L,C,1–128`	Display brightness · screen saver brightness	`LB:127`
`L,P,0–3` · `L,O,s`	Screen saver: 0 off, 1 low brightness, 2 vertical scrolling, 3 display off · time-out 1–36000 s	`LP:2`

Command	Function	Reply (example)
`L,D,0|1`	Flow reading precision: 0 normal, 1 elevated	`LD:1`
`L,A,0–25` · `L,E,value`	Display flow averaging (samples) · display dead band, 0.0–0.99 % FS	`LA:1`
`SC,…`	Signal conditioner: `M`, `P` flow and pressure conditioning on/off (`E`*), `R`, `F`, `T` running average of flow, pressure, temperature (1–255; 1 = off), `A`, `D` pressure compensation parameters. Do not change unless Analyt-MTC support asks you to	`SCM:E`
`MB,A,1–247`	Modbus address (11*)	`MBA:11`
`MB,B,baud`	Modbus baud rate, 1200–115200 (9600*)	`MBB:9600`
`MB,P,0–2` · `MB,S,1|2`	Modbus parity: 0 none*, 1 odd, 2 even · stop bits (2*)	`MBP:0`
`MB,D` · `MB,R`	Modbus message, CRC error, slave message and overrun counters · reset the Modbus port	`MBD:1,0,0,0`
`MR,0–413`	Read an EEPROM memory location	`value`
`MW,115–413,value`	Write an EEPROM memory location (0–114 are read-only)	

Error codes

A command the controller cannot execute is answered with an error code:

1	Command not supported
2	Wrong number of arguments
3	Address out of range (`MR`, `MW`)
4	Wrong number of characters in the argument
5	Attempt to write to a write-protected EEPROM area
6	Command or argument not found
7	Wrong argument value
8	Manufacturer access key wrong or disabled

CHAPTER 7

Calibration and verification

The flow sensor was zeroed at the factory. Zero it again only when the controller shows a flow with no gas flowing; tare the absolute pressure sensor only when its reading is no longer accurate. Analyt-MTC recommends recalibrating the controller once a year (see Recalibration (p. 39)).

Zeroing the flow sensor (auto zero)

Auto zero adjusts the differential pressure sensor so that it reads zero at zero flow. It needs a warm controller and truly no flow.

> **Note**
> A zero taken while gas flows shifts every subsequent reading. Make absolutely sure no gas flows through the controller during auto zero.

1. Let the controller run for at least 15 minutes — better 30 minutes.
2. Shut off the gas supply and set the valve mode to **`Close`**. To make sure no gas seeps in, disconnect the gas source for the duration.
3. Open **`Sensor Zero Calibr.`** › **`Start Auto Zero Now`**, select **`YES`** and press Enter. The status LED alternates red and green every two seconds, and the screen shows `AUTO ZERO IS ON!` with the raw sensor counts.
4. After 5 to 15 seconds the screen shows `AUTO ZERO IS DONE!` and the LED returns to steady green. Press any button.

Auto zero can also be started with the push button (see Push-button functions (p. 31)) or with the `Z,N` command. It succeeds when the sensor can be brought within 0 ±7 counts. If not, the LED turns steady red and the screen shows `Auto Zero ERROR!`. If the error returns after a further attempt, the sensor is probably defective: send the controller to Analyt-MTC for service.

Taring the absolute pressure sensor

The absolute pressure sensor was calibrated at the factory and needs no calibration. Depending on the installation, an occasional tare against a reference improves its accuracy. You need an absolute pressure reference accurate to at least 0.2 % of reading; the tare is only as good as the reference.

> **Note**
> A tare taken with flow, or with a port closed, offsets the absolute pressure reading. Tare the absolute pressure sensor only with no flow and with both ports open to atmosphere.

1. Let the controller run for at least 15 minutes — better 30 minutes.
2. Open both the inlet and the outlet port to atmosphere, so that there is no flow.
3. Open **`Sensor Zero Calibr.`** › **`Start AP Auto Tare`**, select **`YES`** and press Enter.
4. Enter the ambient pressure read from your reference and press Enter. The controller tares the sensor and confirms the result.

Over the digital interface the tare is started with `Z`, `A`, `pressure`, the reference pressure in psia (13.1 to 15.99). The same menu also lets you view the zero parameters and switch the background auto tare on or off.

Recalibration

Analyt-MTC recommends recalibrating the controller once a year. When the calibration is due, contact Analyt-MTC with the model and serial number; see Service, warranty and contacts (p. 48) for the procedure. The hours since the last calibration can be read over the digital interface with `C`, `T` and reset after the calibration with `C`, `T`, `Z`.

NOTICE

A flow calibration needs a gas flow laboratory with traceable standards, and without them the flow measurement cannot be calibrated correctly. Do not try to recalibrate the flow measurement yourself.

CHAPTER 8

Maintenance

A controller that flows clean, dry gas through a suitable filter needs no routine maintenance apart from its yearly calibration. This chapter explains what you can check yourself; how to trace the most common problems is described in Troubleshooting (p. 41).

General care

The flow element consists of narrow stainless-steel channels. Particles or gas that crystallises in them change the restriction and therefore the reading, so keep the gas clean, dry and filtered (see Gas quality and filters, p. 12). Keep the controller away from vibration, hot or corrosive surroundings and strong radio-frequency or magnetic fields. No other maintenance is required.

⚠ WARNING

A controller that has carried toxic, infectious, corrosive or radioactive gas holds residues that endanger the people who handle it. Before you remove such a controller, purge it completely and neutralise any residue. Analyt-MTC cannot accept a contaminated controller (see Sending in a controller, p. 48).

Cleaning

If the controller reads wrongly or cannot reach its set point, switch off the gas and the power, remove the controller and look into the inlet and outlet ports. Remove any debris you can see at the ports. If the blockage remains, do not take the controller apart: send it to Analyt-MTC for cleaning.

NOTICE

Taking the flow body apart can disturb the calibration, and a cleaned flow element always has to be recalibrated. Do not take the controller apart yourself.

CHAPTER 9

Troubleshooting

Many problems have a simple cause. Before you work through the table, check these points:

- All cables are plugged in firmly, and the gas connections are free of leaks.
- The power supply delivers the voltage and current your model needs — with several controllers on one supply, enough current for all of them (see Power supply, p. 15).
- The wiring matches the pin assignment of the Mini-DIN connector (see p. 14); other makes may differ.
- There is enough differential pressure across the controller for the flow you ask for.

The alarm and diagnostic events the controller reports are listed in Table 5-2, p. 27, and Table 5-3, p. 27; the error codes of the serial interface under Error codes, p. 37.

Power, display and signals

Symptom	What to do
Status LED and display stay dark; no output signal	Measure the supply voltage at pins 7 (+) and 8 (−). If it is missing or too low, replace the supply or correct the polarity. If the voltage is right and the controller still does not start, it needs repair: contact Analyt-MTC.
The 0–5 V output fluctuates	Check pins 6 and 4 for a short circuit or overload. The load on the output must be at least 5 kΩ.
The display reads correctly but the voltage output does not change	Either the output circuit is damaged — contact Analyt-MTC — or its stored scaling is corrupted: recalibrate the output (see Calibrating the analogue output (p. 30)).
The 4–20 mA output stays at about 4 mA	The current loop is open, its resistance exceeds 500 Ω, or the output is damaged. Check the loop wiring and load; if they are right, contact Analyt-MTC.
The reading flashes	The value is outside the sensor range — the flow, for example, above 133 % of full scale — and is not accurate. Reduce the flow. If the reading flashes in normal operation, the controller may be defective: contact Analyt-MTC.
The flow at the end of a long analogue cable is lower than the set point	The voltage drops along the cable. On runs of more than 100 ft use wire of at least 22 AWG.

Flow and control

Symptom	What to do
The controller shows a flow when no gas flows	Run an auto zero (see Zeroing the flow sensor (p. 38)).
The reading is off by more than ±0.5 % of full scale	The zero has shifted. Shut off the gas, disconnect the gas source, wait one minute and run an auto zero.
No gas flows	Check the valve mode: in **`Close`** the valve stays shut — set it to **`Auto`**. Check that the set point source is the one you use and that the set point is above zero (see Set point source (p. 21)).
The flow stays below the set point	The differential pressure across the controller is too low for this flow (see Pressure drop, p. 44). Raise the inlet pressure or lower the outlet pressure.
The flow responds slowly or oscillates	Restore the factory control settings (**`Restore Valve PID`**, see Loop types and terms (p. 23)). Check that the differential pressure is not much higher than needed; if it is, reduce it.

Symptom	What to do
The controller disagrees with another flow meter in the line	Check that both are set to the same gas and to the same standard reference conditions (see Reference conditions (p. 23)), and look for a leak between the two instruments.

Digital communication

Symptom	What to do
The controller does not answer over RS-232 or RS-485	• Check the wiring for the interface type that is set (see Digital interface (p. 16)); the push button shows the type (p. 31). • Check that the software uses the right COM port and the same baud rate as the controller. • On RS-485, check that the command carries the controller's address and that no two devices on the bus share an address.

CHAPTER 10

Specifications

The data below apply to the DPC models covered by this manual. The calibration documents shipped with your controller state its gas, range and calibration conditions and are binding for your controller.

Measurement and control

Table 10-1 Performance and operating data

PERFORMANCE	
Accuracy[1]	±0.5 % of reading + 0.2 % of full scale
Repeatability	±0.2 % of full scale
Temperature coefficient	0.05 % of full scale per °C or better
Pressure coefficient	0.01 % of full scale per psi (6.895 kPa) or better
Response time	150 ms (default), adjustable; longer for full scales up to 20 smL/min and above 100 sL/min
Warm-up time	< 5 s
Operating range	0.5–100 % of full scale; controllable up to 125 % of full scale
Turndown ratio	200:1
GAS AND CALIBRATION	
Flow medium	Clean gases; not for liquids. Corrosive gases (Pure corrosives, Refrigerants): corrosion-resistant models only (Appendix B (p. 52))
Calibration conditions	14.7 psia (101.4 kPa) and 70 °F (21.1 °C), unless other conditions were ordered
Mass flow reference conditions	21.11 °C, 1013.25 mbar; for others, ask Analyt-MTC (see Reference conditions (p. 23))
VALVE AND PRESSURE	
Control valve	Proportional, normally closed
Pressure ratings	See Table 3-1, p. 12, and the valve ratings, p. 13
Leak integrity	1×10^{-9} sccs helium maximum, to the outside
ENVIRONMENT	
Operating temperature	−10 to +60 °C (14–140 °F)
Humidity	0–100 %, non-condensing
Ingress protection	IP40
Installation category, pollution degree	Level II, degree II (IEC 664)
Mounting attitude	See Mounting (p. 13)

[1] At the calibration temperature and pressure, after a tare.

Electrical data

Table 10-2 Power, signals and interfaces

	DPC04, 07, 08, 14, 17, 18, 37, 38, 47, 48	DPC57, 58, 67, 68, 77, 78
Supply voltage	12–26 V DC (at least 14 V DC with 4–20 mA output)	24–26 V DC
Supply ripple	less than 150 mV peak to peak	
Power consumption	250 mA max. (DPC04, 07, 08, 14, 17, 18); 300 mA max. (DPC37, 38, 47, 48)	650 mA max.
Protection	Reverse polarity; resettable fuses 300 mA on (+) and (−)	Reverse polarity; resettable fuses 750 mA on (+) and (−)
Analogue output	0–5 V DC (load at least 5 kΩ), 0–10 V DC (at least 5000 Ω) or 4–20 mA, sourcing (loop at most 500 Ω), selectable; noise on the voltage outputs at most 10 mV peak to peak	
Analogue set point input	0–5 V DC or 0–10 V DC (100 kΩ) or 4–20 mA (250 Ω), selectable	
Relay	Solid-state, normally open; 48 V AC peak or DC, 400 mA	
Digital interfaces	RS-232 or RS-485, selectable; Modbus RTU on an isolated RS-485 interface (option)	
Display (option)	128 × 64 yellow OLED with **Esc** button and joystick	
CE conformity	EMC Directive 2014/30/EU; CISPR 11, EN 61000-6-3, group 1, class A	

Pin assignment and wiring: Electrical connections (p. 14).

Pressure drop

Maximum pressure drop across the controller at the flows listed (air). Plan the supply pressure so that at least this difference is available between inlet and outlet.

Table 10-3 Maximum pressure drop (air, 21.11 °C, 1013.25 mbar)

Model	Flow (sL/min)	Max. pressure drop (mm H_2O)	(mbar)	(psid)	(kPa)
DPC04	0.02	56.2	5.5	0.08	0.55
DPC07, DPC08	up to 0.05	879	86	1.25	8.618
DPC14	2	133.6	13.1	0.19	1.31
DPC17, DPC18	1	1758	172	2.5	17.237
	2	2109	207	3.0	20.684
	5	5273	517	7.5	51.711
	10	12304	1207	17.5	120.66
	20	17577	1724	25.0	172.369
DPC37, DPC38	30	5273	517	7.5	51.711
	50	6328	621	9.0	—[1]
DPC47, DPC48	80	9491	931	13.5	93.079
	100	10546	1034	15.0	103.421
DPC57, DPC58	250	1758	172	2.5	17.237
DPC67, DPC68	500	4851	476	6.9	47.57
DPC77, DPC78	1000	10546	1034	15.0	103.4

[1] Not given: the published kPa value does not match the published 9.0 psid and 6328 mm H_2O.

Wetted materials and connections

Wetted materials	Stainless steel, FKM O-rings, high-temperature polyamide, alumina ceramic, epoxy, silicone, glass, gold, C36000 brass
Process connections	Female threads: 10-32 (DPC04, DPC07, DPC08), 1/8" NPT (DPC14, DPC17, DPC18), 1/4" NPT (DPC37, DPC38, DPC47, DPC48), 1/2" NPT (DPC57, DPC58), 3/4" NPT (DPC67, DPC68, DPC77, DPC78). Fittings for tube: see the product page or ask Analyt-MTC.

NOTICE

The materials above are not resistant to every gas, and no corrosion resistance is guaranteed. An incompatible process gas can corrode them. You are responsible for checking that they are compatible with your process gas.

Weights

Models	Controller	Shipping weight
DPC04, DPC07, DPC08, DPC14, DPC17, DPC18	0.635 kg (1.40 lb)	1.5 kg (3.31 lb)
DPC37, DPC38, DPC47, DPC48	0.755 kg (1.66 lb)	1.66 kg (3.66 lb)
DPC57, DPC58	4.53 kg (10.0 lb)	5.7 kg (12.5 lb)
DPC67, DPC68	4.76 kg (10.5 lb)	5.9 kg (13.0 lb)
DPC77, DPC78	5.22 kg (11.5 lb)	6.35 kg (14.0 lb)

Dimensions: Appendix C (p. 56).

CHAPTER 11

Ordering information

Order from Analyt-MTC with the order codes. The controllers below are the standard versions; for any other version, contact Analyt-MTC. Ranges are for air at standard conditions (21.11 °C, 1013.25 mbar).

Accessories

Order code	Description
CBL-A232	RS-232 cable, 3.5 mm stereo plug to 9-pin D-sub socket, 1.5 ft (supplied with RS-232 controllers)
CBL-A485	RS-485 cable, 3.5 mm stereo plug to stripped wires, 3 ft
CBL-8MINIDIN-3	Shielded 8-pin Mini-DIN cable with stripped ends, 3 ft
CBL-8MMINIDIN-12	Shielded 8-pin Mini-DIN cable with stripped ends, 12 ft
USB-RS232	USB to RS-232 converter
USB-RS485	USB to RS-485 converter
PS-GFM-240UK-2	Power supply 240 V AC / 12 V DC, UK plug
PS-GFM-240UK-4	Power supply 240 V AC / 24 V DC, UK plug
PS-GFM-240AU-2	Power supply 240 V AC / 12 V DC, Australian plug
PS-GFM-240AU-4	Power supply 240 V AC / 24 V DC, Australian plug
PS-USA	Power supply 110 V AC / 12 V DC, North America
PS-GFM-110NA-4	Power supply 110 V AC / 24 V DC, North America
PS-GFM-230EU-2	Power supply 220 V AC / 12 V DC, European plug
PS-GFM-230EU-4	Power supply 220 V AC / 24 V DC, European plug
ECS803-1	RJ45 shielded Y adapter (passive tap), for the Modbus option
TDG1026-8C	RJ45 modular coupler, for the Modbus option
MOD27T	RJ45 line terminator, 100 Ω, 0.25 W, for the Modbus option
JMOD4S-1	RJ45 splitter, fully shielded, 1 input and 4 outputs, for the Modbus option
TRD815BL-2	Category 5e patch cable, RJ45 to RJ45, blue, 2 ft
TRD815BL-10	Category 5e patch cable, RJ45 to RJ45, blue, 10 ft
TRD815BL-25	Category 5e patch cable, RJ45 to RJ45, blue, 25 ft
F1C5	Compression fitting, 10-32 thread, 1/8 in tube, 316 stainless steel (DPC04, DPC07, DPC08)
F2C5	Compression fitting, 10-32 thread, 1/8 in tube, nickel-plated brass (DPC04, DPC07)
F2C2	Compression fitting, 1/8 in NPT thread, 1/8 in tube, 316 stainless steel (DPC14, DPC17, DPC18)
F2C4	Compression fitting, 1/8 in NPT thread, 1/4 in tube, 316 stainless steel (DPC14, DPC17, DPC18)
F4C4	Compression fitting, 1/4 in NPT thread, 1/4 in tube, 316 stainless steel (DPC37)
F4C6	Compression fitting, 1/4 in NPT thread, 3/8 in tube, 316 stainless steel (DPC47)
F8C6	Compression fitting, 1/2 in NPT thread, 3/8 in tube, 300 series stainless steel (DPC57)
F8C8	Compression fitting, 1/2 in NPT thread, 1/2 in tube, 300 series stainless steel (DPC57)
1210-1-12-316	Compression fitting, 3/4 in NPT thread, 3/4 in tube, 300 series stainless steel (DPC67, DPC77)

The 24 V DC power supply is needed for the DPC57, DPC58, DPC67, DPC68, DPC77 and DPC78.

Controllers

		Order code			
Model	Range	Without display, without Modbus	Without display, with Modbus	With display, without Modbus	With display, with Modbus
DPC04	0.5–20 smL/min	DPC04-N0	DPC04-NM	DPC04-L0	DPC04-LM
DPC07	0.5–50 smL/min	DPC07-N0	DPC07-NM	DPC07-L0	DPC07-LM
DPC14	21 smL/min – 2 sL/min	DPC14-N0	DPC14-NM	DPC14-L0	DPC14-LM
DPC17	51 smL/min – 20 sL/min	DPC17-N0	DPC17-NM	DPC17-L0	DPC17-LM
DPC37	21–50 sL/min	DPC37-N0	DPC37-NM	DPC37-L0	DPC37-LM
DPC47	51–100 sL/min	DPC47-N0	DPC47-NM	DPC47-L0	DPC47-LM
DPC57	250 sL/min	DPC57-N0	DPC57-NM	DPC57-L0	DPC57-LM
DPC67	500 sL/min	DPC67-N0	DPC67-NM	DPC67-L0	DPC67-LM
DPC77	1000 sL/min	DPC77-N0	DPC77-NM	DPC77-L0	DPC77-LM

CHAPTER 12

Service, warranty and contacts

Calibration, repair, cleaning and technical support for your Aalborg DPC are provided by Analyt-MTC. Talk to Analyt-MTC before you send anything: many problems turn out to be settings that can be corrected on the phone, and the controller never has to leave your installation.

Contact and support

ANALYT-MTC Messtechnik GmbH

German Headquarters

Klosterrunsstraße 18, 79379 Müllheim
Germany

+49 7631 5545

info@analyt-mtc.de

French Subsidiary

175 Avenue d'Alsace, 68000 Colmar
France

+33 3 89 41 47 78

info@analyt-mtc.fr

www.analyt-mtc.com

Before you call

Have the following at hand so that Analyt-MTC can help you quickly:

- the model and serial number from the label, and the firmware version (see Power-up screens, p. 19);
- your gas, set point and inlet and outlet pressures, or the serial command and the reply.

Technical support

Analyt-MTC helps with installation, configuration, control tuning and digital communication. Have the model, serial number and firmware version at hand (see Power-up screens, p. 19), together with a description of your process: gas, set point, and inlet and outlet pressures. The contact details are given above.

Open and follow every service request in the Analyt-MTC customer portal at portal.analyt-mtc.com: where your controller is in the process, and, once the work is done, its certificates, digitally signed.

Sending in a controller

1. **Open a service request.** Open it online in the Analyt-MTC customer portal, portal.analyt-mtc.com, with the model, the serial number and the reason for service: calibration, repair or cleaning. Do not put paper forms in the box: the service request carries everything Analyt-MTC needs.
2. **Decontaminate.** If the controller has carried toxic, infectious, corrosive or radioactive gas, purge it completely and neutralise any residue before you remove it from the line. Residues of hazardous media can injure the people who unpack and service the device. In the service request, state the substances the controller has been in contact with and their hazards, and confirm the safety declaration online. If you are not sure, do not send it.

3. **Pack the controller alone.** Send the controller without power supply, cables, fittings or case unless they are part of the problem; Analyt-MTC is not responsible for accessories sent. Close the ports so that nothing enters the flow path, protect the connectors against electrostatic discharge, and pack each controller individually for transport.
4. **Ship it to Müllheim.** Send the parcel to the Analyt-MTC service centre in Müllheim, Germany, never to the Colmar address.

When the controller arrives, it is registered and assessed, and you receive a quote before any work begins: no work is done without your agreement. If you decline the quote, a bench fee and return transport are charged. Every instrument passes a final check before it is returned with its documentation. A standard service typically takes one to two weeks from arrival to dispatch; this lead time is indicative. Express service can be requested in the service request.

Warranty

The warranty terms for your controller are those agreed in your order confirmation. Warranty claims are handled by Analyt-MTC: give it the serial number and a description of the fault before returning the controller.

What the warranty covers and excludes is set out in Analyt-MTC's terms; ask Analyt-MTC if you are unsure whether an operating condition is covered. Operate the controller within its specifications and as this manual describes.

Disposal

Do not dispose of the controller with household waste. Dispose of it as electrical and electronic equipment under local regulations (WEEE). Remove batteries first where fitted and dispose of them separately.

APPENDIX A

Units of measure

The units below can be selected under Units of measure (p. 22) or over the digital interface (U, VU, PU and TU commands). The unit is entered as written in the second column; the third column shows the unit of the totaliser reading that goes with it.

Standard units (prefix S) refer to the standard conditions set in the controller, normal units (prefix N) to its normal conditions (see Reference conditions (p. 23)). True-mass units need no reference conditions. When you change the flow unit, the totaliser unit changes with it.

Table A-1 Mass flow units

No.	Flow unit	Total	Meaning
STANDARD			
1	%FS	%s	percent of full scale
2	SuL/min	SuL	microlitres per minute
3	SmL/sec	SmL	millilitres per second
4	SmL/min	SmL	millilitres per minute
5	SmL/hr	SmL	millilitres per hour
6	SL/sec	SL	litres per second
7	SL/min	SL	litres per minute
8	SL/hr	SL	litres per hour
9	SL/day	SL	litres per day
10	Sm3/min	Sm3	cubic metres per minute
11	Sm3/hr	Sm3	cubic metres per hour
12	Sm3/day	Sm3	cubic metres per day
13	Sf3/sec	Sf3	cubic feet per second
14	Sf3/min	Sf3	cubic feet per minute
15	Sf3/hr	Sf3	cubic feet per hour
16	Sf3/day	Sf3	cubic feet per day
TRUE MASS			
17	gr/sec	gr	grams per second
18	gr/min	gr	grams per minute
19	gr/hr	gr	grams per hour
20	gr/day	gr	grams per day
21	kg/min	kg	kilograms per minute
22	kg/hr	kg	kilograms per hour
23	kg/day	kg	kilograms per day
24	lb/min	lb	pounds per minute
25	lb/hr	lb	pounds per hour
26	lb/day	lb	pounds per day
27	oz/sec	oz	ounces per second
28	oz/min	oz	ounces per minute

No.	Flow unit	Total	Meaning
NORMAL			
29	NuL/min	NuL	microlitres per minute
30	NmL/sec	NmL	millilitres per second
31	NmL/min	NmL	millilitres per minute
32	NmL/hr	NmL	millilitres per hour
33	NL/sec	NL	litres per second
34	NL/min	NL	litres per minute
35	NL/hr	NL	litres per hour
36	NL/day	NL	litres per day
37	Nm3/min	Nm3	cubic metres per minute
38	Nm3/hr	Nm3	cubic metres per hour
39	Nm3/day	Nm3	cubic metres per day
40	Nf3/sec	Nf3	cubic feet per second
41	Nf3/min	Nf3	cubic feet per minute
42	Nf3/hr	Nf3	cubic feet per hour
43	Nf3/day	Nf3	cubic feet per day
USER-DEFINED			
44	USER	U	user-defined unit (see User-defined unit (p. 23))

Table A-2 Volumetric flow units

No.	Flow unit	Total	Meaning
1	%FS	%s	percent of full scale
2	uL/min	uL	microlitres per minute
3	mL/sec	mL	millilitres per second
4	mL/min	mL	millilitres per minute
5	mL/hr	mL	millilitres per hour
6	L/sec	L	litres per second
7	L/min	L	litres per minute
8	L/hr	L	litres per hour
9	L/day	L	litres per day
10	m3/min	m3	cubic metres per minute
11	m3/hr	m3	cubic metres per hour
12	m3/day	m3	cubic metres per day
13	f3/sec	f3	cubic feet per second
14	f3/min	f3	cubic feet per minute
15	f3/hr	f3	cubic feet per hour
16	f3/day	f3	cubic feet per day

Table A-3 Absolute pressure units

No.	Unit	Display	Meaning
1	PSIA	psiA	pounds per square inch
2	barA	barA	bar
3	mbarA	mbar	millibar
4	hPaA	hPaA	hectopascal
5	kPaA	kPaA	kilopascal
6	MPaA	MPaA	megapascal
7	atm	atm	atmosphere
8	g/cm2A	gcm2	gram-force per square centimetre
9	kg/cmA	kgc2	kilogram-force per square centimetre
10	inHgA	inHg	inch of mercury (0 °C)
11	mmHgA	mmHg	millimetre of mercury (0 °C)
12	cmH2OA	cmH2	centimetre of water (4 °C)
13	inH2OA	inH2	inch of water (4 °C)
14	TorrA	torr	torr
15	%FS	%FS	percent of full scale

%FS refers to the range of the absolute pressure sensor.

Table A-4 Temperature units

No.	Unit	Meaning
1	°F	degree Fahrenheit
2	°C	degree Celsius
3	K	kelvin
4	°R	degree Rankine

Over the digital interface: F, C, K or R.

APPENDIX B

Gas list

Select a gas under Selecting the gas (p. 22) or with the G command and its number; the display groups the gases as below. Your own mixtures get the numbers 200 to 219 (Defining a gas mixture (p. 22)). Numbers not listed are not assigned. The groups Pure corrosives and Refrigerants (gases 129 to 162) are supported only by the corrosion-resistant models DPC08, DPC18, DPC38, DPC48, DPC58, DPC68 and DPC78. If your gas is missing, ask Analyt-MTC.

Table B-1 Gases and gas mixtures (gas data at 70 °F and 14.696 psia)

No.	Name	Gas or composition	Viscosity µPa·s	Density g/L	Compressibility
STANDARD GASES					
0	Air	Air	18.260	1.2000	0.99963
1	Ar	Argon	22.377	1.6555	0.99932
2	CO_2	Carbon Dioxide	14.743	1.8323	0.99473
3	N_2	Nitrogen	17.625	1.1604	0.99977
4	O_2	Oxygen	20.334	1.3261	0.99931
5	He	Helium	19.668	0.1657	1.00049
6	CO	Carbon Monoxide	17.476	1.1605	0.99960
7	C_2H_4	Ethylene	10.187	1.1688	0.99402
8	C_2H_6	Ethane	9.240	1.2552	0.99208
9	n-C_4H_{10}	n-Butane	7.307	2.4853	0.96855
10	i-C_4H_{10}	i-Butane	7.402	2.4755	0.97235
11	C_3H_8	Propane	8.042	1.8576	0.98311
12	D_2	Deuterium	12.473	0.1667	1.00058
13	H_2	Hydrogen	8.820	0.0834	1.00060
14	N_2O	Nitrous Oxide	14.655	1.8332	0.99430
15	CH_4	Methane	10.950	0.6656	0.99816
16	Ne	Neon	30.847	0.8353	1.00048
17	Kr	Krypton	24.839	3.4780	0.99783
18	SF_6	Sulfur Hexafluoride	15.043	6.1212	0.98817
19	Xe	Xenon	22.710	5.4675	0.99450
20	C_2H_2	Acetylene	10.335	3.4606	0.99244
21	C25	25 % CO_2, 75 % Ar	20.455	1.6988	0.99860
22	C10	10 % CO_2, 90 % Ar	21.609	1.6728	0.99906
23	C8	8 % CO_2, 92 % Ar	21.763	1.6694	0.99911
24	C2	2 % CO_2, 98 % Ar	22.224	1.6590	0.99927
25	C75	75 % CO_2, 25 % Ar	16.612	1.7870	0.99640
26	He75	75 % He, 25 % Ar	23.053	0.5376	1.00056
27	He25	25 % He, 75 % Ar	23.043	1.2822	1.00003
28	A1025	90 % He, 7.5 % Ar, 2.5 % CO_2	21.315	0.3187	1.00054
29	Star29	Stargon CS: 90 % Ar, 8 % CO_2, 2 % O_2	21.731	1.6628	0.99911
30	P5	95 % Ar, 5 % CH_4	22.147	1.6061	0.99928

No.	Name	Gas or composition	Viscosity µPa·s	Density g/L	Compressibility
BIOREACTOR GASES					
36	Bio-5M	5 % CH_4, 95 % CO_2	14.654	1.7701	0.99499
37	Bio-10M	10 % CH_4, 90 % CO_2	14.559	1.7147	0.99523
38	Bio-15M	15 % CH_4, 85 % CO_2	14.459	1.6564	0.99545
39	Bio-20M	20 % CH_4, 80 % CO_2	14.353	1.5979	0.99567
40	Bio-25M	25 % CH_4, 75 % CO_2	14.241	1.5394	0.99589
41	Bio-30M	30 % CH_4, 70 % CO_2	14.121	1.4809	0.99610
42	Bio-35M	35 % CH_4, 65 % CO_2	13.993	1.4225	0.99630
43	Bio-40M	40 % CH_4, 60 % CO_2	13.856	1.3641	0.99649
44	Bio-45M	45 % CH_4, 55 % CO_2	13.710	1.3058	0.99667
45	Bio-50M	50 % CH_4, 50 % CO_2	13.552	1.2474	0.99685
46	Bio-55M	55 % CH_4, 45 % CO_2	13.383	1.1892	0.99702
47	Bio-60M	60 % CH_4, 40 % CO_2	13.199	1.1309	0.99718
48	Bio-65M	65 % CH_4, 35 % CO_2	13.001	1.0726	0.99733
49	Bio-70M	70 % CH_4, 30 % CO_2	12.784	1.0144	0.99747
50	Bio-75M	75 % CH_4, 25 % CO_2	12.548	0.9562	0.99761
51	Bio-80M	80 % CH_4, 20 % CO_2	12.289	0.8981	0.99773
52	Bio-85M	85 % CH_4, 15 % CO_2	12.005	0.8399	0.99785
53	Bio-90M	90 % CH_4, 10 % CO_2	11.690	0.7818	0.99796
54	Bio-95M	95 % CH_4, 5 % CO_2	11.340	0.7237	0.99807
BREATHING GASES					
56	EAN-32	32 % O_2, 68 % N_2	18.554	1.2134	0.99961
57	EAN-36	36 % O_2, 64 % N_2	18.665	1.2201	0.99960
58	EAN-40	40 % O_2, 60 % N_2	18.776	1.2267	0.99958
59	HeOx-20	20 % O_2, 80 % He	21.161	0.3974	1.00057
60	HeOx-21	21 % O_2, 79 % He	21.164	0.4090	1.00057
61	HeOx-30	30 % O_2, 70 % He	21.120	0.5133	1.00055
62	HeOx-40	40 % O_2, 60 % He	20.994	0.6292	1.00050
63	HeOx-50	50 % O_2, 50 % He	20.851	0.7452	1.00042
64	HeOx-60	60 % O_2, 40 % He	20.715	0.8612	1.00030
65	HeOx-80	80 % O_2, 20 % He	20.500	1.0934	0.99993
66	HeOx-99	99 % O_2, 1 % He	20.339	1.3145	0.99935
67	EA-40	Enriched air, 40 % O_2	19.156	1.2506	0.99952
68	EA-60	Enriched air, 60 % O_2	19.560	1.2757	0.99945
69	EA-80	Enriched air, 80 % O_2	19.953	1.3009	0.99938
70	Metabol	Metabolic Exhalant (16 % O_2, 78.04 % N_2, 5 % CO_2, 0.96 % Ar)	18.049	1.2250	0.99953
CHROMATOGRAPHY GASES					
71	P-5	5 % CH_4, 95 % Ar	22.147	1.6061	0.99928
72	P-10	10 % CH_4, 90 % Ar	21.900	1.5566	0.99924
FUEL GASES					
74	SynG-1	40 % H_2, 29 % CO, 20 % CO_2, 11 % CH_4	15.253	0.8078	0.99952
75	SynG-2	64 % H_2, 28 % CO, 1 % CO_2, 7 % CH_4	14.781	0.4428	1.00033
76	SynG-3	70 % H_2, 4 % CO, 25 % CO_2, 1 % CH_4	14.725	0.5672	0.99990

No.	Name	Gas or composition	Viscosity µPa·s	Density g/L	Compressibility
77	SynG-4	83 % H_2, 14 % CO, 3 % CH_4	13.737	0.2515	1.00052
78	NatG-1	93 % CH_4, 3 % C_2H_6, 1 % C_3H_8, 2 % N_2, 1 % CO_2	11.020	0.7164	0.99799
79	NatG-2	95 % CH_4, 3 % C_2H_6, 1 % N_2, 1 % CO_2	11.006	0.6997	0.99804
80	NatG-3	95.2 % CH_4, 2.5 % C_2H_6, 0.2 % C_3H_8, 0.1 % n-C_4H_{10}, 1.3 % N_2, 0.7 % CO_2	10.998	0.6989	0.99805
81	Coal Gas	50 % H_2, 35 % CH_4, 10 % CO, 5 % C_2H_4	12.234	0.4764	0.99890
82	Endo	75 % H_2, 25 % N_2	13.713	0.3525	1.00052
83	HHO	66.67 % H_2, 33.33 % O_2	16.838	0.4971	1.00042
84	HD-5	LPG: 96.2 % C_3H_8, 1.5 % C_2H_6, 0.4 % C_3H_6, 1.9 % n-C_4H_{10}	8.057	1.8597	0.98306
85	HD-10	LPG: 85 % C_3H_8, 10 % C_3H_6, 5 % n-C_4H_{10}	8.061	1.8793	0.98275
LASER GASES					
89	LG-4.5	4.5 % CO_2, 13.5 % N_2, 82 % He	19.876	0.3744	1.00054
90	LG-6	6 % CO_2, 14 % N_2, 80 % He	19.810	0.4042	1.00052
91	LG-7	7 % CO_2, 14 % N_2, 79 % He	19.770	0.4207	1.00051
92	LG-9	9 % CO_2, 15 % N_2, 76 % He	19.644	0.4638	1.00047
93	HeNe-9	9 % Ne, 91 % He	22.267	0.2237	1.00048
94	LG-9.4	9.4 % CO_2, 19.25 % N_2, 71.35 % He	19.488	0.5127	1.00046
O_2 CONCENTRATOR GASES					
99	OCG-89	89 % O_2, 7 % N_2, 4 % Ar	20.276	1.3277	0.99934
100	OCG-93	93 % O_2, 3 % N_2, 4 % Ar	20.373	1.3343	0.99933
101	OCG-95	95 % O_2, 1 % N_2, 4 % Ar	20.422	1.3377	0.99932
STACK GASES					
104	FG-1	2.5 % O_2, 10.8 % CO_2, 85 % N_2, 1 % Ar	17.554	1.2415	0.99939
105	FG-2	2.9 % O_2, 14 % CO_2, 82.1 % N_2, 1 % Ar	17.489	1.2635	0.99927
106	FG-3	3.7 % O_2, 15 % CO_2, 80.3 % N_2, 1 % Ar	17.485	1.2716	0.99923
107	FG-4	7 % O_2, 12 % CO_2, 80 % N_2, 1 % Ar	17.642	1.2570	0.99933
108	FG-5	10 % O_2, 9.5 % CO_2, 79.5 % N_2, 1 % Ar	17.782	1.2453	0.99940
109	FG-6	13 % O_2, 7 % CO_2, 79 % N_2, 1 % Ar	17.922	1.2336	0.99947
WELDING GASES					
114	C-2	2 % CO_2, 98 % Ar	22.224	1.6590	0.99927
115	C-8	8 % CO_2, 92 % Ar	21.763	1.6694	0.99911
116	C-10	10 % CO_2, 90 % Ar	21.609	1.6728	0.99906
117	C-15	15 % CO_2, 85 % Ar	21.225	1.6815	0.99891
118	C-20	20 % CO_2, 80 % Ar	20.840	1.6902	0.99876
119	C-25	25 % CO_2, 75 % Ar	20.455	1.6988	0.99860
120	C-50	50 % CO_2, 50 % Ar	18.525	1.7426	0.99764
121	C-75	75 % CO_2, 25 % Ar	16.612	1.7870	0.99640
122	He-25	25 % He, 75 % Ar	23.043	1.2822	1.00003
123	He-50	50 % He, 50 % Ar	23.467	0.9097	1.00041
124	He-75	75 % He, 25 % Ar	23.053	0.5376	1.00056
125	He-90	90 % He, 10 % Ar	21.817	0.3145	1.00055
126	A1025	90 % He, 7.5 % Ar, 2.5 % CO_2	21.315	0.3187	1.00054
127	Star29	Stargon CS: 90 % Ar, 8 % CO_2, 2 % O_2	21.731	1.6628	0.99911

No.	Name	Gas or composition	Viscosity µPa·s	Density g/L	Compressibility
PURE CORROSIVES (CORROSION-RESISTANT MODELS ONLY)					
129	NH_3	Ammonia	9.948	0.7132	0.98889
130	1Butene	Butylene (1-Butene)	7.607	2.3936	0.97077
131	cButene	Cis-Butene (cis-2-butene)	7.526	2.4012	0.96769
132	iButene	Iso-Butene	7.740	2.3935	0.97079
133	tButene	Trans-Butene	7.530	2.4010	0.96775
134	COS	Carbonyl Sulfide	12.195	2.5172	0.98838
135	Cl_2	Chlorine	13.351	2.9759	0.98677
136	CH_3OCH_3	Dimethylether	9.101	1.9454	0.98075
137	H_2S	Hydrogen Sulfide	12.217	1.4228	0.99203
138	NF_3	Nitrogen Trifluoride	0.996	2.9524	0.99622
139	NO	Nitric Oxide	18.926	0.5376	1.00056
140	C_3H_6	Propylene	8.446	1.7693	0.98499
141	SiH_4	Silane	11.459	1.3390	0.99424
142	SO_2	Sulfur Dioxide	12.682	2.7012	0.98221
REFRIGERANTS (CORROSION-RESISTANT MODELS ONLY)					
145	R-11	Trichlorofluoromethane	10.127	5.8437	0.96371
146	R-115	Chloropentafluoroethane	12.358	6.5234	0.98065
147	R-116	Hexafluoroethane	13.609	5.7792	0.98902
148	R-124	1-Chloro-1,2,2,2-tetrafluoroethane	11.437	5.8115	0.97255
149	R-125	Pentafluoroethane	12.795	5.0513	0.98403
150	R-134A	1,1,1,2-Tetrafluoroethane	11.666	4.3187	0.97845
151	R-14	Tetrafluoromethane	17.049	3.6593	0.99607
152	R-142b	1-Chloro-1,1-difluoroethane	10.280	4.2776	0.97295
153	R-143a	1,1,1-Trifluoroethane	11.062	3.5437	0.98218
154	R-152a	1,1-Difluoroethane	9.944	2.7986	0.97745
155	R-22	Chlorodifluoromethane	12.461	3.6367	0.98468
156	R-23	Trifluoromethane	14.724	2.9232	0.99191
157	R-32	Difluoromethane	12.446	2.1830	0.98697
158	RC-318	Octafluorocyclobutane	11.549	8.5528	0.96864
159	R-404A	44 % R-125, 4 % R-134a, 52 % R-143a	11.926	4.1144	0.98244
160	R-407C	23 % R-32, 25 % R-125, 52 % R-134a	12.119	3.6315	0.98308
161	R-410A	50 % R-32, 50 % R-125	13.176	3.0481	0.98621
162	R-507A	50 % R-125, 50 % R-143a	12.012	4.1664	0.98266

APPENDIX C

Dimensions

Dimensions in inches and millimetres. Mounting threads and port positions are shown for planning the installation; see Mounting (p. 13).

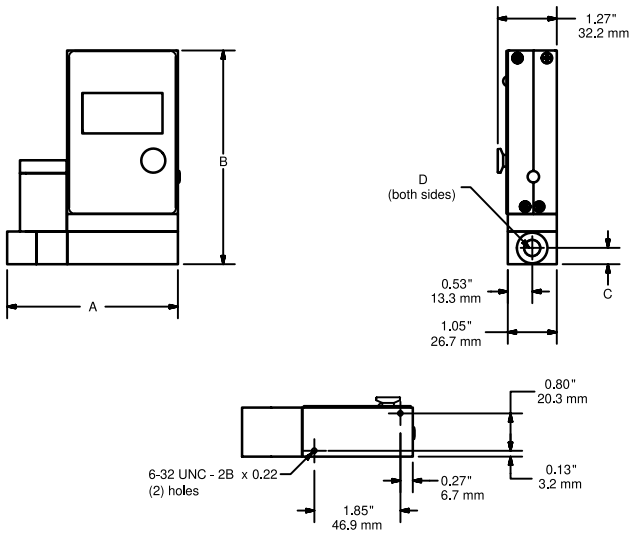


Figure C-1. DPC04, DPC07, DPC08, DPC14, DPC17 and DPC18. Dimensions A to D depend on the model (Table C-1).

Table C-1 Model-dependent dimensions, DPC04 to DPC18

Model	A	A, corrosion-resistant	B	C	D (port thread)
DPC04, DPC07, DPC08	3.68" (93.4 mm)	4.98" (126.5 mm)	4.58" (116.2 mm)	0.34" (8.5 mm)	10-32 UNF
DPC14	3.85" (97.7 mm)	–	4.84" (122.8 mm)	0.42" (10.7 mm)	1/8" NPT
DPC17, DPC18	3.66" (92.9 mm)	5.13" (130.4 mm)	4.40" (111.8 mm)	0.35" (8.9 mm)	1/8" NPT

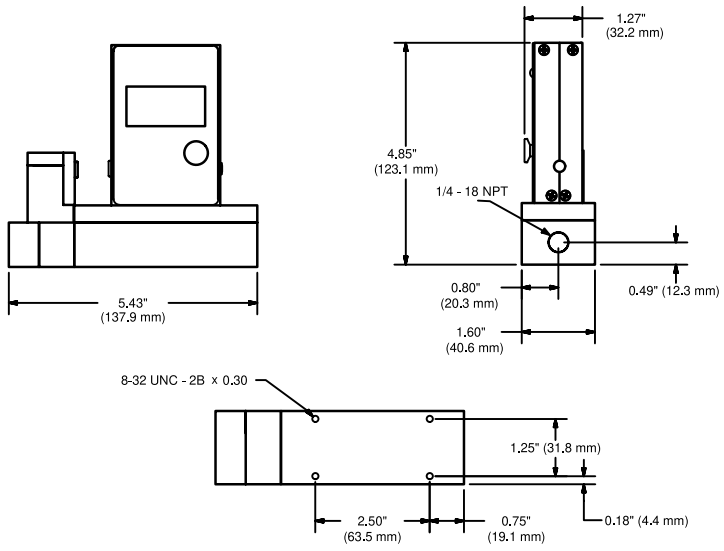


Figure C-2. DPC37 and DPC47.

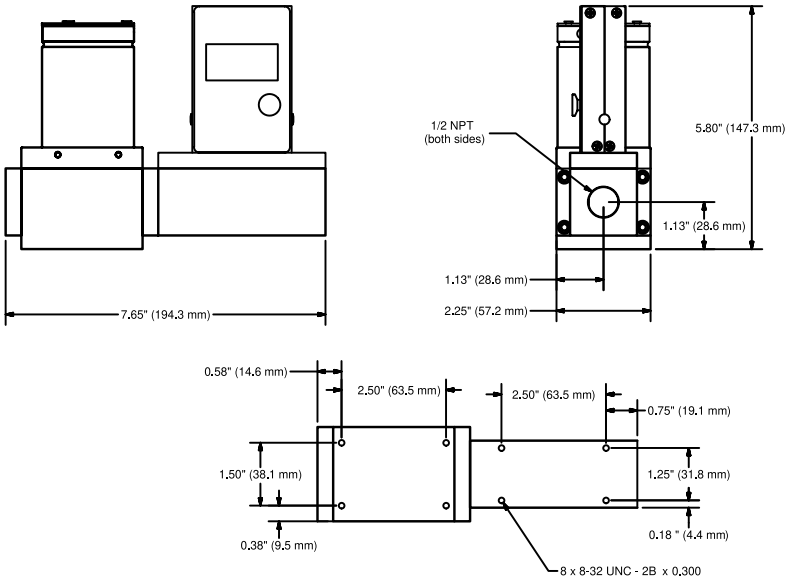


Figure C-3. DPC57.

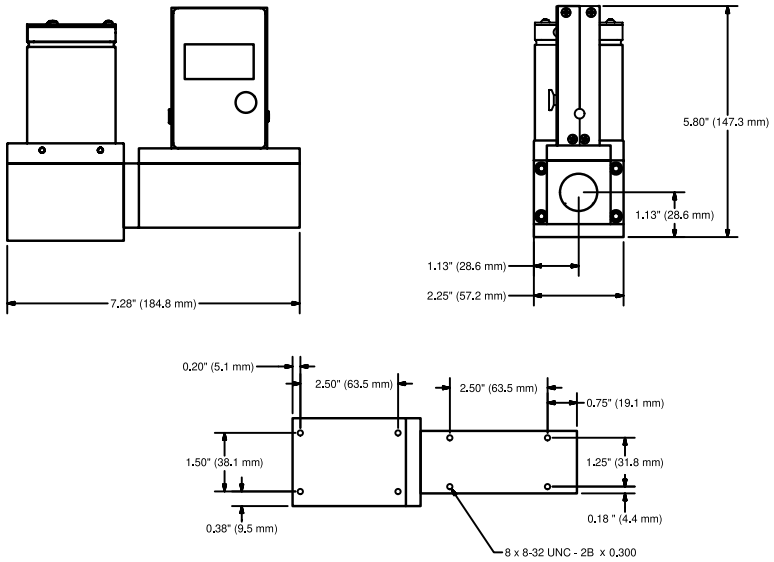


Figure C-4. DPC67 and DPC77.

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