ANALYT MESSTECHNIK



COMMUNICATION GUIDE

358 Series EtherCAT

Process data objects, commands, status codes and LED signals for reading and controlling 358 Series flow and pressure devices over EtherCAT.

AMTC-CG-0008

About this guide

This guide explains how to read measurements from, and send commands to, 358 Series flow and pressure devices over EtherCAT. The devices take part in an EtherCAT network as a modular device. The guide describes the data available as cyclic process data and through the CoE mailbox, the device commands and their status codes, the status LEDs and the network connection.

Object indices and subindices are written in hexadecimal with the prefix `0x`, for example `0x7010:01` for subindex 01 of object 0x7010. The data types (REAL, UINT, BITARR32) are explained under Data types (p. 8).

If you are connecting a device for the first time, start with Interface and wiring (p. 5). If you already know EtherCAT and only need the objects, go straight to the Command and register reference (p. 9).

The guide describes the data the devices provide by default. If your application needs other readings, ask Analyt-MTC.

Conventions in this guide:

- Commands you send and replies the device returns are set in monospace type, for example `0x7010:01`.

Abbreviations

Abbreviation	Meaning
ADC	Analogue-to-digital converter
CoE	CANopen over EtherCAT: the mailbox through which the master reads and writes objects outside the cyclic process data
EoE	Ethernet over EtherCAT: standard Ethernet communication with the device through the EtherCAT network
ESI	EtherCAT Slave Information: the device description file supplied with the instrument
IP	Internet Protocol
PDI	Process data interface
PDO	Process data object
PID	Proportional-integral-derivative (the control loop of a controller)
RxPDO	Receive PDO: data the master writes to the device
TxPDO	Transmit PDO: data the device sends to the master

Safety notices in this guide

Note
Information that helps understanding; never a hazard.

Contact and support

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

- the model and serial number of the device (on its label);
- the state of the ERR and RUN LEDs;
- the command ID and argument you sent and the command status you received.

Document information

Title	358 Series EtherCAT — Communication guide
Document number	AMTC-CG-0008
Revision	Rev. 1 — October 2026
Applies to	358 Series flow meters and controllers, pressure gauges and controllers with the EtherCAT interface
Language	English
Related documents	358 Series Modbus RTU and Modbus TCP/IP — Communication guide (AMTC-CG-0001); 358 Series serial interface (RS-232/RS-485) — Communication guide (AMTC-CG-0002); 358 Series M, MB, MLW and MLWB Mass Flow Meters — Operating manual (AMTC-MN-0004); 358 Series MC Mass Flow Controllers — Operating manual (AMTC-MN-0005); 358 Series L Liquid Flow Meters — Operating manual (AMTC-MN-0002); 358 Series LC Liquid Flow Controllers — Operating manual (AMTC-MN-0003); 358 Series P Pressure Transducers — Operating manual (AMTC-MN-0006); 358 Series PC Pressure Controllers — Operating manual (AMTC-MN-0007); 358 Series Dual-Valve Pressure Controllers — Operating manual (AMTC-MN-0001)

Revision history

Rev.	Date	Change
1	October 2026	First issue.

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CHAPTER 1

Interface and wiring

Ethernet ports

An EtherCAT device has two 10/100 Mbit/s Ethernet ports. The label on the upper back of the device marks them IN and OUT (Figure 1):

- **IN** — input, from the master;
- **OUT** — output, to the next device.

Connect the IN port to the master or to the OUT port of the previous device. In this way you build a chain of devices.

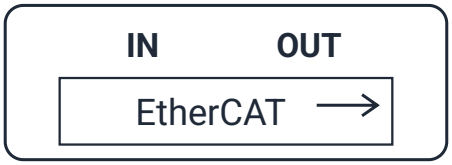


Figure 1. Label on the upper back of the device: IN and OUT ports.

Status LEDs

Two LEDs next to the Ethernet ports show the EtherCAT state of the device: the ERR LED and the RUN LED (Figure 2).

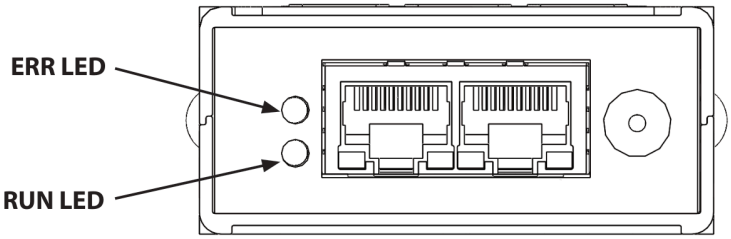


Figure 2. Top view of the device: ERR LED and RUN LED.

ERR LED	EtherCAT state
Off	No error
Blinking	Invalid configuration
Single flash	Unsolicited state change
Double flash	Application watchdog timeout
Flickering	Booting error
On	PDI watchdog timeout

RUN LED	EtherCAT state
Off	Init
Blinking	Pre-Operational
Single flash	Safe-Operational
Flashes	Initialisation or Bootstrap
On	Operational

IP66/67 devices: M12 Ethernet and M8 power connectors

An IP66/67 device has two 4-pin M12 Ethernet sockets on top and a 4-pin M8 power plug on the side.

Note

When you use multi-strand cables, identify the wiring by a continuity check and by colour. For custom wiring options, the calibration certificate of the device is the definitive reference.

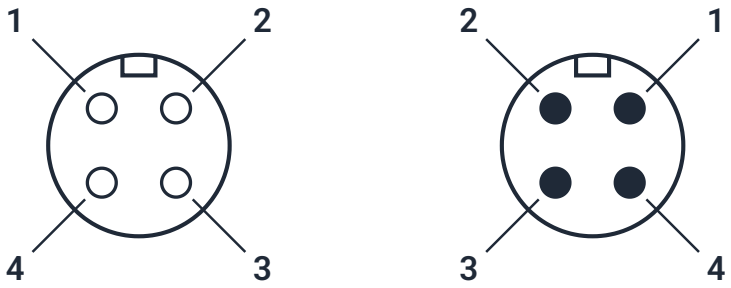


Figure 3. M12 Ethernet, 4 pins, seen from the top: female socket on the device (left), male plug on the cable (right).

Pin	Signal	Function
1	Tx+	Send data +
2	Rx+	Receive data +
3	Tx−	Send data −
4	Rx−	Receive data −

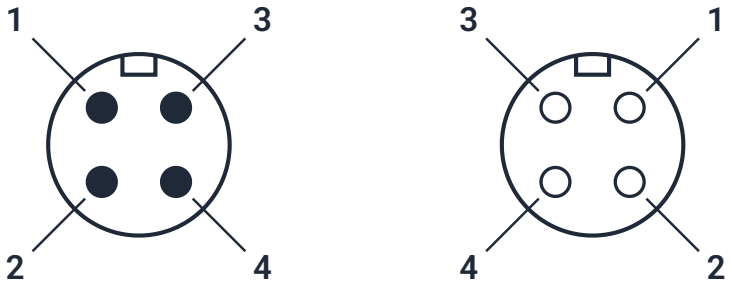


Figure 4. M8 power, 4 pins, seen from the side: male plug on the device (left), female socket on the cable (right).

Pin	Function
1	Reserved
2	Power in: powers the device. See the spec sheet of the device for details.
3	Reserved
4	Ground: common ground for power, digital communication, analogue signals and alarms.

Network settings

The device supports the Ethernet over EtherCAT (EoE) protocol, which allows standard Ethernet communication with the device. The EtherCAT master sets the IP address of the device during initialisation. For the procedure to assign an IP address, see the documentation of your master.

The device description file (ESI) for the device is supplied with the instrument.

Data IO tab of the web server

The device runs an embedded web server. It shows the readings available through the RxPDOs and TxPDOs, with their units.

1. Let the EtherCAT master assign an IP address to the device through EoE.
2. Open a web browser and go to that address.
3. Click the *Data IO* tab on the left. The page lists the RxPDOs, the TxPDOs with the configured readings and their units, and the bits of the device status (Figure 5).

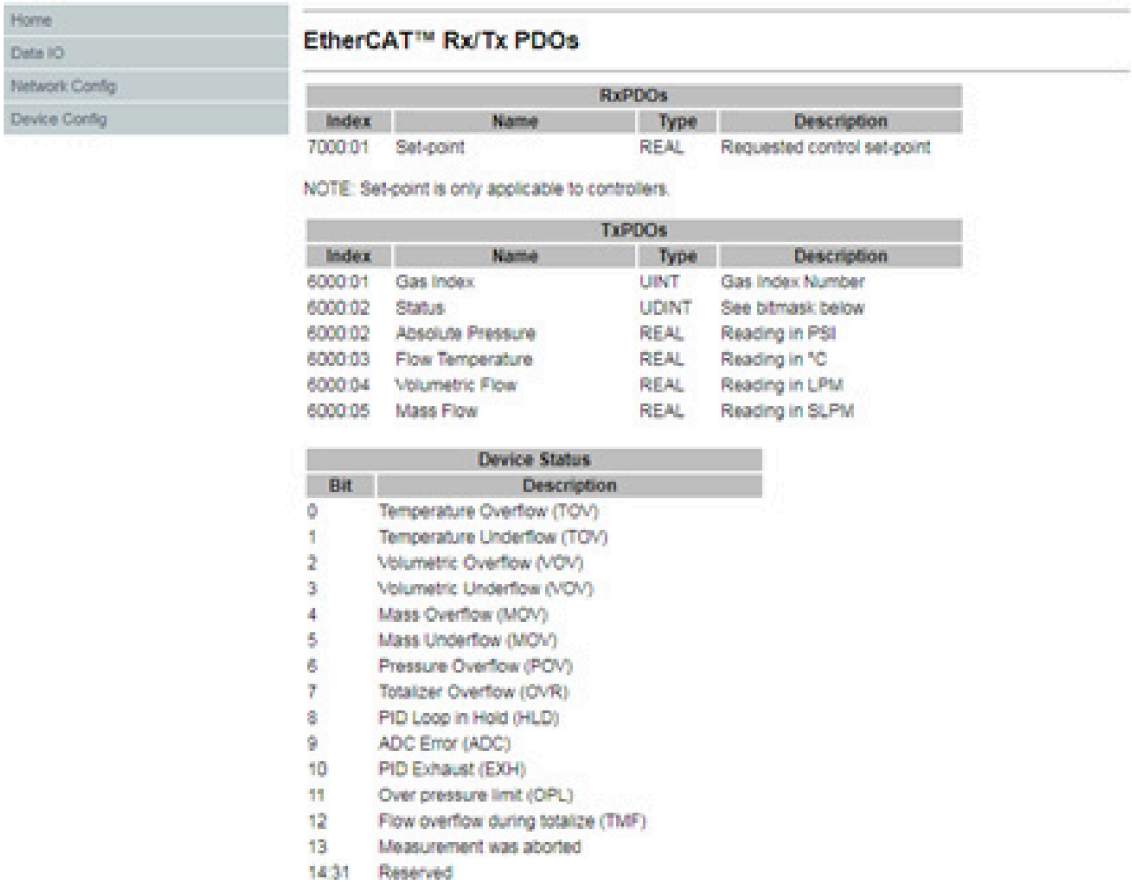


Figure 5. *Data IO* tab of the web server.

CHAPTER 2

Protocol conventions

What EtherCAT gives you

A 358 Series device supports the EtherCAT protocol as a modular device. Your master exchanges two kinds of data with it:

- **Cyclic process data** — the set point, the readings, the device status and the command interface, organised in process data objects (PDOs).
- **The CoE mailbox** — objects outside the process data, such as the gas mix configuration.

Process data objects

EtherCAT organises input and output data into process data objects. RxPDOs carry data from the master to the device; TxPDOs carry data from the device to the master. Each PDO index (`0x1600`, `0x1601`, `0x1A00`, `0x1A01`) maps entries of an object (`0x7000`, `0x7010`, `0x6000`, `0x6010`). The tables of Chapter 3 (p. 9) give both.

PDO	Direction	Content
RxPDO `0x1600` → `0x7000`	Master to device	Set point
RxPDO `0x1601` → `0x7010`	Master to device	Command ID and command argument
TxPDO `0x1A00` → `0x6000`	Device to master	Gas index, device status, device readings 1–14
TxPDO `0x1A01` → `0x6010`	Device to master	Last command ID and last command status

Data types

Type	Use
`REAL`	IEEE floating-point value: the set point and the device readings
`UINT`	Unsigned integer: gas index, command ID, command argument, command status, gas mix entries
`BITARR32`	Array of 32 bits: the device status (see Device status (p. 10))

Units and scaling

The readings are sent in the units configured on the device. The *Data IO* tab of the web server shows the configured readings and their units (Data IO tab of the web server (p. 7)). A pressure reading can be absolute, gauge or differential pressure, depending on the configuration of the device.

Gas mix percentages are integers in hundredths of a percent: 50 % is written as 5000.

How commands take effect

A command takes effect when the RxPDO changes. To issue the same command again with a different argument, first send the command ID 0, then the command ID you want. The result appears in TxPDO `0x6010`.

CHAPTER 3

Command and register reference

RxPDO mapping

The master writes these RxPDOs to the device. The set point is an IEEE floating-point value and applies to controllers only; a meter ignores it. Command ID and command argument send asynchronous commands to the device (Device commands (p. 10)).

PDO index	PDO entry	Type	Parameter
0x1600:01	0x7000:01	REAL	Set point
0x1601:01	0x7010:01	UINT	Command ID
0x1601:02	0x7010:02	UINT	Command argument

TxPDO mapping

The master reads these TxPDOs from the device. The device readings are described under Device readings (p. 9), the command interface under Device commands (p. 10).

PDO index	PDO entry	Type	Parameter
0x1A00:01	0x6000:01	UINT	Gas index
0x1A00:02	0x6000:02	BITARR32	Device status
0x1A00:03	0x6000:03	REAL	Device reading 1
0x1A00:04	0x6000:04	REAL	Device reading 2
0x1A00:05	0x6000:05	REAL	Device reading 3
0x1A00:06	0x6000:06	REAL	Device reading 4
0x1A00:07	0x6000:07	REAL	Device reading 5
0x1A00:08	0x6000:08	REAL	Device reading 6
0x1A00:09	0x6000:09	REAL	Device reading 7
0x1A00:10	0x6000:10	REAL	Device reading 8
0x1A00:11	0x6000:11	REAL	Device reading 9
0x1A00:12	0x6000:12	REAL	Device reading 10
0x1A00:13	0x6000:13	REAL	Device reading 11
0x1A00:14	0x6000:14	REAL	Device reading 12
0x1A00:15	0x6000:15	REAL	Device reading 13
0x1A00:16	0x6000:16	REAL	Device reading 14
0x1A01:01	0x6010:01	UINT	Last command ID
0x1A01:02	0x6010:02	UINT	Last command status

Device readings

The device can send up to 14 different configurable readings (statistics) through TxPDO 0x6000. The tables below give the default readings of four device types. To see the readings and units configured on your device, open the *Data IO* tab of its web server (Data IO tab of the web server (p. 7)). To have the output of your device customised, ask Analyt-MTC.

The value returned for a pressure reading can be absolute, gauge or differential pressure, depending on the configuration of the device.

Mass flow controller

Reading	Statistic
1	Pressure
2	Flow temperature
3	Volumetric flow
4	Mass flow
5	Mass flow set point
6	Mass total*

Mass flow meter

Reading	Statistic
1	Pressure
2	Flow temperature
3	Volumetric flow
4	Mass flow
5	Mass total*

Pressure gauge

Reading	Statistic
1	Pressure

Pressure controller

Reading	Statistic
1	Pressure
2	Pressure set point

* Mass total is only available on devices with the totaliser option.

Device status

TxPDO `0x6000:02` holds the device status as a bit field, one bit per condition. The abbreviation in brackets is what the display of the device shows for the condition.

Bit	Description
0	Temperature overflow (TOV)
1	Temperature underflow (TOV)
2	Volumetric overflow (VOV)
3	Volumetric underflow (VOV)
4	Mass overflow (MOV)
5	Mass underflow (MOV)
6	Pressure overflow (POV)
7	Totaliser overflow (OVR)
8	PID loop in hold (HLD)
9	ADC error (ADC)
10	PID exhaust (EXH)
11	Over pressure limit (OPL)
12	Flow overflow during totalise (TMF)
13	Measurement was aborted
14–31	Reserved

Device commands

Send a command to the device through RxPDO `0x7010`, subindices 01 (command ID) and 02 (command argument). Read the result from TxPDO `0x6010`. A command takes effect when the RxPDO changes. To issue the same command again with a different argument, first send the command ID 0, then the command ID you want.

RxPDO `0x7010`

Parameter	Type	Comment
Command ID	UINT	See the valid values below.
Command argument	UINT	—

TxPDO `0x6010`

Parameter	Type	Description
Command ID	UINT	ID of the last command
Command status	UINT	Status of the last command (Command status values (p. 15))

Supported commands

Command ID	Action	Argument
1	Change gas number	Gas table index (Appendix A (p. 16))
2	Mix gas	Gas mixture index (236–255), or 0 to use the next available index (Gas mixing (p. 11))
3	Delete gas mixture	Gas mixture index
4	Tare	0 = Pressure 1 = Abs Pressure 2 = Volume
5	Totaliser reset	None
6	Valve setting. Exhaust is only supported on dual-valve devices.	0 = Cancel 1 = Hold close 2 = Hold current 3 = Exhaust
7	Display lock. Only supported on devices with a display.	0 = Unlock 1 = Lock
8	Change P in the PID loop	0–65535
9	Change D in the PID loop	0–65535
10	Change I in the PID loop	0–65535
11	Change the control loop variable	0 = Mass Flow 1 = Volumetric Flow 2 = Diff Pressure 3 = Absolute Pressure 4 = Gauge Pressure
12	Save the current set point as the power-up value	None

The command status values returned in TxPDO `0x6010:02` are listed with their remedies in Chapter 5 (p. 15).

Gas mixing

A gas mix combines 2 to 5 gases. Mixing takes two steps:

1. Write the indices and percentages of the constituent gases to the mix configuration object `0x8000` through the CoE mailbox. Percentages are integers in hundredths of a percent and must add up to 100 %: for 50 %, write 5000. The device uses the first gases with a percentage that is not zero.

2. Write the mix gas command (ID 2) to RxPDO `0x7010`, with the mixture index as argument:
    - argument 0: the device stores the mix in the next empty mixture index, starting at 255 and working down to 236. If no mixture index is free, the command does not complete and an error is returned in TxPDO `0x6010`;
    - argument 236–255: the device creates the mixture with this index, or updates it to the new composition;
    - any other argument: an error is returned.

When mixing is complete, TxPDO `0x6010` holds the result. If the mix was valid, it returns the index of the mixed gas. If a constituent gas does not exist or the percentages do not add up to 100 %, it returns an error value and the mix is not created.

Mix configuration object `0x8000` (CoE mailbox)

Index	Type	Parameter
`0x8000:01`	UINT	Mixture gas 1 index
`0x8000:02`	UINT	Mixture gas 1 percentage
`0x8000:03`	UINT	Mixture gas 2 index
`0x8000:04`	UINT	Mixture gas 2 percentage
`0x8000:05`	UINT	Mixture gas 3 index
`0x8000:06`	UINT	Mixture gas 3 percentage
`0x8000:07`	UINT	Mixture gas 4 index
`0x8000:08`	UINT	Mixture gas 4 percentage
`0x8000:09`	UINT	Mixture gas 5 index
`0x8000:10`	UINT	Mixture gas 5 percentage

CHAPTER 4

Examples

Four common tasks, shown as the objects your master writes and reads. Use them to check your own configuration.

How to read the examples

Each example lists the PDO entries or CoE objects in the order your master writes them, then what it reads back. Objects and values are explained in Chapter 3 (p. 9).

Example 1: send a set point to a controller

Step	Object	Value	Meaning
Write	`0x7000:01`	50.0 (REAL)	New set point, in the units configured on the device
Read	`0x6000:07`	REAL	On a mass flow controller with the default readings: reading 5, the mass flow set point

A meter ignores the set point.

Example 2: tare the flow reading

Command 4 with argument 2 tares the volume (flow) reading.

1. Write the command ID 0 to `0x7010:01`, so that the next command counts as a change.
2. Write the argument 2 to `0x7010:02`.
3. Write the command ID 4 to `0x7010:01`. The command takes effect.
4. Read `0x6010:01` and `0x6010:02`. When `0x6010:01` holds 4 and `0x6010:02` holds 0 (success), the tare is done. Any other status is explained in Command status values (p. 15).

Example 3: create a gas mixture of 50 % argon and 50 % helium

1. Through the CoE mailbox, write the mix configuration object:

Object	Value	Meaning
`0x8000:01`	1	Gas 1: argon (Appendix A, gas 1)
`0x8000:02`	5000	50.00 %
`0x8000:03`	7	Gas 2: helium (Appendix A, gas 7)
`0x8000:04`	5000	50.00 %
`0x8000:05–0x8000:10`	0	Gases 3 to 5 not used

2. Write the command ID 0 to `0x7010:01`, then the argument 0 to `0x7010:02`, then the command ID 2 (mix gas) to `0x7010:01`. With argument 0, the device picks the next empty mixture index.
3. Read `0x6010:02`. If the mix was valid, it holds the index of the new mixture: 255 if no mixture has been stored before. An error value (`0x8004–0x8006`) means that the mix was not created.
4. To use the mixture, send command 1 (change gas number) with the mixture index as argument. `0x6000:01` then shows that gas index.

Example 4: read the measurements of a mass flow controller

With the default readings of a mass flow controller (Device readings (p. 9)), read TxPDO `0x6000`:

Object	Type	Content
`0x6000:01`	UINT	Gas index
`0x6000:02`	BITARR32	Device status; for example, bit 8 set means the PID loop is in hold (HLD)
`0x6000:03`	REAL	Reading 1: pressure
`0x6000:04`	REAL	Reading 2: flow temperature
`0x6000:05`	REAL	Reading 3: volumetric flow
`0x6000:06`	REAL	Reading 4: mass flow
`0x6000:07`	REAL	Reading 5: mass flow set point
`0x6000:08`	REAL	Reading 6: mass total (devices with the totaliser option)

The units of each reading are shown on the *Data IO* tab of the web server (Data IO tab of the web server (p. 7)).

CHAPTER 5

Error handling

The command status values, the ERR LED and common symptoms, with their meaning and what to do. If none of these fits, contact Analyt-MTC support with the information listed in About this guide (p. 2).

Command status values

TxPDO `0x6010:02` returns the status of the last command; `0x6010:01` returns its ID.

Status	Description	Remedy
`0`	Success	—
`0x8001`	Invalid command ID	Use a command ID from the list of supported commands (Device commands (p. 10)).
`0x8002`	Invalid setting	Check the argument in `0x7010:02` against the list of supported commands.
`0x8003`	Requested feature is unsupported	The device does not support the feature: exhaust works only on dual-valve devices, display lock only on devices with a display.
`0x8004`	Invalid gas mix index	Use 0 or a mixture index from 236 to 255. With argument 0, all indices from 236 to 255 are in use: delete a mixture you no longer need (command 3).
`0x8005`	Invalid gas mix constituent	Every gas index in `0x8000` must exist (Appendix A (p. 16)).
`0x8006`	Invalid gas mix percentage	The percentages in `0x8000` must add up to 100 %, that is 10000.

Symptoms and remedies

Symptom	Cause and remedy
ERR LED blinking	Invalid configuration. Check the configuration of the device in your master.
ERR LED single flash, double flash, flickering or on	Unsolicited state change, application watchdog timeout, booting error or PDI watchdog timeout (Status LEDs (p. 5)).
The next device in the chain is not found	Connect IN to the master or to the previous device, and OUT to the next device (Ethernet ports (p. 5)).
The web server cannot be reached	The IP address is set by the EtherCAT master through EoE. Assign the address as described in the documentation of your master.
A repeated command does nothing	A command takes effect only when the RxPDO changes. Send the command ID 0, then the command ID again (Device commands (p. 10)).
The set point has no effect	The device is a meter, which ignores the set point.
A reading is not the one you expect	The readings and their units are configurable. Check them on the *Data IO* tab of the web server. A pressure reading can be absolute, gauge or differential pressure.
Mass total is missing	Mass total is only available on devices with the totaliser option.

APPENDIX A

Gas properties

Use the gas numbers of this table as the argument of command 1 (change gas number) and in the gas mix configuration object `0x8000`. Numbers 236 to 255 are reserved for your own gas mixtures (Gas mixing (p. 11)).

A-1 Gas viscosity at 25 °C; density and compressibility at 25 °C, 14.696 psia

#	Gas	Short name	Absolute viscosity*	Density**	Compressibility
0	Air	Air	184.918	1.1840	0.9997
1	Argon	Ar	225.593	1.6339	0.9994
2	Methane	CH_4	111.852	0.6569	0.9982
3	Carbon monoxide	CO	176.473	1.1453	0.9997
4	Carbon dioxide	CO_2	149.332	1.8080	0.9949
5	Ethane	C_2H_6	93.540	1.2385	0.9924
6	Hydrogen	H_2	89.153	0.08235	1.0006
7	Helium	He	198.457	0.16353	1.0005
8	Nitrogen	N_2	178.120	1.1453	0.9998
9	Nitrous oxide	N_2O	148.456	1.8088	0.9946
10	Neon	Ne	311.149	0.8246	1.0005
11	Oxygen	O_2	204.591	1.3088	0.9994
12	Propane	C_3H_8	81.458	1.8316	0.9841
13	normal-Butane	n-C_4H_{10}	74.052	2.4494	0.9699
14	Acetylene	C_2H_2	104.448	1.0720	0.9928
15	Ethylene	C_2H_4	103.177	1.1533	0.9943
16	iso-Butane	i-C_4H_{10}	74.988	2.4403	0.9728
17	Krypton	Kr	251.342	3.4274	0.9994
18	Xenon	Xe	229.785	5.3954	0.9947
19	Sulfur hexafluoride	SF_6	153.532	6.0380	0.9887
20	75 % Ar / 25 % CO_2	C-25	205.615	1.6766	0.9987
21	90 % Ar / 10 % CO_2	C-10	217.529	1.6509	0.9991
22	92 % Ar / 8 % CO_2	C-8	219.134	1.6475	0.9992
23	98 % Ar / 2 % CO_2	C-2	223.973	1.6373	0.9993
24	75 % CO_2 / 25 % Ar	C-75	167.451	1.7634	0.9966
25	75 % Ar / 25 % He	HE-75	230.998	1.2660	0.9997
26	75 % He / 25 % Ar	HE-25	234.306	0.5306	1.0002
27	90 % He / 7.5 % Ar / 2.5 % CO_2 (Helistar A1025)	A1025	214.840	0.3146	1.0003
28	90 % Ar / 8 % CO_2 / 2 % O_2 (Stargon CS)	Star29	218.817	1.6410	0.9992
29	95 % Ar / 5 % CH_4	P-5	223.483	1.5850	0.9993

* In micropoise (1 poise = 1 g/(cm·s)). ** In grams per litre. Reference: NIST REFPROP 7 database.

A-2 Flow conversions (both sides of a line at the same standard conditions)

1.00 scfm	=	28.3160 sL/min
100.00 sL/min	=	3.5316 scfm
1.00 scfh	=	0.4719 sL/min
100.00 sL/min	=	211.9093 scfh
100.00 scim	=	1.6390 sL/min
1.00 sL/min	=	61.0128 scim
1000.00 scih	=	0.2732 sL/min
1.00 sL/min	=	3660.7688 scih

scim and scih: standard cubic inches per minute and per hour.

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AMTC-CG-0008 · Rev. 1 · 2026-10

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