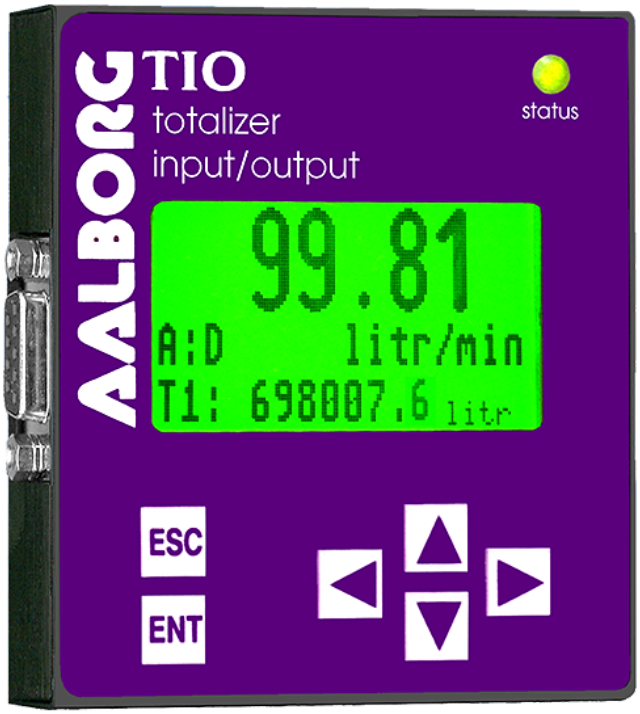
ANALYT MESSTECHNIK



OPERATING MANUAL

Aalborg TIO Totalizer Input/Output

Mounting, wiring, set-up, operation, serial communication and troubleshooting of the TIO flow monitor and controller module for GFM and GFC devices and flow instruments of other makes.

AMTC-MN-0050

Rev. 1 · October 2026

About this manual

This manual explains how to mount, wire, set up and operate the Aalborg TIO Totalizer Input/Output, a flow monitor and controller module for GFM mass flow meters, GFC mass flow controllers and flow meters and controllers of other makes. It also lists the serial commands of the TIO and the parameters in its memory.

Read Safety (p. 7) before you mount or wire the TIO. To set up a new TIO, follow the chapters in order: Installation (p. 12), Commissioning (p. 24), then Operation (p. 25). If you work with the TIO from a computer or PLC, Communication (p. 35) lists every command. The Specifications (p. 44) and the appendices are reference material you can turn to at any time. The first set-up alone is also described in the quick start guide AMTC-QG-0002.

The TIO is manufactured by Aalborg. Service, calibration, repairs and technical support are provided by Analyt-MTC; the contact details are in Service, warranty and contacts (p. 47) and on the back cover.

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

Conventions

- Buttons, menu entries and display texts are printed as the TIO shows them, like this: **`General Settings`**.
- Commands you send and replies the TIO returns are set in monospace type, for example `!12`, `F`.
- **% FS** stands for percent of full scale: of the Full Scale Range set in the TIO (Full Scale Range (p. 40)).
- Pin numbers, such as “pin 4”, refer to the 9-pin D-connector of the TIO (Pin assignment (p. 13)) unless another connector is named.

Abbreviations

Abbreviation	Meaning
ADC	Analogue-to-digital converter
ASCII	American Standard Code for Information Interchange
CR	Carriage return, the character that ends every serial command
DAC	Digital-to-analogue converter
EEPROM	Electrically erasable programmable read-only memory: the non-volatile memory of the TIO
ESD	Electrostatic discharge
EU	Engineering unit: the unit of measure the TIO displays
FS	Full scale
GND	Ground: the signal reference
LCD	Liquid crystal display
NRF	Noise reduction filter
PFS	Fraction of full scale (0.0–1.0)
PI	Process information: the main screens of the TIO
PLC	Programmable logic controller

Abbreviation	Meaning
PP	Program protection
PSP	Program set point
PV	Process variable: the flow signal from the mated device
PWM	Pulse-width modulation
RTS	Request to send, a serial handshake line
RX, TX	Receive, transmit
SP	Set point
SRAM	Static random-access memory: volatile memory, cleared when the power is off
TD	Transmit data, a serial line
WEEE	Waste electrical and electronic equipment

Safety notices in this manual

⚠ WARNING

A hazardous situation which, if not avoided, could result in death or serious 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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Revision history

Rev.	Date	Change
1	October 2026	First issue.

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CHAPTER 1

Safety

Read this chapter before you mount, wire or set up the TIO. Each message is repeated, with its context, in the section where it applies.

Intended use

The TIO displays and totalises the flow measured by a flow meter or mass flow controller with an analogue 0–5 V DC, 0–10 V DC or 4–20 mA interface, and can give the set point to a mass flow controller. It is made mainly for GFM flow meters and GFC mass flow controllers, mounted on the device or on its own on a panel or table.

Install and operate the TIO only as this manual describes. If the TIO is not used as instructed, the manufacturer's warranty and responsibility lapse.

⚠ WARNING

The TIO is not designed for life-support applications. There, a malfunction of the TIO could cause personal injury. Do not use the TIO in life-support applications.

Before you start

Keep these points in mind whenever you mount, wire, adjust or service the TIO.

⚠ WARNING

The optically isolated outputs have a maximum absolute voltage rating of 250 Vrms. A higher voltage on them can cause personal injury or damage the TIO. Never apply more than this voltage to the outputs.

NOTICE

Some components of the TIO are sensitive to electrostatic discharge, which can damage the circuitry permanently. Before you install or connect any wires, discharge yourself by touching the protective earth of the building, and wear a grounded wrist strap when you adjust or service the TIO.

NOTICE

Connecting or disconnecting a cable or wire with the power on can damage the TIO or cause faulty operation. Switch the power off before you connect or disconnect any cable or wire in the system.

NOTICE

A supply voltage above 28 V DC damages the TIO or causes faulty operation. Never apply more than 28 V DC to the power input.

NOTICE

Signals above the rated values of the jumper configuration, wrong wiring or reversed polarity can damage the TIO or cause faulty operation. Before you switch on, check the actual J2 jumper configuration, keep within the rated values and check the wiring and the polarity of the power supply and the signals.

NOTICE

The 4–20 mA set point output is a self-powered, non-isolated current loop; an external voltage source connected to the set point output terminals can damage it. Do not connect an external voltage source to the set point output.

NOTICE

The optically isolated outputs need an external DC voltage across their terminals; outside 2 V < UCE < 40 V (collector-emitter voltage) and 0.2 mA < ICE < 150 mA (collector-emitter current) they can be damaged. Keep the external voltage and current within these limits.

K factors. Gas conversion factors are approximations at best. Do not rely on them where you need an accuracy better than ±5 to 10 % (K factor settings (p. 29)).

Qualified personnel

Mounting, electrical installation, configuration of the parameters, start-up and maintenance of the TIO are work for trained personnel who have read and understood this manual. Only trained personnel may operate the TIO and open its housing. The calibration parameters are changed only by properly trained personnel (Calibration and verification (p. 40)).

Damage and repair

Inspect the package for damage when the TIO arrives (Unpacking (p. 12)). A TIO that shows a fatal error or overheats again after cooling down goes back for repair (Troubleshooting (p. 42)); repairs are made by Analyt-MTC (Service, warranty and contacts (p. 47)).

CHAPTER 2

Product description

The TIO is a microcontroller-driven display and interface module. It reads the analogue flow signal of a flow meter or mass flow controller, linearises it, and displays the instantaneous flow rate and the total. Mated to a mass flow controller, it can also give the set point.

How the TIO works

The mated device sends its flow signal to the analogue input of the TIO: 0–5 V DC, 5–10 V DC, 0–10 V DC or 4–20 mA, selected by jumpers. The TIO converts the signal with a 12-bit converter and scales it to the full scale range you enter, in litres per minute. From the instantaneous flow it calculates two totals by integrating the flow over time.

Set as a controller, the TIO sends a set point signal to the mass flow controller through its analogue output: a value you enter on the keypad, a value sent over the serial interface, or the steps of a program of up to 16 steps.

The TIO watches the flow for alarm conditions, counts pulses for a pulse output and logs diagnostic events. Two optically isolated outputs report these events to your equipment, and an RS-232 or RS-485 interface gives a computer or PLC access to every setting and reading. All settings are kept in the EEPROM.

Functions

- Built-in flow linearizer, with 10-point linearisation of the flow curve
- 47 volumetric and mass flow units, including one user-defined unit
- Graphic LCD with 13 mm digits for the flow rate and 5.5 mm digits for the total; backlight and contrast adjustable
- RS-232 or RS-485 digital interface; RS-485 multidrop for up to 64 devices
- Mounting on the device, on a panel, on a wall or in the field
- Two independent programmable totalisers
- Programmable, optically isolated pulse output
- Two programmable, optically isolated digital outputs for events
- Low and high flow alarms with programmable action delay
- Set point control for mass flow controllers from the keypad or the digital interface
- Programmable set point table of up to 16 steps, with ramping up and down
- Free configuration and monitoring software

Controls and connections



Figure 2-1. Front of the TIO. The 9-pin D-connector is on the left side of the housing, the terminal block J1 of the digital outputs on its top.

Element	Function
Display	128 × 64 graphic LCD with backlight; shows the PI screens and the menus
ESC	Switches between the PI screens and the menus; leaves an entry without saving
ENT	Opens the highlighted menu item; saves a value; on the main PI screen of a controller, starts the set point entry
UP, **DN**	Page through the PI screens and menus; change the digit under the cursor
LEFT, **RIGHT**	Move the cursor to another digit; toggle mask entries
D-connector	Miniature 9-pin female D-sub: power, analogue input and output, serial interface
Terminal block J1	4 positions, 3.5 mm: the two optically isolated outputs

Display

When the power is switched on, the TIO shows its banner for 2 seconds, then for another 2 seconds the firmware and EEPROM table revisions, the interface type, the baud rate and the RS-485 address in hexadecimal (Figure 2-2). It then shows the process information.

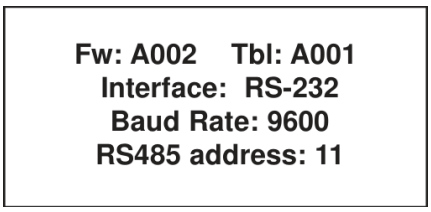


Figure 2-2. Firmware and interface screen after power-up. The content varies with the model and the configuration.

The first PI screen shows the flow rate in large digits. Below it, a meter shows the alarm status (**A:**) and the unit; a controller shows the set point (**S:**). The last line shows totaliser 1 (Figure 2-3, Figure 2-4).



Figure 2-3. First PI screen, Device Function set to meter.

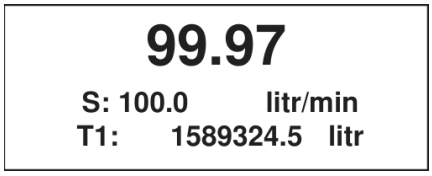


Figure 2-4. First PI screen, Device Function set to controller.

Press **UP** or **DN** to see the other PI screens. Which screens there are depends on the Device Function:

Table 2-1 PI screens

Screen	Meter	Controller
1	Flow rate, alarm status and unit, totaliser 1	Flow rate, set point and unit, totaliser 1
2	Flow rate, K factor status and unit, totaliser 2	Flow rate, K factor status and unit, totaliser 2
3	Flow rate and unit, alarm and K factor status, totalisers 1 and 2	Flow rate and unit, alarm and K factor status, totalisers 1 and 2

Screen	Meter	Controller
4	Flow rate and unit, alarm and K factor status, event register, pulse output, assignment of the two digital outputs	Flow rate and unit, set point program: set point, step, step time, program mode, loop and run status (Running a set point program (p. 25))

The status letters on the PI screens are the same as in the serial replies: **D** disabled, **E** enabled; a flow alarm shows **L** (low) or **H** (high). How to mask screens or let them cycle automatically is in Display settings (p. 32).

Supplied items and accessories

Check the delivery against the packing list (Unpacking (p. 12)). The input and output jumpers of the TIO are set at the factory for the interface you ordered. Mounting kits with or without cables, for GFM and GFC devices, are listed under Ordering information (p. 46).

CHAPTER 3

Installation

The TIO is mounted on a GFM flow meter or a GFC mass flow controller, or used on its own on a panel or table top with a flow meter or controller of another make. This chapter covers unpacking, the electrical connections and the three ways of mounting it.

Unpacking

1. When the carton arrives, inspect it for external damage. If it is damaged, contact the carrier at once.
2. Open the carton carefully from the top and check the TIO for concealed transport damage. Send a copy of any damage report to Analyt-MTC as well as to the carrier.
3. Check that every item on the packing list is there, and report any shortage to Analyt-MTC promptly.

General directions

- Mounting, electrical installation, configuration of the parameters, start-up and maintenance are done by trained personnel who have read and understood this manual.
- Wire the power and every input and output signal as the wiring diagrams in this chapter show.
- Only trained personnel may open the housing of the TIO.

NOTICE

Some components of the TIO are sensitive to electrostatic discharge, which can damage the circuitry permanently. Before you install or connect any wires, discharge yourself by touching the protective earth of the building, and wear a grounded wrist strap when you adjust or service the TIO.

NOTICE

Connecting or disconnecting a cable or wire with the power on can damage the TIO or cause faulty operation. Switch the power off before you connect or disconnect any cable or wire in the system.

Electrical connections

Power, the analogue input (process variable, PV), the analogue output (set point, SP) and the serial interface are all connected through the miniature 9-pin female D-sub connector of the TIO. The digital outputs have their own terminal block J1.

Pin assignment

Table 3-1 9-pin D-connector of the TIO

Pin	Function	Note
1	Power supply, common	Power input
2	Power supply, positive	Power input 12–26 V DC
3	RS-232 RX, optional RS-485 (+)	Communication (RS-232 input, RS-485 input/output)
4	Analogue input (+), PV input	Input
5	Analogue output (+), PV set point	Output
6	RS-232 signal ground, GND (RS-485 GND, optional)	Communication reference
7	RS-232 TX, optional RS-485 (–)	Communication (RS-232 output, RS-485 input/output)
8	Analogue input/output reference (common for pins 4 and 5)	
9	+5 V DC reference input (for the 5–10 V DC interface only)	

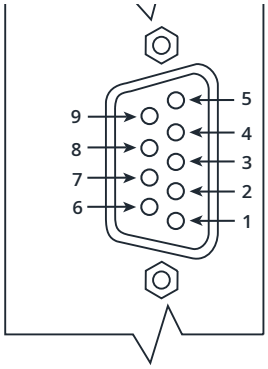


Figure 3-1. Pin positions of the 9-pin D-connector.

Power supply

The TIO needs a unipolar DC supply of 12 to 26 V DC. Connect DC power (+) to pin 2 and DC power (–) to pin 1. When several devices share a supply, choose one with a sufficient current rating.

NOTICE

A supply voltage above 28 V DC damages the TIO or causes faulty operation. Never apply more than 28 V DC to the power input.

Input and output jumpers

The type of the analogue input and of the analogue output is set with the jumper block J2 (Figure 3-2): J2A to J2C set the output, J2D to J2F the input, and J2G the RS-485 termination. The jumpers are set at the factory to your order; change them only if you use another signal. Where J2 sits on the circuit board is shown in Appendix C (p. 53).

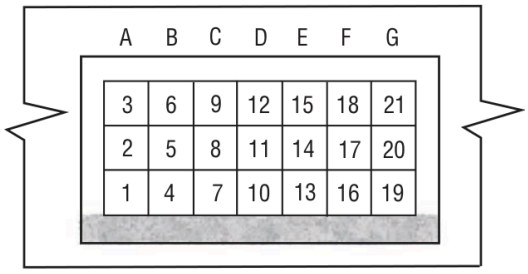


Figure 3-2. Jumper block J2, columns A to G with the pin numbers 1 to 21.

NOTICE

Signals above the rated values of the jumper configuration, wrong wiring or reversed polarity can damage the TIO or cause faulty operation. Before you switch on, check the actual J2 jumper configuration, keep within the rated values and check the wiring and the polarity of the power supply and the signals.

Analogue input (PV)

Depending on J2, the input takes 0–5 V DC, 5–10 V DC, 0–10 V DC or 4–20 mA. Connect PV input (+) to pin 4 and PV input (−) to pin 8.

Table 3-2 Maximum rated values for the PV input

PV input	J2D	J2E	J2F	Maximum signal	Note
0–5 V DC	10–11	14–15	17–18	≤ 6 V DC	
5–10 V DC	11–12	14–15	17–18	≤ 11 V DC	The +5 V DC reference signal must be used (GFM/GFC option).
0–10 V DC	11–12	14–15	17–18	≤ 11 V DC	Special order: the circuit board must be changed.
4–20 mA	10–11	13–14	16–17	≤ 25 mA	249 Ω passive current input, not isolated.

Analogue output (SP)

The set point output is needed only when the TIO is mated to a mass flow controller and gives its set point. Depending on J2, the output delivers 0–5 V DC, 0–10 V DC or 4–20 mA. Connect SP output (+) to pin 5 and SP output (−) to pin 8.

Table 3-3 Maximum rated load for the SP output

SP output	J2A	J2B	J2C	Load	Note
0–5 V DC	2–3	5–6	8–9	≥ 1000 Ω	
0–10 V DC	2–3	5–6	8–9	≥ 5000 Ω	Special order: the circuit board must be changed.
4–20 mA	1–2	4–5	7–8	≤ 900 Ω (24 V DC supply)	Self-powered, non-isolated current loop. With a 12 V DC supply the load must not exceed 400 Ω.

NOTICE

The 4–20 mA set point output is a self-powered, non-isolated current loop; an external voltage source connected to the set point output terminals can damage it. Do not connect an external voltage source to the set point output.

Serial interface

The standard TIO has an RS-232 interface; RS-485 is an option. The interface gives access to every configuration parameter and reading (Communication (p. 35)). It works with 8 data bits, 1 stop bit, no parity and no flow control; the baud rate is 9600 by default.

RS-232. Make a crossover connection to the 9-pin port of the host PC:

Host PC, 9-pin port	TIO, 9-pin D-connector
Pin 2, RS-232 RX	Pin 7 (TX−)
Pin 3, RS-232 TX	Pin 3 (RX+)
Pin 5, RS-232 signal GND	Pin 6

RS-485. Configure the RS-485 converter or adapter for multidrop, 2-wire, half-duplex operation (Figure 3-3). Its transmitter must be enabled by TD (transmit data) or RTS (request to send), whichever the converter has; set the receiver to follow the transmitter, so that there is no echo. Connect T(−) or R(−) to pin 7 (TX−), T(+) or R(+) to pin 3 (RX+) and, if the converter has one, its GND to pin 6.

If the TIO is the last device on the RS-485 bus segment and a 220 Ω termination is needed, set jumper J2G to position 19–20: this connects a 220 Ω resistor between RS-485 (+) and (−).

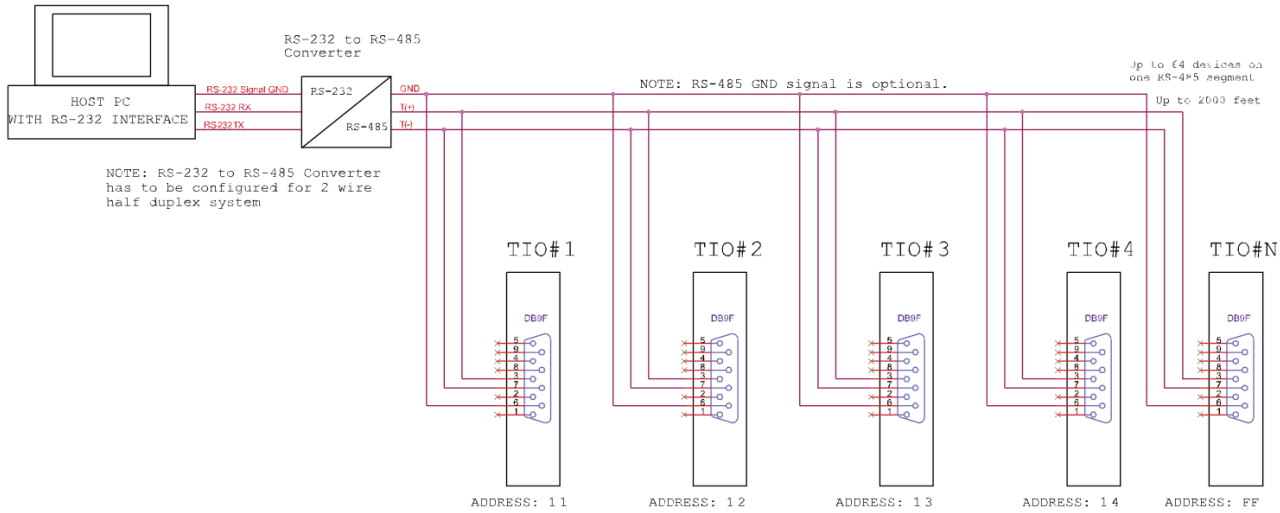


Figure 3-3. RS-485 multidrop, half-duplex, two-wire system: up to 64 devices on one segment, each with its own address. The RS-485 GND line is optional.

Digital outputs

The TIO has two programmable, optically isolated digital outputs. Each can be assigned to one of several events or work as the pulse output (Digital output settings (p. 31)). They are wired to the 4-position, 3.5 mm terminal block J1 on the top of the housing; the mating connector is Tyco Electronics part number 284510-4.

Output	Plus (+), passive	Minus (–), passive
Optocoupler 1	J1 pin 1	J1 pin 2
Optocoupler 2	J1 pin 3	J1 pin 4

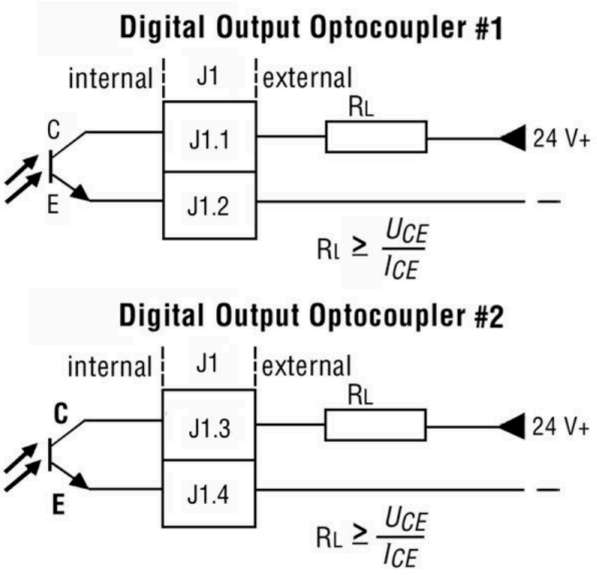


Figure 3-4. Wiring of the two optocoupler outputs with an external supply and load R_L; choose $R_L \geq U_{CE}/I_{CE}$.

NOTICE

The optically isolated outputs need an external DC voltage across their terminals; outside 2 V < UCE < 40 V (collector-emitter voltage) and 0.2 mA < ICE < 150 mA (collector-emitter current) they can be damaged. Keep the external voltage and current within these limits.

⚠ WARNING

The optically isolated outputs have a maximum absolute voltage rating of 250 Vrms. A higher voltage on them can cause personal injury or damage the TIO. Never apply more than this voltage to the outputs.

Mounting on a GFM flow meter

Mounting

Attach the TIO to the GFM with a GFM mounting kit (Table 3-4): remove the screws of the two D-connectors, fit the bracket over both connectors and fasten it with the four screws of the kit (Figure 3-5).

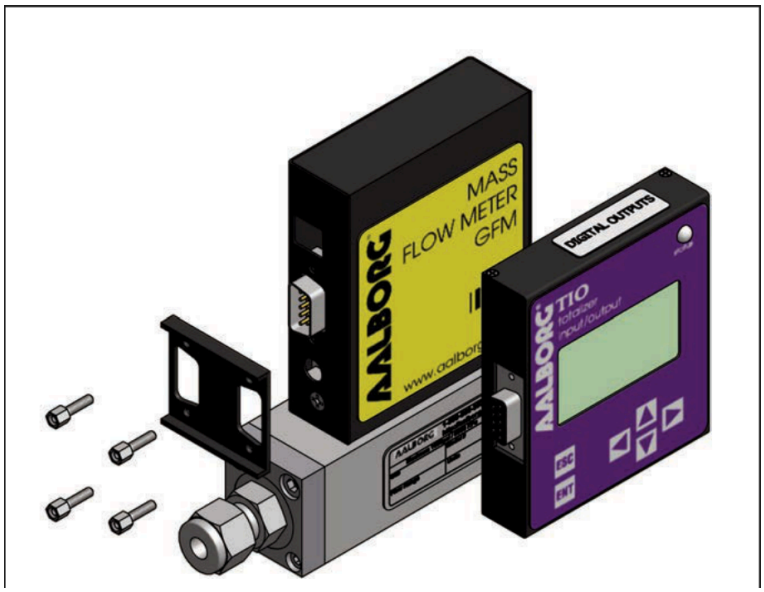


Figure 3-5. Mounting the TIO on a GFM flow meter.

Electrical connection

A GFM gives its flow signal on one of three outputs: 0–5 V DC, 5–10 V DC or 4–20 mA (Figures 3-6 to 3-8). The cable kits in Table 3-4 suit these connections. With every GFM kit except KIT-TM, the power supply is connected to the DC jack of the GFM and the TIO takes its power from the GFM.

Table 3-4 GFM cable and mounting kits

Order code	Description	TIO input	Communication cable	GFM supply
KIT-TM-DD	Shielded cable with two 9-pin D-connectors for the process signals, and a 6 ft communication branch	0–5 V DC	Yes	12 and 24 V DC
KIT-TM-RD	4-wire cable between the RJ11 connector of the GFM and the 9-pin D-connector of the TIO	5–10 V DC	No	12 V DC only
KIT-TM-FD	Flat 4-wire cable between the 9-pin D-connectors of the GFM and the TIO	0–5 V DC	No	12 and 24 V DC
KIT-TM	GFM mounting kit, no cables	–	–	–

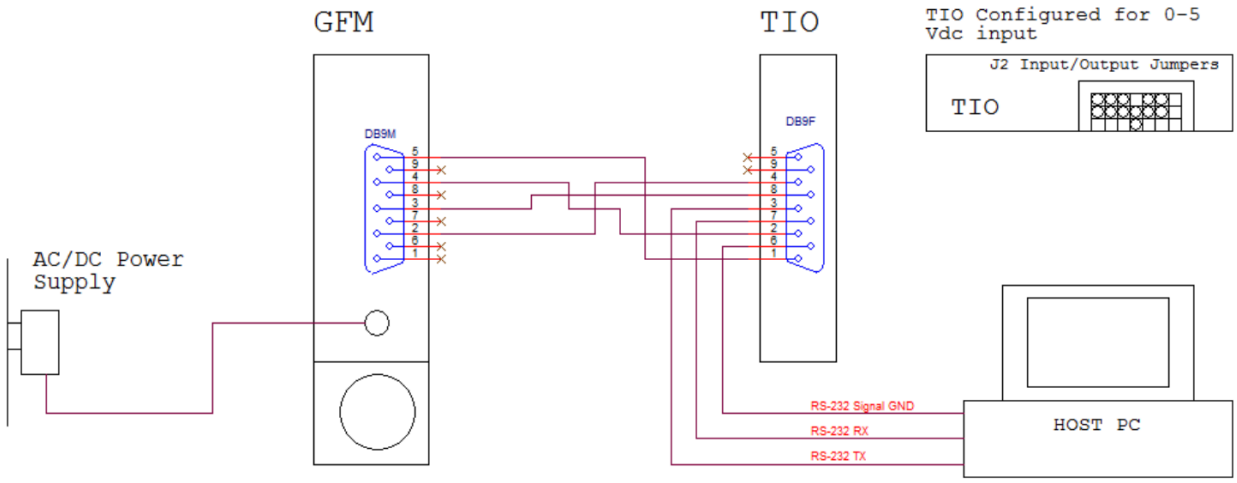


Figure 3-6. TIO on a GFM, 0–5 V DC output from the 9-pin D-connector of the GFM.

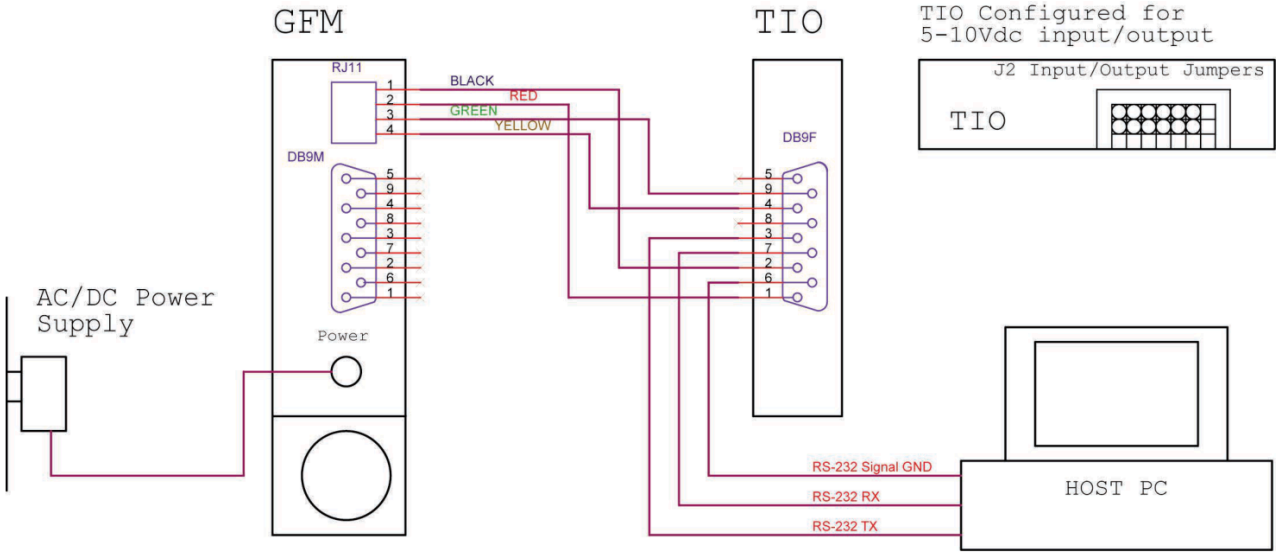


Figure 3-7. TIO on a GFM, 5–10 V DC output from the RJ11 connector of the GFM.

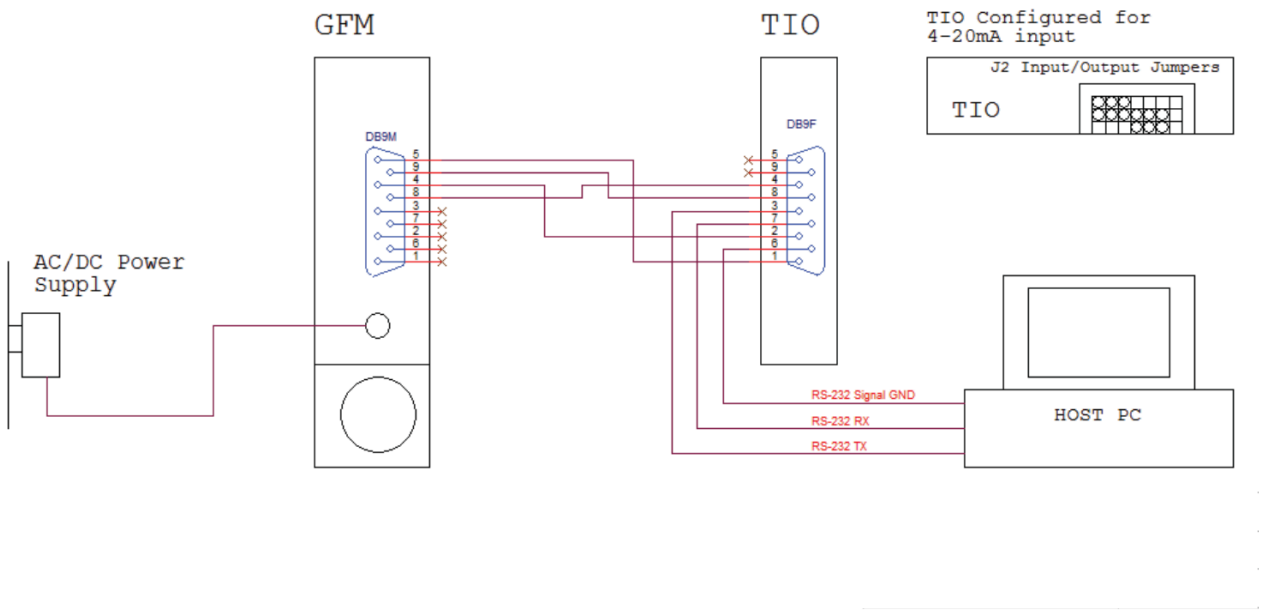


Figure 3-8. TIO on a GFM, 4–20 mA output from the 9-pin D-connector of the GFM.

Jumper configuration

The jumpers are set at the factory to your order; change them only if you use another input. Before you apply power and signals, check that they are in the right position for your GFM (Table 3-5).

Table 3-5 J2 jumpers for GFM flow meters

TIO input	J2A	J2B	J2C	J2D	J2E	J2F	GFM cable kit	Note
0–5 V DC	2–3	5–6	8–9	10–11	14–15	17–18	KIT-TM-DD, KIT-TM-FD	
5–10 V DC	2–3	5–6	8–9	11–12	14–15	17–18	KIT-TM-RD	The +5 V DC reference signal must be used.
0–10 V DC	2–3	5–6	8–9	11–12	14–15	17–18	Not supported for the GFM	Special order: the circuit board must be changed.
4–20 mA	2–3	5–6	8–9	10–11	13–14	16–17	None: your own cable	249 Ω passive current input, not isolated.

Parameters

Set **`Device Function`** to **`Meter`**, set **`Full Scale Range`** to the full scale flow of the GFM in litres per minute, and set **`Fluid Std. Density`** if you use mass units (Commissioning (p. 24)). All other parameters can be set as your application requires (Operation (p. 25)).

Mounting on a GFC mass flow controller

Mounting

Attach the TIO to the GFC with a GFC mounting kit (Table 3-6), in the same way as on a GFM (Figure 3-9).

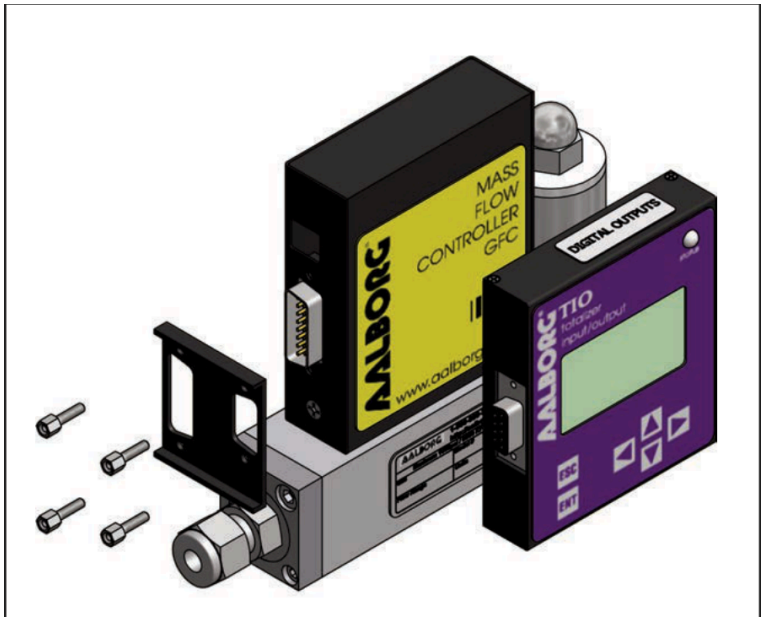


Figure 3-9. Mounting the TIO on a GFC mass flow controller.

Electrical connection

A GFC gives its flow signal on a 0–5 V DC or a 4–20 mA output and takes its set point as 0–5 V DC or 4–20 mA, selected by jumper on the GFC circuit board (Figure 3-10, Figure 3-11). Every GFC kit except KIT-TC includes a power supply for the GFC, and the TIO takes its power from the GFC.

Table 3-6 GFC power supply, cable and mounting kits (TIO input and output 0–5 V DC)

Order code	Description	Communication branch	GFC supply
KIT-TC-110NA-2C	Shielded cable, North America plug, 110 V AC to 12 V DC power supply	Yes	12 V DC
KIT-TC-110NA-2N	Shielded cable, North America plug, 110 V AC to 12 V DC power supply	No	12 V DC
KIT-TC-110NA-4C	Shielded cable, North America plug, 110 V AC to 24 V DC power supply	Yes	24 V DC
KIT-TC-110NA-4N	Shielded cable, North America plug, 110 V AC to 24 V DC power supply	No	24 V DC
KIT-TC-230EU-2C	Shielded cable, European plug, 230 V AC to 12 V DC power supply	Yes	12 V DC
KIT-TC-230EU-2N	Shielded cable, European plug, 230 V AC to 12 V DC power supply	No	12 V DC
KIT-TC-230EU-4C	Shielded cable, European plug, 230 V AC to 24 V DC power supply	Yes	24 V DC
KIT-TC-230EU-4N	Shielded cable, European plug, 230 V AC to 24 V DC power supply	No	24 V DC
KIT-TC-240AU-2C	Shielded cable, Australia plug, 240 V AC to 12 V DC power supply	Yes	12 V DC
KIT-TC-240AU-2N	Shielded cable, Australia plug, 240 V AC to 12 V DC power supply	No	12 V DC
KIT-TC-240AU-4C	Shielded cable, Australia plug, 240 V AC to 24 V DC power supply	Yes	24 V DC
KIT-TC-240AU-4N	Shielded cable, Australia plug, 240 V AC to 24 V DC power supply	No	24 V DC
KIT-TC-240UK-2C	Shielded cable, UK plug, 240 V AC to 12 V DC power supply	Yes	12 V DC
Ask Analyt-MTC	Shielded cable, UK plug, 240 V AC to 12 V DC power supply	No	12 V DC
KIT-TC-240UK-4C	Shielded cable, UK plug, 240 V AC to 24 V DC power supply	Yes	24 V DC
KIT-TC-240UK-4N	Shielded cable, UK plug, 240 V AC to 24 V DC power supply	No	24 V DC
KIT-TC	GFC mounting kit, no cables, no power supply	–	–

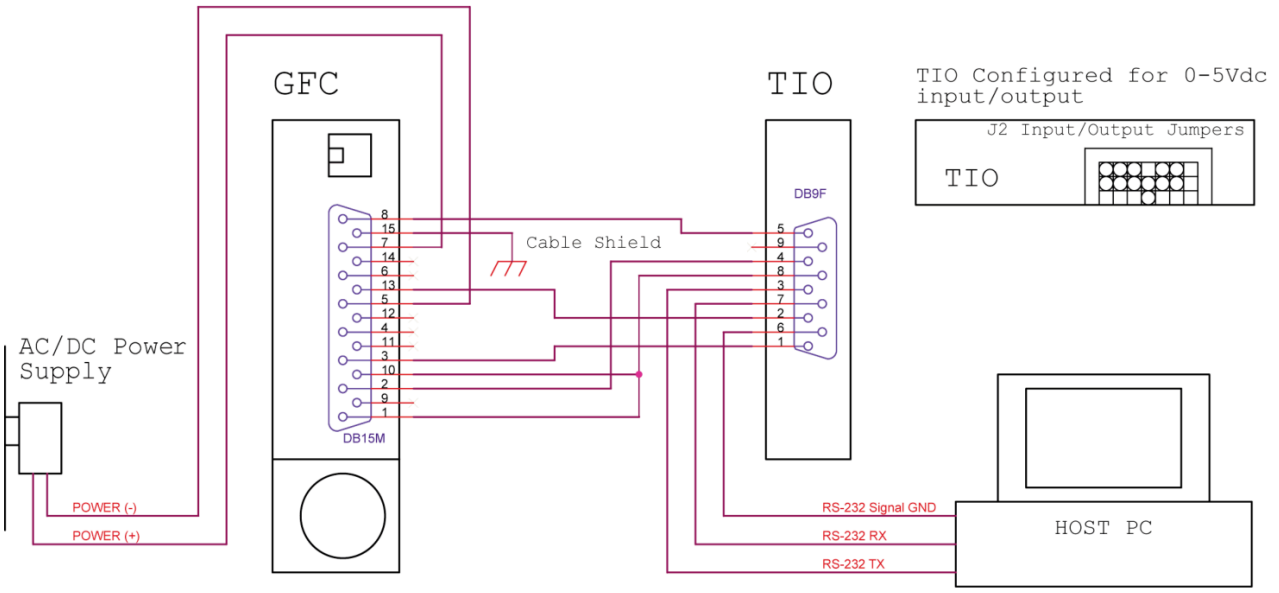


Figure 3-10. TIO on a GFC, 0–5 V DC input and output from the 15-pin D-connector of the GFC.

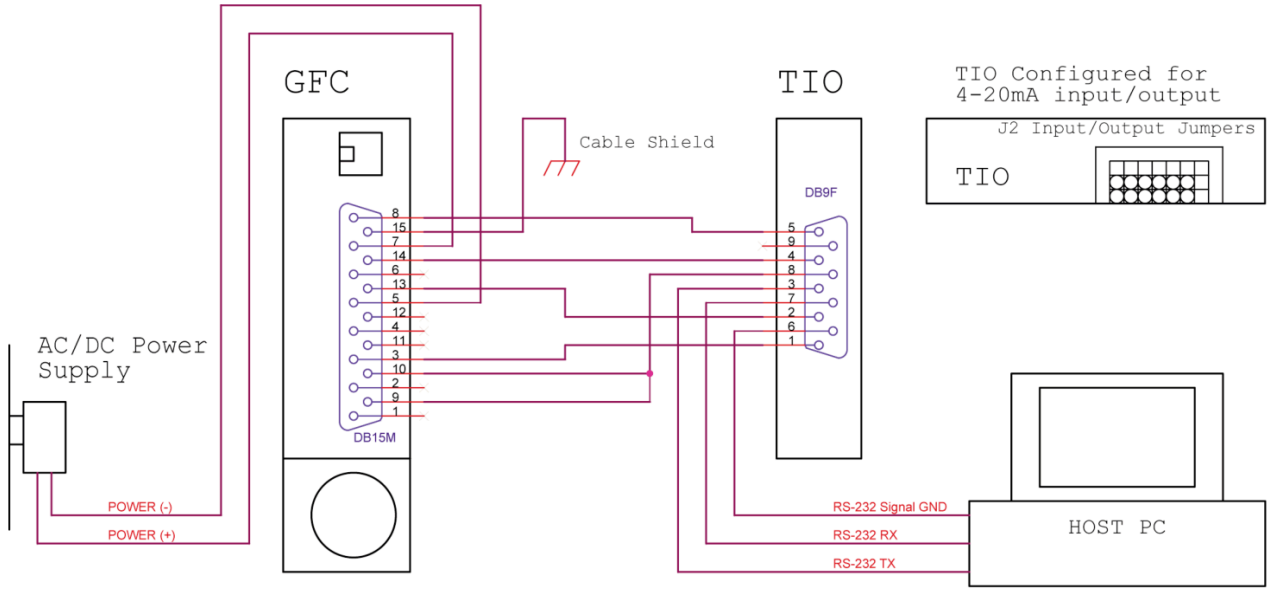


Figure 3-11. TIO on a GFC, 4–20 mA input and output from the 15-pin D-connector of the GFC.

Jumper configuration

The jumpers are set at the factory to your order; change them only if you use another signal. Before you apply power and signals, check that they are in the right position for your GFC (Table 3-7).

Table 3-7 J2 jumpers for GFC mass flow controllers

TIO output	TIO input	J2A	J2B	J2C	J2D	J2E	J2F	GFC cable kit
0–5 V DC	0–5 V DC	2–3	5–6	8–9	10–11	14–15	17–18	All GFC kits except KIT-TC
0–5 V DC	4–20 mA	2–3	5–6	8–9	10–11	13–14	16–17	None: your own cable
4–20 mA	0–5 V DC	1–2	4–5	7–8	10–11	14–15	17–18	None: your own cable

TIO output	TIO input	J2A	J2B	J2C	J2D	J2E	J2F	GFC cable kit
4–20 mA	4–20 mA	1–2	4–5	7–8	10–11	13–14	16–17	None: your own cable
0–10 V DC	0–10 V DC	2–3	5–6	8–9	11–12	14–15	17–18	Not supported for the GFC; special order, the circuit board must be changed

Parameters

Set **`Device Function`** to **`Controller`**, set **`Full Scale Range`** to the full scale flow of the GFC in litres per minute, and set **`Fluid Std. Density`** if you use mass units (Commissioning (p. 24)). All other parameters can be set as your application requires (Operation (p. 25)).

Use with devices of other makes

Mounting

With a flow meter or controller of another make, the TIO stands on its own on a table top or is mounted on a panel. The back of the housing has four tapped holes, 4-40 UNC-2B (Unified National Coarse thread), for panel mounting; their positions are in Figure 9-1.

Electrical connection

The TIO works with any flow meter or controller that has a 0–5 V DC or 4–20 mA interface (Figure 3-12, Figure 3-13). A 0–10 V DC interface is a special order. When you connect equipment of another make, wire the cables and connectors carefully to the right pins.

NOTICE

A TIO not ordered for 0–10 V DC can be damaged by more than 5.5 V DC on its input or output circuitry. Do not connect it to higher voltages; if you are unsure of the input and output type, check the order code or ask Analyt-MTC.

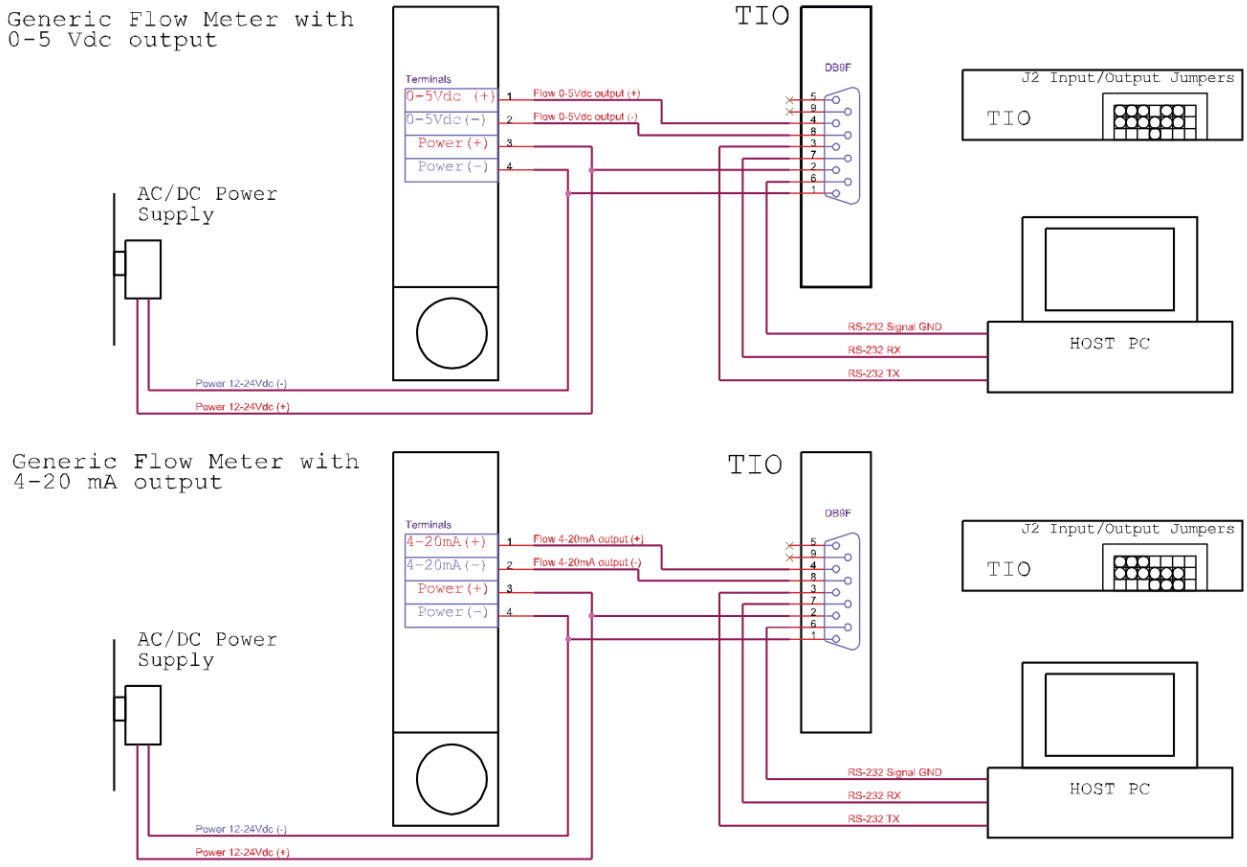


Figure 3-12. TIO with a flow meter of another make: 0–5 V DC output (top), 4–20 mA output (bottom).

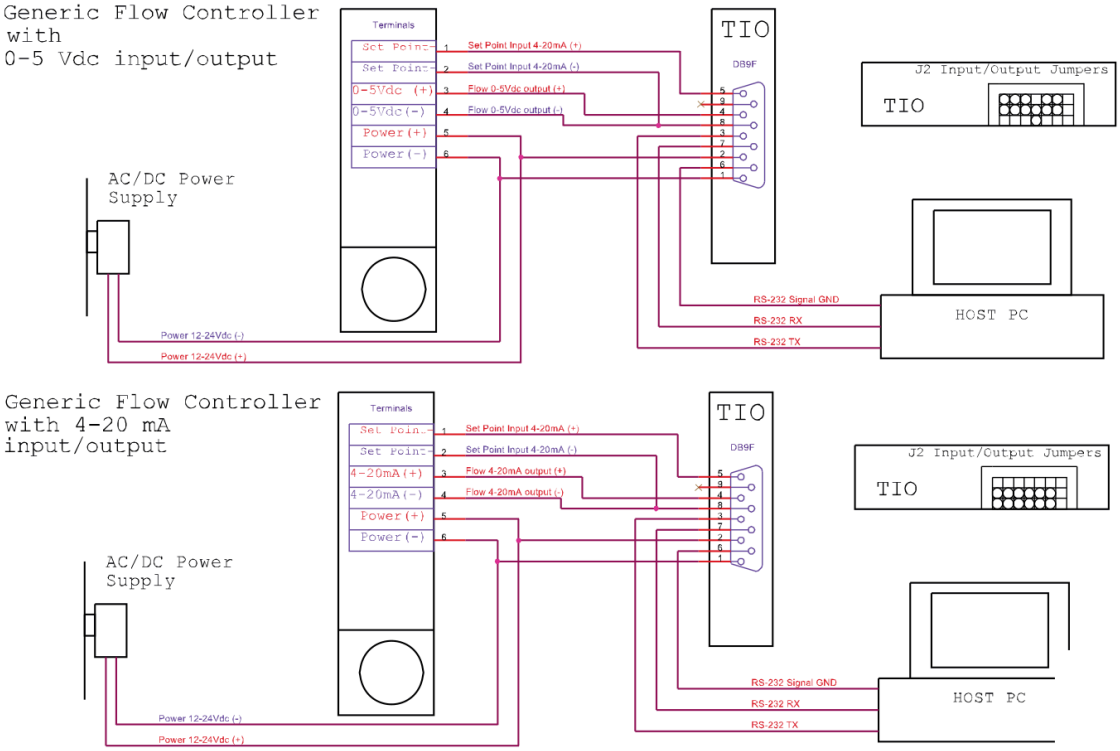


Figure 3-13. TIO with a mass flow controller of another make: 0–5 V DC input and output (top), 4–20 mA input and output (bottom).

Jumper configuration

The jumpers are set at the factory to your order; change them only if you use another signal. Before you apply power and signals, check that they are in the right position (Table 3-8). On a flow meter the

output circuitry is not used: leave J2A, J2B and J2C as they are; to switch the analogue output off, remove J2B.

Table 3-8 J2 jumpers for flow meters and controllers of other makes

TIO output	TIO input	J2A	J2B	J2C	J2D	J2E	J2F	Note
0–5 V DC	0–5 V DC	2–3	5–6	8–9	10–11	14–15	17–18	
0–5 V DC	4–20 mA	2–3	5–6	8–9	10–11	13–14	16–17	
4–20 mA	0–5 V DC	1–2	4–5	7–8	10–11	14–15	17–18	
4–20 mA	4–20 mA	1–2	4–5	7–8	10–11	13–14	16–17	
–	5–10 V DC	2–3	5–6	8–9	11–12	14–15	17–18	An external +5 V DC reference signal must be connected to pin 9.
0–10 V DC	0–10 V DC	2–3	5–6	8–9	11–12	14–15	17–18	Special order: the circuit board must be changed.
0–10 V DC	4–20 mA	2–3	5–6	8–9	10–11	13–14	16–17	Special order: the circuit board must be changed.
4–20 mA	0–10 V DC	1–2	4–5	7–8	11–12	14–15	17–18	Special order: the circuit board must be changed.
0–5 V DC	0–10 V DC	2–3	5–6	8–9	11–12	14–15	17–18	Special order: the circuit board must be changed.
0–10 V DC	0–5 V DC	2–3	5–6	8–9	10–11	14–15	17–18	Special order: the circuit board must be changed.

Parameters

Set **`Device Function`** to **`Controller`** for a mass flow controller or **`Meter`** for a flow meter, set **`Full Scale Range`** to the full scale flow of the mated device in litres per minute, and set **`Fluid Std. Density`** if you use mass units (Commissioning (p. 24)).

CHAPTER 4

Commissioning

Three parameters tell the TIO what it is mated to. Set them before you rely on any reading: with wrong values the TIO displays wrong flow and total figures and can behave in unexpected ways.

First start

1. Check that the TIO is mounted and wired (Installation (p. 12)) and that the J2 jumpers match the mated device.
2. Switch on the power. The banner appears for 2 seconds, then the firmware and interface screen for another 2 seconds (Figure 2-2), then the first PI screen.
3. Check on the firmware and interface screen that the interface type, baud rate and RS-485 address are the ones you expect.

Setting the three parameters

The settings are protected by the program protection. A new TIO leaves the factory with the PP password set to zero, so no password is needed: switch the protection off as described in Program protection (p. 27), then set the parameters below. How to enter values is in Entering values (p. 27).

Table 4-1 Parameters to set before first use

Parameter	Menu	Value
`Device Function`	`General Settings` › `Device Function`	`Meter` for a flow meter (GFM), `Controller` for a mass flow controller (GFC)
`Full Scale Range`	`General Settings` › `Device Calibration`	The full scale range of the mated device, converted to litres per minute
`Fluid Std. Density`	`General Settings` › `Device Calibration`	The density of the fluid at standard conditions, in g/L; needed only for mass units

Then set the measuring unit (Measuring units (p. 28)) before the other settings, because some of them are entered in that unit. Configure the other parameters as your application requires (Operation (p. 25)).

Warm-up

Most mass flow meters and controllers need a warm-up time after power-up before their output is stable. The TIO can ignore the input for a set time after power-up (Flow power-up delay (p. 40)) and start each totaliser after a delay of its own (Totaliser 1 (p. 30)).

CHAPTER 5

Operation

Everything on the TIO is set from its keypad, through a menu, or over the serial interface (Communication (p. 35)). This chapter follows the menu from the PI screens to the diagnostic menu.

PI screens

The PI screens show the process (Table 2-1). In the static mode, **UP** pages forward through the screens and **DN** backward; after the last screen the TIO returns to the first. In the dynamic mode the TIO changes screens by itself at a set interval. Both modes, the interval and the screens shown are set under Display settings (p. 32).

Set point control

Set as a controller, the TIO gives the set point to the mated mass flow controller through its analogue output. The set point can be entered on the keypad, sent over the serial interface, or run as a program of up to 16 steps. The input and output jumpers are set at the factory to your order; check that the analogue input of the mass flow controller matches the analogue output of the TIO before you apply power and signals (Input and output jumpers (p. 13)).

Entering the set point on the keypad

The current set point is shown on the second line of the first PI screen, after **S**.

1. On the first PI screen, press **ENT**. The first digit of the set point flashes.
2. Change the digit with **UP** or **DN**; move to another digit with **RIGHT** or **LEFT**.
3. Press **ENT** to accept the value and save it in the EEPROM. To leave without a change, press **ESC**: the previous set point is restored.

A set point saved from the keypad is in the EEPROM and is used again at the next power-up. It can be changed over the serial interface at any time.

While a set point program runs, its next step replaces any set point entered on the keypad or over the interface.

Running a set point program

Enter the program in the program table first (Program set point (p. 33)). Then:

1. Enable the program set point mode (**Program SP Mode**).
2. Set the loop mode (**PSP Loop Mode**) as you need it.
3. Go to PI screen 4 and switch the program run status on with **RIGHT** or **LEFT**. The default is off.

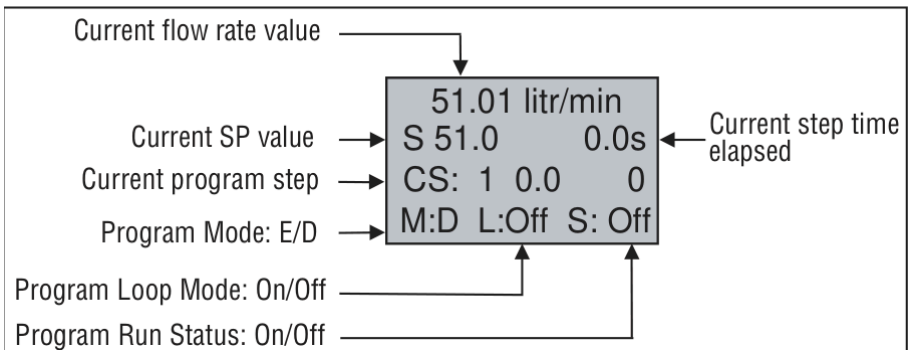


Figure 5-1. PI screen 4 during a set point program.

Switching the run status off pauses the program: the set point stays at its current value until you switch it on again.

Menu structure

ESC switches between the PI screens and the menu. **UP** and **DN** move through the items of a menu; after the last item the menu returns to the first, and from the first item **UP** goes to the last. **ENT** opens the highlighted item. Table 5-1 shows the menu of firmware version A001.

Table 5-1 Menu structure

Main menu	Submenu	Items
Program Protection (PP)	–	**Enabled**, **Disabled**
Change PP Password	–	Old and new password
Device Information	–	**Device ID & FS Flow**, **Analog/Com Interface**, **Firmware/EE Version**, **Alarm Settings**, **Totalizer#1 Settings**, **Totalizer#2 Settings**, **Pulse & Dig. Outputs**, **Mated Device Info**, **General Settings**
EngUnits & K-Factor	**Measuring Units**	The 47 units of Table 5-2
	UserDefined Units	**UD Unit K-Factor**, **UD Unit Time Base**, **UD Unit Use Density**
	K-Factor Settings	**K-Factor Mode**, **Int. K-Factor Index**, **User Def'd K-Factor**
Alarm Settings	–	**Flow Alarm Mode**, **Low Flow Alarm**, **High Flow Alarm**, **Flow Alarm Delay**, **Flow Alarm Latch**
Totalizer Settings	**Totalizer #1**	**Totalizer #1 Mode**, **Tot#1 Flow Start**, **Tot#1 Action Vol.**, **Tot#1 PowerOn Delay**, **Tot#1 Auto Reset**, **Tot#1 AutoRes Delay**, **Reset Totalizer #1**
	Totalizer #2	**Totalizer #2 Mode**, **Tot#2 Configuration**, **Tot#2 Flow Start**, **Tot#2 Action Vol.**, **Tot#2 PowerOn Delay**, **Tot#2 Auto Reload**, **Tot#2 AutoRel Delay**, **Reset Totalizer #2**
	Pulse Output	**PulseOutput Mode**, **Pulse Flow Start**, **[Unit]/Pulse**, **Pulse Active Time**
Opt Output Settings	**Opt Output #1 Set**, **Opt Output #2 Set**	**Disabled**, **Low F. Alarm**, **High F. Alarm**, **F. Range H-L**, **Total#1 Event**, **Total#2 Event**, **Pulse Output**, **Diagnostic**, **Manual On**

Main menu	Submenu	Items
General Settings	Display Settings	Display Mode, Screen Cycle Time, Screen Mask, Display Back Light, Display Contrast
	Device Function	Flow Meter, Flow Controller
	Communication Sett.	Baud Rate Settings, RS-485 Bus Address
	Device Calibration	Full Scale Range, Low Flow Cut-off, Flow PowerUp Delay, Fluid Std. Density, Analog Output Cal., Analog Input Cal., Pilot Cal. Timer
	Signal Conditioner	Signal Condit. Mode, NRF Num. of Samples, NRF Time Interval, NRF Error Limit, Aver.Filter Damping, FlowLinearizer Mode
	Program Set Point	Program SP Mode, PSP Loop Mode, PSP Steps Mask, PSP Steps Settings
Device Diagnostic	Event Register Menu	Event Reg. Status, Event Latch Mask, Event Reg. Mask, Reset Event Reg.
	–	Analog Input counts, Analog Output Value, LCD Back Light Set., Pulse Output Queue, CPU Temperature

Program protection

All configuration parameters are protected by a password. To change them, switch the program protection off; it switches itself on again at every power-up. A new TIO leaves the factory with the PP password set to zero: protection is then off and no password is needed.



Figure 5-2. Program protection screen.

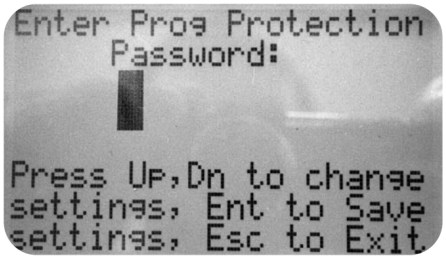


Figure 5-3. Password prompt.

1. Press **ESC** to open the menu. **`Program Protection (PP)`** is selected.
2. If the PP password is not zero, the TIO asks for it (**`Enter PP Password`**, Figure 5-3). Enter the password, up to 3 digits.
3. On the program protection screen (Figure 5-2), select **`Disabled`** with **UP** or **DN** and press **ENT**.

The protection stays off until the next power-up.

Entering values

A parameter is entered in one of two ways:

- **Numerical entry:** change the digit under the cursor with **UP** or **DN**, move to another digit with **RIGHT** or **LEFT**, and press **ENT** to accept the value and save it in the EEPROM.
- **Tabular entry:** choose an option with **UP** or **DN** and press **ENT** to accept it.

The TIO checks every value. A value it cannot accept is rejected, with a message that the new value was not accepted.

Changing the PP password

1. Switch the program protection off (Program protection (p. 27)).
2. Open **Change PP Password**.
3. Enter the old password, then the new one. The TIO confirms that the new password is saved.

If the password is lost or forgotten, contact Analyt-MTC.

Device information

Device Information shows the main configuration parameters of the TIO (Table 5-1). They are read-only and need no password.

Measuring units

EngUnits & K-Factor › **Measuring Units** sets the unit of the flow rate for every PI screen and record; the totalisers follow in the matching volume or mass unit. The TIO has 47 volumetric and mass units (Table 5-2). Set the unit first, because some later settings are entered in it. The display and the serial interface write the units as Table 5-2 shows them, for example **litr/min**; the text of this manual writes L/min and g/L.

Table 5-2 Units of measure

No.	Flow rate	Total	Description
1	%FS	%s	Percent of full scale
2	ml/sec	ml	Millilitre per second
3	ml/min	ml	Millilitre per minute
4	ml/hr	ml	Millilitre per hour
5	ml/day	ml	Millilitre per day
6	litr/sec	litr	Litre per second
7	litr/min	litr	Litre per minute
8	litr/hr	litr	Litre per hour
9	litr/day	litr	Litre per day
10	m^3/sec	m^3	Cubic metre per second
11	m^3/min	m^3	Cubic metre per minute
12	m^3/hr	m^3	Cubic metre per hour
13	m^3/day	m^3	Cubic metre per day
14	f^3/sec	f^3	Cubic foot per second
15	f^3/min	f^3	Cubic foot per minute
16	f^3/hr	f^3	Cubic foot per hour
17	f^3/day	f^3	Cubic foot per day
18	gal/sec	gal	Gallon per second
19	gal/min	gal	Gallon per minute
20	gal/hr	gal	Gallon per hour
21	gal/day	gal	Gallon per day
22	gram/sec	gram	Gram per second
23	gram/min	gram	Gram per minute

No.	Flow rate	Total	Description
25	gram/day	gram	Gram per day
26	kg/sec	kg	Kilogram per second
27	kg/min	kg	Kilogram per minute
28	kg/hr	kg	Kilogram per hour
29	kg/day	kg	Kilogram per day
30	lb/sec	lb	Pound per second
31	lb/min	lb	Pound per minute
32	lb/hr	lb	Pound per hour
33	lb/day	lb	Pound per day
34	Mton/min	Mton	Metric ton per minute
35	Mton/hr	Mton	Metric ton per hour
36	Igal/sec	Igal	Imperial gallon per second
37	Igal/min	Igal	Imperial gallon per minute
38	Igal/hr	Igal	Imperial gallon per hour
39	Igal/day	Igal	Imperial gallon per day
40	MilL/min	MilL	Million litres per minute
41	MilL/hr	MilL	Million litres per hour
42	MilL/day	MilL	Million litres per day
43	bbl/sec	bbl	Barrel per second
44	bbl/min	bbl	Barrel per minute
45	bbl/hr	bbl	Barrel per hour
46	bbl/day	bbl	Barrel per day
47	User	User	User-defined

No.	Flow rate	Total	Description
24	**gram/hr**	**gram**	Gram per hour

User-defined unit

Unit 47 is a unit you define under **EngUnits & K-Factor** › **UserDefined Units**, with three parameters:

- **UD Unit K-Factor**: the size of the unit in litres. The default is 1.00 litre.
- **UD Unit Time Base**: 1 second, 60 seconds (1 minute), 3600 seconds (1 hour) or 86400 seconds (1 day). The default is 60 seconds.
- **UD Unit Use Density**: set it to **YES** for a mass unit. The default is **NO**: the fluid density is not used for the flow rate.

Set the conversion factor and the time base before you use the unit.

K factor settings

When the mated device is calibrated for nitrogen and you measure or control another gas, a conversion factor relative to nitrogen (K factor) corrects the reading. The TIO stores K factors for 22 common gases (Appendix B (p. 52)) and takes one user-defined factor. A K factor applies to every unit except % FS. Under **EngUnits & K-Factor** › **K-Factor Settings**:

- **K-Factor Mode**: disabled, internal index or user-defined. The default is disabled.
- **Int. K-Factor Index**: 1 to 22, the gas in the internal table.
- **User Def'd K-Factor**: 0.001 to 999.9. The default is 1.000.

K factors are approximations at best. Do not rely on them where you need an accuracy better than ±5 to 10 %.

Alarm settings

The flow alarm watches the flow for values outside the limits you set, shows them on the display and can switch a digital output. How the alarm is judged depends on the Device Function:

- **Meter:** an alarm is raised when the flow reaches or passes the high or the low alarm level.
- **Controller:** an alarm is raised when the difference between the set point and the flow reaches or passes the high or the low alarm level.

The alarm can act after a delay, separately for high and low, and each output can latch or follow the alarm. Under **Alarm Settings**:

Table 5-3 Alarm settings

Setting	Function	Range, default
Flow Alarm Mode	Switches the flow alarm on or off (tabular entry).	Enabled, Disabled; default Disabled
Low Flow Alarm	Low alarm level. A meter raises the alarm when the flow is below it; a controller when the flow is below the set point by at least this value. The display shows **L**.	0–100 % FS in steps of 0.1 %
High Flow Alarm	High alarm level. A meter raises the alarm when the flow is above it; a controller when the flow is above the set point by at least this value. The display shows **H**.	0–100 % FS in steps of 0.1 %

Setting	Function	Range, default
Flow Alarm Delay	Time the flow must stay above the high or below the low limit before the alarm is valid.	0–3600 seconds; default 0, no delay
Flow Alarm Latch	When enabled, an output assigned to the alarm stays on; by default the alarm shows only while the flow is outside the limits.	Disabled, Enabled; default non-latching

For the meter function, the low alarm level must be lower than the high alarm level. To switch an output with the alarm, assign it under Digital output settings (p. 31).

Totaliser 1

The TIO has two independent programmable totalisers, which integrate the instantaneous flow over time. Totaliser 1 is the main totaliser: its value is saved in the EEPROM every second, so a power failure does not lose it. Its settings are under **Totalizer Settings** › **Totalizer #1**.

> **Note**
> **Before you enable a totaliser,** set all its other settings. Enter the flow start in the active flow unit and the action volume in the active volume or mass unit. The totaliser does not count while the flow is below its flow start. If you do not need an action at a set volume, leave the action volume at zero.

Table 5-4 Totaliser 1 settings

Setting	Function	Range, default
Totalizer #1 Mode	Switches totaliser 1 on or off.	Enabled, Disabled; default Disabled
Tot#1 Flow Start	The totaliser counts only while the flow is at or above this value.	0–100 % FS in steps of 0.1 %
Tot#1 Action Vol.	Volume at which the totaliser 1 event becomes true; zero switches the event off.	In the active volume or mass unit; default 0
Tot#1 PowerOn Delay	Time after power-up before the totaliser starts, so that the mated device can warm up.	0–3600 seconds; default 0, no delay
Tot#1 Auto Reset	Resets the totaliser when it reaches the action volume, for repeated batches.	Enabled, Disabled; default Disabled
Tot#1 AutoRes Delay	Delay before the automatic reset.	0–3600 seconds; default 0, no delay
Reset Totalizer #1	Resets the reading: select **YES**; the TIO confirms with **Totalizer Has been reset!**	–

Totaliser 2

Totaliser 2 is the pilot totaliser. Its value is kept in volatile memory and updated every 100 ms, with a backup in the EEPROM every 6 minutes (Table 6-3). A power failure can therefore lose the reading: it may come back at zero or changed. Use totaliser 2 for short-term totals such as batches, and do not rely on its reading after a power failure. Its settings are under **Totalizer Settings** › **Totalizer #2**; the note on enabling a totaliser applies to it too (Totaliser 1 (p. 30)).

Table 5-5 Totaliser 2 settings

Setting	Function	Range, default
Totalizer #2 Mode	Switches totaliser 2 on or off.	Enabled, Disabled; default Disabled

Setting	Function	Range, default
Tot#2 Configuration	Counts up or down. Counting down, the event becomes true when the totaliser reaches zero; set the action volume above zero.	Count UP, Count DN; default Count UP
Tot#2 Flow Start	The totaliser counts only while the flow is at or above this value.	0–100 % FS in steps of 0.1 %
Tot#2 Action Vol.	Counting up: volume at which the event becomes true; zero switches the event off. Counting down: the starting volume.	In the active volume or mass unit; default 0
Tot#2 PowerOn Delay	Time after power-up before the totaliser starts.	0–3600 seconds; default 0, no delay
Tot#2 Auto Reload	Resets the totaliser at the action volume (counting up) or reloads it at zero (counting down), for repeated batches.	Enabled, Disabled; default Disabled
Tot#2 AutoRel Delay	Delay before the automatic reset or reload.	0–3600 seconds; default 0, no delay
Reset Totalizer #2	Resets the reading: select **YES**; the TIO confirms with **Totalizer Has been reset!**	–

Pulse output

The pulse output works independently of the totalisers and gives a pulse frequency proportional to the instantaneous flow. Under **Totalizer Settings** › **Pulse Output** you can:

- switch the pulse output on or off (**PulseOutput Mode**);
- start it at a set flow, 0.0 to 100.0 % FS (**Pulse Flow Start**);
- set the volume per pulse, in the current unit (**[Unit]/Pulse**);
- set the active on time of a pulse, 10 to 6553 ms (**Pulse Active Time**).

Example. The maximum flow is 1200 kg/min, that is 20 kg/sec. With 1200 kg per pulse the output gives one pulse a minute; with 20 kg per pulse, one pulse a second.

The active on time is at least 10 ms, and the output cannot give more than one pulse every 100 ms. Set the volume per pulse to the maximum flow per second, in the same unit: the output then gives no more than one pulse a second. When the flow brings more pulses than the output can deliver, they wait in a queue and are given out later, when the flow falls; it is better to raise the volume per pulse.

The pulses come out on a digital output: assign one of the two to **Pulse Output** (Digital output settings (p. 31)) and wire it to terminal block J1 (Digital outputs (p. 15)).

Digital output settings

The two optically isolated outputs switch equipment of your own when an event occurs, or under your direct control. Under **Opt Output Settings**, assign each output one of nine functions. Both outputs are disabled by default.

Table 5-6 Functions of the digital outputs

Menu entry	The output is switched on
Disabled	Never: no event is assigned and the output is not energised.
Low F. Alarm	On a low flow alarm.
High F. Alarm	On a high flow alarm.
F. Range H-L	While the flow is in the range between the high and the low alarm settings.
Total#1 Event	When the reading of totaliser 1 exceeds its set limit.
Total#2 Event	When the reading of totaliser 2 exceeds its set limit.

Menu entry	The output is switched on
Pulse Output	The output gives the pulses of the pulse output.
Diagnostic	While any diagnostic or system event is active.
Manual On	At once, until you select **Disabled**.

The outputs are on terminal block J1 and need an external DC voltage across their terminals (Digital outputs (p. 15)).

Display settings

Under **General Settings** › **Display Settings**:

Table 5-7 Display settings

Setting	Function	Range, default
Display Mode	Static: you change the PI screens with **UP** and **DN**. Dynamic: the TIO changes them by itself.	Static, Dynamic; default Static
Screen Cycle Time	Time each PI screen is shown in the dynamic mode.	1–3600 seconds
Screen Mask	Shows or hides each of the four PI screens; hidden screens are skipped. Select a screen with **UP** or **DN** and press **RIGHT**: an asterisk [*] marks a screen that is shown. Press **ENT** to save. PI screen 1 cannot be hidden.	Default: all screens shown
Display Back Light	Backlight level; set with **UP** and **DN**, save with **ENT**.	19 levels
Display Contrast	Contrast level; set with **UP** and **DN**, save with **ENT**.	16 levels; default 6, the best level at room temperature (20 °C or 70 °F)

Device Function

General Settings › **Device Function** tells the TIO what it is mated to: select **Meter** for a flow meter and **Controller** for a mass flow controller. The Device Function decides which PI screens appear (Table 2-1), which functions are available (set point control only for a controller) and how some functions behave, such as the flow alarm. Set it to match the device actually used.

Signal conditioner

For pulsating flow or a noisy signal, the TIO has two noise filters: the noise reduction filter (NRF) and a running average. A flow linearizer improves the linearity of the measurement. Under **General Settings** › **Signal Conditioner**:

Table 5-8 Signal conditioner settings

Setting	Function	Range, default
Signal Condit. Mode	Switches the filter off or selects the NRF or the running average.	Disabled, NRF, Running Average; default NRF
NRF Num. of Samples	Number of previous inputs averaged. More samples make the reading slower to follow a change of flow; 12 is a good starting point for most applications.	1–32; default 12
NRF Time Interval	Response time of the filter to a change of flow: the higher the value, the slower the response. Zero switches the filter off.	0–199 ms; default 50
NRF Error Limit	Difference of a sample from the previous value above which the filter rejects it as a noise spike, while it allows normal variation of the flow signal.	0.0–10.0 % FS; default 2.0 % FS

Setting	Function	Range, default
Aver.Filter Damping	Running average only: response time to a 0 to 66 % step change of flow. Zero switches it off.	0–500 ms; default 200
FlowLinearizer Mode	Switches the flow linearizer on or off.	Default off

The default linearisation table is linear and does not change the signal. The table is calibrated only over the serial interface with the TIO configuration utility software, which has an automated procedure for it. It holds 11 pairs of values at 0, 10, 20 … 100 % FS: the actual flow (EEPROM indexes 98, 100 … 118) and the matching sensor reading (indexes 99, 101 … 119), each as a fraction of full scale from 0.000000 to 1.000000, with up to 6 decimal places (Appendix A (p. 49)).

NOTICE

Indexes 98 and 99 are the zero-flow points of the linearisation table and must stay 0.0. Changing them makes the flow reading wrong. Do not change indexes 98 and 99.

Program set point

A set point program runs up to 16 steps you enter in advance: ramps, pulses, or linear increases and decreases of the flow. Each step has a set point in % FS and a time in seconds: the time the set point takes to move linearly to the new value. During the program you can switch the loop mode on or off and pause the program (Running a set point program (p. 25)). The program set point works only when the Device Function is **Controller**. Under **General Settings** › **Program Set Point**:

Table 5-9 Program set point settings

Setting	Function	Range, default
Program SP Mode	Switches the program set point on or off.	Enabled, Disabled; default Disabled
PSP Loop Mode	When enabled, the program starts again at the first enabled step after the last one.	Enabled, Disabled; default Disabled
PSP Steps Mask	Enables or skips each step. Select a step with **UP** or **DN** and press **RIGHT**: an asterisk [*] marks an enabled step. Press **ENT** to save.	Default: all steps enabled
PSP Steps Settings	Set point and time of each step. Select a step with **UP** or **DN** and press **ENT**; adjust the flashing value with **UP**, **DN**, **LEFT** and **RIGHT**, then press **ENT** to save.	Set point in % FS, time in seconds

Event register

The TIO logs alarm and diagnostic events in an event register, which you read on the display or over the serial interface. Open it under **Device Diagnostic** › **Event Register Menu**.

Table 5-10 Alarm and diagnostic events

Code	Event
0	Temperature of the central processing unit (CPU) too high
1	High flow alarm
2	Low flow alarm
3	Flow in the range between high and low
4	Totaliser 1 exceeds the set event volume
5	Totaliser 2 exceeds the set event volume
6	Overflow of the pulse output queue

Code	Event
7	Flow rate above the limit
8	Supply voltage (Vcc) out of range
9	Serial communication error
A	EEPROM error
B	Power-on event (power-on delay timer above 0)
C	Password event
D	Fatal error (unrecoverable)

An event whose bit is set in the latch mask stays in the register until you reset it, on the keypad or over the interface; an event that is not latched shows only while it lasts. The register is kept in volatile memory and is cleared by a power failure.

- **`Event Reg. Status`** (read-only) lists the active events, with their number in the header line, for example **`Event Reg. Status: 2`** with **`2 - Low Flow Alarm`** and **`B - Power On Event`**, or **`No Active Events`**. With more than 7 events, scroll with **`UP`** and **`DN`**.
- **`Event Latch Mask`** sets for each event whether it latches. By default only event 0, CPU temperature too high, latches.
- **`Event Reg. Mask`** enables or disables each event; a disabled event is neither processed nor shown, even when it occurs. By default only event 0 is enabled.
- **`Reset Event Reg.`** clears the register after you select **`YES`**; the TIO confirms with **`Event Reg. Has been reset!`**

In both masks, select an event with **`UP`** or **`DN`** and press **`RIGHT`**: an asterisk [*] marks an enabled entry. Press **`ENT`** to save.

Diagnostic menu

The other items of **`Device Diagnostic`** show internal values for troubleshooting. They are read-only.

Table 5-11 Diagnostic menu

Item	Shows
`Analog Input counts`	Raw, averaged and filtered ADC counts of the analogue input
`Analog Output Value`	Configuration of the analogue output and the DAC counts
`LCD Back Light Set.`	Backlight level, duty cycle of the pulse-width modulation (PWM) and contrast
`Pulse Output Queue`	Pulses waiting in the pulse output queue, and its maximum, for example 250
`CPU Temperature`	Present temperature of the circuit board and the CPU, in °C

CHAPTER 6

Communication

Over its RS-232 interface, or the RS-485 interface on request, a computer or PLC reads every value of the TIO and changes every setting with a set of ASCII commands. The free TIO Configuration Utility software uses the same interface. The wiring is in Serial interface (p. 14).

Communication settings

The interface works with 8 data bits, 1 stop bit, no parity and no flow control. Under **General Settings** › **Communication Sett.**:

- **Baud Rate Settings**: 1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200 baud. The default is 9600. Set the TIO to the baud rate of the computer or PLC it is connected to.
- **RS-485 Bus Address**: two hexadecimal characters, 01 to FF. The default is 11 hexadecimal. The address is not used on a TIO with the RS-232 interface.

Address 00 is reserved for global addressing: all devices on the RS-485 bus execute a command sent to it, and none of them replies. Do not assign address 00 to a device.

NOTICE

Two or more devices with the same address on one RS-485 bus cause communication collisions, and the communication fails. Give each device on the bus its own address.

Command format

All values are sent as printable ASCII characters. A command ends with a carriage return; the TIO strips line feeds. On RS-485 a command starts with the start character `!` and the two characters of the address; on RS-232 leave out both.

Table 6-1 Command format

Interface	Format	Example
RS-485	`!<Addr>,<Cmd>,Arg1,Arg2,Arg3,Arg4<CR>`	`!12,F<CR>`
RS-232	`<Cmd>,Arg1,Arg2,Arg3,Arg4<CR>`	`F<CR>`

- `Addr`: RS-485 address of the device, two hexadecimal ASCII characters, 00 to FF.
- `Cmd`: the command of one or two characters (Table 6-3).
- `Arg1` to `Arg4`: the arguments of the command, separated by commas.
- `CR`: the carriage return character.

Examples

The examples assume a TIO with address 18 (12 hexadecimal) on the RS-485 bus.

Table 6-2 Command examples

Task	Command	Reply
Read the flow (here 50.0 % FS)	`!12,F<CR>`	`!12,50.0<CR>`

Task	Command	Reply
Read the flow alarm status (here no alarm)	`!12,A,R<CR>`	`!12,AR:N<CR>`
Read totaliser 1 (here 93.5)	`!12,T,1,R<CR>`	`!12,T1R:93.5<CR>`
Set the high and low alarm limits to 90 % and 10 % of full scale	`!12,A,C,90.0,10.0<CR>`	`!12,AC:90.0,10.0<CR>`

Command reference

An asterisk (*) marks the power-up default. EU stands for the engineering unit set on the TIO. Values in % FS are entered from 0.0 to 100.0.

Table 6-3 ASCII commands

No.	Cmd	Arguments	Function	Reply, example
1	F	–	Reads the flow in the current EU.	`<value>`
2	S	–	Reads the set point in the current EU.	`S:20.5`
		`<value>`	Writes the set point; not saved in the EEPROM.	`S:20.5`
		`<value>,S`	Writes the set point and saves it in the EEPROM.	`S:20.5,S`
3	D	–	Reads the fluid density at standard conditions, in g/L.	`D:1.25`
		`<value>`, 0.000001–10000.0	Writes and saves the density.	`D:1.56`
4	DE	–	Reads the event register, 16 bits (Table 6-5).	`DE:0x10`
		R	Resets the event register to 0x0000.	`DE:0x0`
5	DM	–	Reads the event mask, 16 bits; a set bit enables the event, a clear bit disables it.	`DM:0x9FFF`
		`<value>`, 0x0000–0xFFFF, all 6 characters	Writes the event mask.	`DM:0x9FFF`
6	DL	–	Reads the event latch mask, 16 bits; a set bit enables latching.	`DL:0x100F`
		`<value>`, 0x0000–0xFFFF, all 6 characters	Writes the event latch mask.	`DL:0x100F`
7	DI	–	Reads the configuration: full scale range in L/min, Device Function (M flow meter, C mass flow controller), input and output (V voltage, C current), low flow cut-off in % FS, flow power-up delay in seconds.	`DI: 100.0,M,V,V,2.0,2`
8	A	C, high limit, low limit, in % FS	Sets the alarm limits.	`AC:40.1,20.5`
		A, delay 0–3600 seconds	Sets the alarm action delay.	`AA:<value>`
		E	Enables the flow alarm.	`A:E`
		D*	Disables the flow alarm.	`A:D`
		R	Reads the alarm status: N no alarm, H high, L low.	`AR:N`
		S	Reads the settings: mode, high, low, delay, latch.	`AS:E,40.0,20.0,2,0`
		L, 0* disabled or 1 enabled	Sets the alarm latch.	`AL:0`
9	O	1 or 2 (output), then D*, AL, AH, AR, T1, T2, PO, DE or M	Assigns the output: no action, low alarm, high alarm, range between high and low, totaliser 1 above limit, totaliser 2 above limit, pulse output, diagnostic events, manual on.	`O1:AL`, `O2:PO`
		1 or 2, then S	Reads the assignment.	`O1:D`
10	DF	– or M (flow meter), C (mass flow controller)	Reads or sets the Device Function.	`DF:M`

No.	Cmd	Arguments	Function	Reply, example
11	T	1 or 2 (totaliser), then:	Totaliser 1 is kept in the EEPROM and survives a power cycle. Totaliser 2 is kept in volatile memory and backed up in the EEPROM every 6 minutes; a power cycle can reset it to zero or change its reading. Totaliser 1 cannot be reset when EEPROM index 70 is 1.	
		Z	Resets the totaliser to zero.	T1Z
		C, flow start in % FS, limit volume in the current volume EU	Sets the flow start and the event volume; a limit volume of zero switches the event off. Counting down, the limit volume must be above zero.	T1C:2.5, 0.0
		P, 0–3600 seconds	Sets the power-on delay.	T1P:10
		D* or E	Disables or enables the totaliser.	T1:E
		R	Reads the totaliser, in the current EU.	T1R:<value>
		S	Reads the settings: mode, direction, flow start, limit volume, power-on delay, auto reset mode, auto reset delay.	T1S:E,0,0.5, 2045.2,10,0,5
		A, 0 disable, 1 enable	Sets the auto reset (totaliser 1) or auto reload (totaliser 2).	T2A:1
		I, 0–3600 seconds	Sets the auto reset or reload delay.	T1I:2
		B (totaliser 1 only), M 0 up or 1 down (totaliser 2 only)	Restores totaliser 1 from the EEPROM backup; sets the counting direction of totaliser 2.	T1B
12	P	U, volume per pulse in the current EU	Sets the volume per pulse. The EU must not be time-based.	PU:10
		T, 10–6553 ms	Sets the pulse active time. It must be no more than half the pulse period.	PT:100
		D* or E	Disables or enables the pulse output.	P:E
		Q	Reads the number of pulses in the queue.	PQ:<value>
		F, 0.0–100.0 % FS	Sets the flow start.	PF:1.0
		S	Reads the settings: mode, flow start, volume per pulse, pulse time.	PS:E,1.0,1.666,100
13	U	–	Reads the unit of measure.	U:litr/min
		A unit of Table 5-2 as displayed, for example litr/min; %FS*	Sets the unit of the flow rate and the totalisers.	U: litr/min
		USER, K factor from L/min (> 0.0), time base S, M, H or D, density Y or N	Sets the user-defined unit.	U:USER,1.5,M,N
14	K	S	Reads the K factor mode (D disabled, I internal, U user-defined), the index and the user-defined value.	KS:U,1,0.91200
		D	Disables the K factor (K factor = 1.0).	KD
		I, index 1–22	Selects an internal K factor (Appendix B (p. 52)).	KI:1,Ar
		U, 0.00001–999.9	Sets a user-defined K factor.	KU:0.91200
15	C	P, – or seconds	Reads or sets the flow power-up delay.	CP:3
		F, – or L/min	Reads or sets the full scale range.	CF:1000.0
		L, – or % FS	Reads or sets the low flow cut-off.	CL:5.0
		T	Reads the hours since the last calibration.	CT:1024.2
		Z	Sets the calibration timer to zero; do this after each calibration.	CT:Z

No.	Cmd	Arguments	Function	Reply, example
16	SC	M, – or N (none), F (NRF), A (running average)	Reads or sets the signal conditioner mode.	SCM:F
		D, – or 0–500 ms, 0 disabled	Reads or sets the running average damping.	SCD:50
		F, – or samples 1–32, time limit 0–199, error limit 0.0–10 %	Reads or sets the NRF parameters.	PWF:4,8,0.0
		L, – or E, D	Reads, enables or disables the flow linearizer.	SCL:E
17	L	M, – or S (static), D (dynamic)	Reads or sets the PI screen mode.	LM:S
		C, – or 1–16	Reads or sets the LCD contrast.	LC:6
		B, – or 1–19	Reads or sets the LCD backlight.	LB:16
		T, – or 1–3600 seconds	Reads or sets the screen time in the dynamic mode.	LT:5
		S, – or 0x0000–0x00FF, all 6 characters	Reads or sets the screen mask; a set bit shows the screen. Bit 0x01: flow or set point, totaliser 1; 0x02: flow, totaliser 2; 0x04: flow, totalisers 1 and 2.	LS:0x03
18	PI	–	Reads the process information: flow rate and totalisers 1 and 2 in the current EU, flow alarm status (D, N, L, H), event register.	24.5,1254.2,12.0,N,0x0
19	PS	M, – or E, D	Reads or sets the program set point mode.	PSM:D
		L, – or E, D	Reads or sets the loop mode.	PSL:D
		P, step 1–16; to change it, also set point 0–100 % FS and time 0–86400 s	Reads or sets a program step.	PSP02: 50.0,25
		A, – or 0x0000–0xFFFF, all 6 characters	Reads or sets the step mask; a set bit enables the step.	PSA:0xFFFE
		C, – or R (run), S (stop)	Reads or sets the run status of the program.	PSC:R
20	MR	Index 0–163	Reads an EEPROM variable (Appendix A (p. 49)).	<value>
21	MW	Index 20–163, value	Writes an EEPROM variable. Some indexes are write protected.	MW,105,101.3

NOTICE

The MW command writes straight into the EEPROM table, and a wrong value can make the TIO malfunction. Use MW with care, check the index and the value against Appendix A, and read the value back with MR.

Error codes

Table 6-4 Error codes of the serial interface

Code	Meaning
1	Command not supported, or back door not enabled
2	Wrong number of arguments
3	Address out of range (MR or MW commands)
4	Wrong number of characters in the argument
5	Attempt to alter a write-protected area of the EEPROM
6	Proper command or argument not found
7	Wrong value of the argument
8	Reserved
9	Manufacturer-specific EEPROM key wrong or disabled

Event codes and bit positions

Table 6-5 Bits of the event register and masks

Code	Event	Bit
0	CPU temperature high	0x0001
1	High flow alarm	0x0002
2	Low flow alarm	0x0004
3	Range between high and low	0x0008
4	Totaliser 1 above limit	0x0010
5	Totaliser 2 above limit	0x0020
6	Pulse output queue	0x0040
7	Flow over limit	0x0080
8	Vcc out of range	0x0100
9	Serial communication error	0x0200
A	EEPROM error	0x0400
B	Power-on event	0x0800
C	Password event	0x1000
D	Fatal error	0x2000

CHAPTER 7

Calibration and verification

The settings under **`General Settings`** › **`Device Calibration`** are set to match the mated flow meter or controller and the process conditions. Only properly trained personnel should change them.

Full Scale Range

Set **`Full Scale Range`** to the full scale range of the mated device, converted to litres per minute. The TIO scales its analogue input and output to this value. For example, with a Full Scale Range of 10.0 L/min and a 0–5 V DC input, 5.0 V DC on the input reads as 100.0 % FS when % FS is the unit of measure.

NOTICE

A Full Scale Range that does not match the full scale range of the mated device, in litres per minute, gives wrong readings and unexpected behaviour of the TIO. Before you rely on any reading, set Full Scale Range to the full scale range of the mated device, converted to litres per minute.

Low flow cut-off

`Low Flow Cut-off` is set between 0.0 and 10.0 % of the full scale range. A flow below the cut-off is driven to zero and is not totalised. The default is zero, cut-off disabled.

Flow power-up delay

Most mass flow meters and controllers need some warm-up time after power-up before their output is stable and their reading accurate. **`Flow PowerUp Delay`** sets a time that must pass after power-up before the TIO processes its input. During the delay the flow is driven to zero and is not totalised. The range is 0 to 3600 seconds; the default is 0, no delay.

Fluid standard density

`Fluid Std. Density` is the density of the fluid at standard temperature and pressure, in g/L. The TIO uses it only for mass units. The range is 0.000001 to 10000.0 g/L; the factory default is 1.25 g/L (nitrogen).

Calibrating the analogue output and input

The analogue output and input of the TIO were calibrated at the factory. They need a new calibration only after the DAC, the output amplifier, the CPU, the input amplifier or passive components of these circuits have been replaced, and only when Analyt-MTC recommends it. Changing the scaling variables of the analogue output or input in the EEPROM table voids the calibration warranty supplied with the TIO.

The calibration calculates the offset and span variables from two calibration points, 0 and 100 % FS, and saves them in the EEPROM. The 0–5 (0–10) V DC circuits have only a scale variable; the 4–20 mA

circuits have an offset and a scale variable.

NOTICE

Signals above the rated values of the jumper configuration, wrong wiring or reversed polarity can damage the TIO or cause faulty operation. Before you switch on, check the actual J2 jumper configuration, keep within the rated values and check the wiring and the polarity of the power supply and the signals.

Do not apply more than 5.0 V DC to the input unless the TIO was configured at the factory for 0–10 V DC; check the model number and the specification.

1. Power up the TIO for at least 15 minutes before you start.
2. Check the position of the output or input jumper (Input and output jumpers (p. 13)).
3. For **`Analog Output Cal.`**, connect a measuring device of the matching type to pins 5 (plus) and 8 (minus) of the 9-pin D-connector. For **`Analog Input Cal.`**, connect a calibration signal source of the matching type to pins 4 (plus) and 8 (minus).
4. Follow the prompts of the firmware: adjust the calibration points to the reading of the measuring device, or apply the calibration points as the screen instructs. Press **ESC** to abort.
5. At the end the TIO shows the new offset and span values. Press **ENT** to save them in the EEPROM, or **ESC** to leave without saving. The TIO confirms with a message.

Pilot calibration timer

`Pilot Cal. Timer` counts the operating hours since the last calibration, in steps of 6 minutes. To reset it, press **RIGHT** and select **Yes** on the confirmation screen. Reset the timer after each calibration; over the serial interface use `C,Z` (Command reference (p. 36)).

Calibration by Analyt-MTC

The TIO was calibrated at the factory for the input and output configuration you ordered. For a recalibration or a repair, contact Analyt-MTC (Service, warranty and contacts (p. 47)).

CHAPTER 8

Troubleshooting

The TIO was checked at many quality control points during and after manufacture, calibrated for your input and output configuration, and packed to prevent damage in transit. If it does not work as expected, check the common conditions first, then look up the indication in Table 8-1.

Common conditions

- Are all cables connected correctly?
- Do the pin assignments of the connectors match (Pin assignment (p. 13))?
- Are the J2 input and output jumpers set correctly (Input and output jumpers (p. 13))?
- Does the power supply meet the requirements? When several devices are used, choose a supply with a sufficient current rating.
- With equipment of other makes, are the cables and connectors wired for the correct pin assignment?
- Are Device Function, Full Scale Range and Fluid Std. Density set correctly (Setting the three parameters (p. 24))?

Troubleshooting guide

Table 8-1 Indications, likely causes and remedies

No.	Indication	Likely cause	Remedy
1	The display stays blank at power-up; the status LED (light-emitting diode) is off.	Power supply bad, or polarity reversed.	Measure the voltage between pins 2 and 1 of the D-connector. If it is outside the specified range, replace the power supply. If the reading is negative, correct the polarity.
		Circuit board defective.	Return the TIO for repair (Service, warranty and contacts (p. 47)).
2	The display shows the flow, but the 4–20 mA set point output does not change.	J2 input and output jumpers set wrongly.	Check the J2 jumper configuration (Input and output jumpers (p. 13)).
		External loop open, or load resistance too high.	Check the external connections to pin 5 and the reference pin 8 of the D-connector. Keep the loop resistance below 400 Ohm with a 12 V DC supply and below 900 Ohm with a 24 V DC supply.
		4–20 mA circuit burnt out or damaged.	Under **`Device Diagnostic`**, open **`Analog Output Value`**, note the DAC counts and send them to Analyt-MTC.
3	Fluid flows through the flow meter or controller, but the flow reading or the totaliser does not respond.	Flow below the low flow cut-off.	Check and adjust the low flow cut-off (Low flow cut-off (p. 40)).
		J2 input and output jumpers set wrongly.	Check the J2 input jumper configuration (Input and output jumpers (p. 13)); if needed, ask Analyt-MTC for help.
		Circuit board defective.	Taking precautions against electrostatic discharge (ESD), measure the voltage between pin 4 and the reference pin 8 of the D-connector. If it follows the output signal of the flow meter or controller, open **`Analog Input counts`** under **`Device Diagnostic`**, note the ADC counts and send them to Analyt-MTC.

No.	Indication	Likely cause	Remedy
4	Fluid flows and the flow reading responds, but the totaliser does not change.	Flow below the flow start of totaliser 1.	Check and adjust **`Tot#1 Flow Start`** (Totaliser 1 (p. 30)).
		Totaliser disabled.	Set **`Totalizer #1 Mode`** to **`Enabled`**.
		Power-on delay of the totaliser set high; the firmware keeps the totaliser off.	Check **`Tot#1 PowerOn Delay`** and lower it if it is too high.
5	Erratic flow reading.	J2 input and output jumpers set wrongly.	Check the J2 input jumper configuration; if needed, ask Analyt-MTC for help.
		Full Scale Range, in L/min, not equal to the full scale range of the mated device.	Set **`Full Scale Range`** to the full scale flow of the mated device in L/min (Full Scale Range (p. 40)).
		Mass units selected, and Fluid Std. Density not set for the fluid used.	Check **`Fluid Std. Density`** (Fluid standard density (p. 40)).
6	Wrong totaliser reading.	J2 input and output jumpers set wrongly.	Check the J2 input jumper configuration; if needed, ask Analyt-MTC for help.
		Full Scale Range, in L/min, not equal to the full scale range of the mated device.	Set **`Full Scale Range`** to the full scale flow of the mated device in L/min.
7	The display shows the flow, but the serial interface does not work.	Wrong interface on the computer, or wrong wiring.	Use the same interface type, RS-232 or RS-485, on the computer as on the TIO; if needed, use an RS-232 to RS-485 converter. Check the wiring (Serial interface (p. 14)).
		RS-485: the address of the TIO does not match the address used by the computer.	Set the RS-485 address of the TIO to match the software of the computer (Communication settings (p. 35)).
8	Event 0, CPU temperature high, is active.	Temperature of the CPU or circuit board too high (overload).	Disconnect the power. Make sure the ambient temperature is within the specified range, below 70 °C. Let the TIO cool down for at least 15 minutes, apply power and check the event again. If the overload shows again, return the TIO for repair.
9	Event D, fatal error, is active.	EEPROM or SRAM corrupted.	Switch the power off and on. If event D shows again, return the TIO for repair.

CHAPTER 9

Specifications

Table 9-1 Specifications

Measurement and signals	
ADC and DAC resolution	12 bit
Accuracy	±0.1 % of full scale
Analogue inputs	0–5 V DC, 4–20 mA, 5–10 V DC (selected by jumpers); 0–10 V DC on special order
Analogue outputs	0–5 V DC, 4–20 mA (selected by jumpers); 0–10 V DC on special order
Display and keypad	
LCD	128 × 64 graphic LCD with the instantaneous flow and the total; contrast and backlight adjustable; refreshed 10 times a second
Keypad	6 push buttons
Data protection	All settings backed up in the EEPROM, totaliser 1 every second; data retention at least 10 years; configuration protected by password
Outputs	
Pulse output	Programmable, optically isolated; active low time 10–6550 ms; UCE ≤ 40 V DC, ICE ≤ 150 mA; isolation voltage 250 Vrms
Digital outputs	Two, programmable, optically isolated; UCE ≤ 40 V DC, ICE ≤ 150 mA; isolation voltage 250 Vrms
Serial interface	
Type	RS-232, or RS-485 2-wire (multidrop for up to 64 devices)
Protocol	Proprietary ASCII command set
Speed	1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200 baud; default 9600 baud
Configuration	1 stop bit, 8 data bits, no parity, no flow control
Addressing (RS-485 only)	Up to 255 addresses; default address 11 hexadecimal
Power and connections	
Power supply	12–26 V DC, 100 mV maximum peak-to-peak output noise (up to 60 mA maximum load)
Connectors	Process signals and serial interface: miniature 9-pin female D-sub. Digital outputs: 4-position shrouded terminal block header, 3.5 mm, male pins (mating connector Tyco Electronics 284510-4)
Environment and mechanics	
Environment	Installation level II, pollution degree II
Electromagnetic compatibility	Compliant with 89/336/EEC as amended. Emission: EN 55011:1991, group 1, class A. Immunity: EN 55082-1:1992
Operating temperature	−10 °C to +70 °C (14 °F to +158 °F)
Dimensions (W × H × D)	86.4 × 76.2 × 19.1 mm (3.4" × 3.0" × 0.75")
Weight	Approximately 125 g (0.3 lbs)

Dimensions

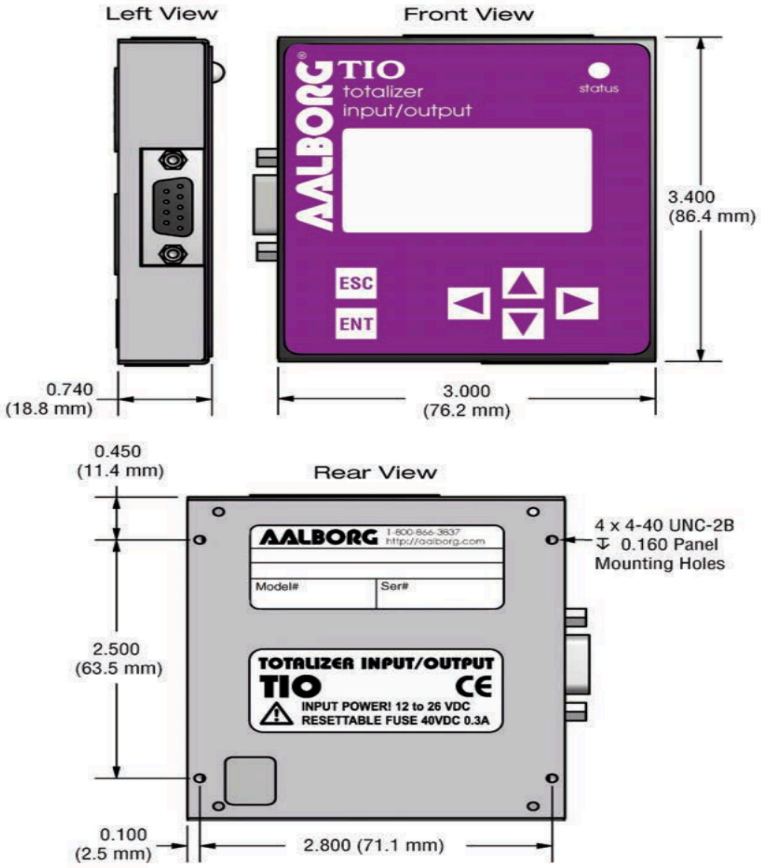


Figure 9-1. Dimensions of the TIO. For certified dimensions, contact Analyt-MTC.

CHAPTER 10

Ordering information

Order the TIO and its kits from Analyt-MTC with the order codes. The order codes of the TIO itself, by input, output and interface, are in the TIO spec sheet AMTC-SS-0027.

Kits for GFM flow meters

Table 10-1 GFM cable and mounting kits

Order code	Description
KIT-TM-DD	Mounting kit with shielded cable, two 9-pin D-connectors and a 6 ft communication branch; 0–5 V DC
KIT-TM-RD	Mounting kit with 4-wire cable, RJ11 of the GFM to the 9-pin D-connector of the TIO; 5–10 V DC, GFM supply 12 V DC only
KIT-TM-FD	Mounting kit with flat 4-wire cable between the 9-pin D-connectors; 0–5 V DC
KIT-TM	Mounting kit, no cables

Kits for GFC mass flow controllers

Each kit except KIT-TC has a mounting kit, a shielded cable and a power supply for the GFC; the TIO input and output are 0–5 V DC. In the order code, 2 stands for a 12 V DC and 4 for a 24 V DC power supply, C for a cable with a communication branch and N for one without (Table 3-6).

Table 10-2 GFC power supply, cable and mounting kits

Order code	Mains plug	GFC power supply	Communication branch
KIT-TC-110NA-2C	North America, 110 V AC	12 V DC	Yes
KIT-TC-110NA-2N	North America, 110 V AC	12 V DC	No
KIT-TC-110NA-4C	North America, 110 V AC	24 V DC	Yes
KIT-TC-110NA-4N	North America, 110 V AC	24 V DC	No
KIT-TC-230EU-2C	Europe, 230 V AC	12 V DC	Yes
KIT-TC-230EU-2N	Europe, 230 V AC	12 V DC	No
KIT-TC-230EU-4C	Europe, 230 V AC	24 V DC	Yes
KIT-TC-230EU-4N	Europe, 230 V AC	24 V DC	No
KIT-TC-240AU-2C	Australia, 240 V AC	12 V DC	Yes
KIT-TC-240AU-2N	Australia, 240 V AC	12 V DC	No
KIT-TC-240AU-4C	Australia, 240 V AC	24 V DC	Yes
KIT-TC-240AU-4N	Australia, 240 V AC	24 V DC	No
KIT-TC-240UK-2C	UK, 240 V AC	12 V DC	Yes
Ask Analyt-MTC	UK, 240 V AC	12 V DC	No
KIT-TC-240UK-4C	UK, 240 V AC	24 V DC	Yes
KIT-TC-240UK-4N	UK, 240 V AC	24 V DC	No
KIT-TC	Mounting kit only, no cables, no power supply		

CHAPTER 11

Service, warranty and contacts

Calibration, repair and technical support for your TIO are provided by Analyt-MTC. Talk to Analyt-MTC before you send anything: many problems turn out to be wiring or settings that can be sorted out on the phone.

Contact and support

ANALYT-MTC Messtechnik GmbH

German Headquarters

Klosterrunsstraße 18, 79379 Müllheim
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+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 contact Analyt-MTC

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

- the model number and serial number from the label on the back of the TIO;
- the firmware version shown after power-up (Display (p. 10));
- the flow meter or controller the TIO is mated to, and its full scale range;
- a description of the fault and of what you have already checked (Troubleshooting (p. 42)).

Contact

The contact details are given above and on the back cover.

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

Sending in a TIO

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 or repair. Do not put paper forms in the box: the service request carries everything Analyt-MTC needs.

> **⚠ WARNING**
>
> Equipment that has been in contact with hazardous media can hold residues. Residues endanger the people who unpack and service it. Never ship such equipment without purging and neutralising it.

2. **Decontaminate the equipment.** If you send the TIO with its flow meter or controller, purge it and neutralise all residues of toxic, infectious, corrosive or radioactive media. In the service request, state the substances the equipment 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 TIO alone.** Send the TIO without power supply, cables or case unless they are part of the problem; Analyt-MTC is not responsible for accessories sent. Pack it in anti-static material, in a sturdy carton that withstands shipping. Close the process ports of a flow meter or controller sent with it so that nothing enters the flow path, protect the connectors against electrostatic discharge, and pack each TIO 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 TIO 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 TIO are those agreed in your order confirmation. Warranty claims are handled by Analyt-MTC: give Analyt-MTC the serial number and a description of the fault before returning the TIO.

Disposal

Do not dispose of the TIO with household waste. Dispose of it as electrical and electronic equipment under local regulations (WEEE).

APPENDIX A

EEPROM variables

The EEPROM table of firmware revision A001. Read a variable with the MR command and write it with MW (Command reference (p. 36)); indexes 0 to 19 are protected. %s stands for percent-seconds.

Table A-1 EEPROM variables

Index	Name	Type	Description
0	BlankEEPROM[10]	char[10]	Table revision; do not modify (protected)
1	SerialNumber[20]	char[20]	Serial number (protected)
2	ModelNumber[20]	char[20]	Model number (protected)
3	SoftwareVer[10]	char[10]	Firmware version (protected)
4–19	ManufReserved…, ReservedText[12]	float, uint, int, char[12]	Manufacturer-specific data (protected)
20	TimeSinceCalHr	float	Hours since the last calibration
21	ProtectionCode	uint	Program protection code [0–255]
22	DeviceFunction	uint	Device Function: 0 flow meter, 1 mass flow controller
23	BaudRate	uint	Baud rate index [0–7]
24	Address485	char[4]	RS-485 address, two hexadecimal characters [01–FF]
25	FlowUnits	int	Current unit of measure [0–46]
26	UDUnitKfactor	float	Conversion factor of the user-defined unit
27	UDUnitTimeBase	int	Time base index of the user-defined unit [0–3]
28	UDUnitDensity	uint	User-defined unit uses the density: 1 yes, 0 no
29	KfactorMode	uint	K factor mode: 0 disabled, 1 internal, 2 user-defined
30	KfactorIndex	uint	Internal K factor index [0–21]
31	UserDefKfactor	float	User-defined K factor
32	DiagEventMask	uint	Event mask; a clear bit masks the event
33	PSP_Mode	uint	Program set point mode: 0 disabled, 1 enabled
34	SetPointPFS	float	Set point as a fraction of full scale [0.0–1.1]
35	DiagEventLatchMask	uint	Event latch mask; a clear bit masks the event
36–37	Reserved3, Reserved4	float	Reserved
38	OptOut1_Config	uint	Function of optical output 1
39	OptOut2_Config	uint	Function of optical output 2
40	GLCD_Mode	uint	PI screen mode: 0 static, 1 dynamic
41	GLCD_Static_Mode	uint	Type of the static screen [0–3]
42	GLCD_AUTO_Mode_Mask	uint	Screen mask of the dynamic mode
43	Cycle_Time	uint	Time each screen is shown in the dynamic mode, in seconds
44	GLCD_Contrast	uint	LCD contrast [1–16]
45	GLCD_Reserved	uint	Reserved
46	GLCD_LED_PWM	uint	Backlight PWM duty cycle [1–19]
47	PSP_StepMasc	uint	Step mask of the set point program [0x0000–0xFFFF]
48	PSP_LoopMode	uint	Loop mode of the set point program: 0 disabled, 1 enabled

Index	Name	Type	Description
49–50	`Out_Scale_mA, Out_Offset_mA`	float	Scale and offset of the 4–20 mA output
51–52	`In_mA_Mode, In_mA_Reserved`	uint	Reserved
53–54	`In_Scale_mA, In_ Offset _mA`	float	Scale and offset of the 4–20 mA input
55–56	`OutScaleV, OutOffsetV`	float	Scale and offset of the 0–5/0–10 V DC output
57–58	`InScaleV, InOffsetV`	float	Scale and offset of the 0–5/0–10 V DC input
59	`F_AlarmMode`	uint	Flow alarm mode: 0 disabled, 1 enabled
60	`F_LowAlarmPFS`	float	Low flow alarm, fraction of full scale [0–1.0]
61	`F_HiAlarmPFS`	float	High flow alarm, fraction of full scale [0–1.0]
62	`F_AlmDelay`	uint	Action delay of the flow alarm, 0–3600 seconds
63	`F_AlarmLatch`	uint	Flow alarm latch
64	`F_AlarmSpare`	uint	Spare
65	`Total1_Mode`	uint	Totaliser 1 mode: 0 disabled, 1 enabled
66	`Total1_Config`	uint	Totaliser 1 configuration: 0 count up
67	`Total1_FlowStart`	float	Flow start, fraction of full scale [0–1.0]
68	`Total1_VolStop`	float	Limit volume in %s; 0 disables
69	`Total1_PowOnDelay`	uint	Power-on delay [0–3600] seconds
70	`Total1_ValueLock`	uint	Reset lock: 0 can be reset, 1 cannot be reset
71	`Total1_Volume_BkUp`	float	Backup volume in %s, saved every 6 minutes
72	`Total1_AutoReset`	uint	Reset at the limit volume: 0 no, 1 yes
73	`Total1_AtoResetDelay`	uint	Delay before the automatic reset [0–3600] seconds
74	`Total1_Reserved`	uint	Reserved
75	`Total2_Mode`	uint	Totaliser 2 mode: 0 disabled, 1 enabled
76	`Total2_Config`	uint	Totaliser 2 configuration: 0 count up, 1 count down
77	`Total2_FlowStart`	float	Flow start, fraction of full scale [0–1.0]
78	`Total2_VolStop`	float	Limit volume in %s; 0 disables
79	`Total2_PowOnDelay`	uint	Power-on delay [0–3600] seconds
80	`Total2_Volume_BkUp`	float	Backup volume in %s, saved every 6 minutes
81	`Total2_ReloadVolStop`	uint	Reload the limit volume when counting down reaches zero: 0 no, 1 yes
82	`Total2_ReloadDelay`	uint	Delay before the reload [0–3600] seconds
83	`Total2_10SecBackUp`	uint	Backup to the EEPROM every 10 seconds (reserved for a future release)
84	`Total2_Reserved`	uint	Reserved
85	`Flow_Pulse_Mode`	uint	Pulse output mode: 0 disabled, 1 enabled
86	`PulseFlowStart`	float	Flow start of the pulse output, fraction of full scale [0–1.0]
87	`Units_Per_Pulse`	float	Units per pulse
88	`Active_Low_Time`	uint	Active time of a pulse, in ms
89	`Flow_Pulse_Reserved`	uint	Reserved
90	`FlowCondMode`	uint	Signal conditioner: 0 none, 1 NRF, 2 running average
91	`Flow_NRF_NSample`	uint	NRF number of samples [1–32]
92	`Flow_NRF_ErrLimit`	float	NRF error limit [0.05–10.0] % FS
93	`Flow_NRF_TimeLimit`	uint	NRF time interval [0–199]; 0 disabled

Index	Name	Type	Description
94	`Flow_Damping`	uint	Damping 0–500 ms
95	`Flow_Window`	uint	Running average window [0–32]; 0 disabled
96	`FlowLinearizer`	uint	Flow linearizer: 1 on, 0 off
97	`Flow_SC_Reserved`	uint	Reserved
98–119	`FlowTbl[0]…[10].FlowPFSIn, .FlowPFSOut`	float	Linearisation table, points 0 to 10: even indexes the actual flow (In), odd indexes the sensor reading (Out), as fractions of full scale [0.0–1.0]; indexes 98 and 99 must be 0.0
120	`MDSerialNumber`	char[20]	Serial number of the mated device
121	`MeterFSRange`	float	Full scale range of the device in L/min at standard conditions
122	`LowFlowCutOff`	float	Low flow cut-off, fraction of full scale [0–0.1]
123	`FlowPowerUpDelay`	uint	Flow power-up delay [0–1200] seconds
124	`Density`	float	Fluid density, g/L
125	`FluidName[20]`	char[20]	Name of the fluid used for calibration
126	`CalibratedBy[20]`	char[20]	Name of the person who calibrated the device
127	`CalibratedAt[20]`	char[20]	Name of the calibration laboratory
128	`DateCalibrated[12]`	char[12]	Calibration date
129	`DateCalibrationDue[12]`	char[12]	Date the next calibration is due
130	`UserTagName`	char[20]	User-defined tag name or number of the device
131–162	`PSPTbl[0]…[15].PFS, .Time`	float	Set point program, steps 1 to 16: odd indexes the set point as a fraction of full scale (0.0–1.0), even indexes the time in seconds
163	`EEMagicNumber`	uint	Number used to verify the integrity of the EEPROM

APPENDIX B

Internal K factors

The 22 K factors stored in the TIO, relative to nitrogen, with the specific heat c_p and the density from which they are derived. Select one with **`Int. K-Factor Index`** (K factor settings (p. 29)) or with the command `K,I,<index>`.

> **Note**
> K factors are approximations at best. Do not rely on them where you need an accuracy better than ±5 to 10 %.

Table B-1 Internal K factors

Index	Gas	K factor relative to N_2	c_p [cal/g]	Density [g/L]
1	Argon Ar	**1.4573**	0.1244	1.782
2	Arsine AsH_3	**0.6735**	0.1167	3.478
3	Boron trifluoride BF_3	**0.5082**	0.1778	3.025
4	Bromine Br_2	**0.8083**	0.0539	7.130
5	Acetylene C_2H_2	**0.5829**	0.4036	1.162
6	Cyanogen C_2N_2	**0.61**	0.2613	3.322
7	Methane CH_4	**0.7175**	0.5328	0.715
8	Chlorine Cl_2	**0.86**	0.114	3.163
9	Carbon dioxide CO_2	**0.7382**	0.2016	1.964
10	Carbonyl fluoride COF_2	**0.5428**	0.1710	2.945
11	Carbonyl sulfide COS	**0.6606**	0.1651	2.680
12	Carbon disulfide CS_2	**0.6026**	0.1428	3.397
13	Fluorine F_2	**0.9784**	0.1873	1.695
14	Hydrogen H_2	**1.0106**	3.419	0.0899
15	Helium He	**1.454**	1.241	0.1786
16	Nitrous oxide N_2O	**0.7128**	0.2088	1.964
17	Ammonia NH_3	**0.7310**	0.492	0.760
18	Neon Ne	**1.46**	0.246	0.9
19	Nitric oxide NO	**0.99**	0.2328	1.339
20	Oxygen O_2	**0.9926**	0.2193	1.427
21	Sulfur dioxide SO_2	**0.69**	0.1488	2.858
22	Xenon Xe	**1.44**	0.0378	5.858

APPENDIX C

Circuit layout

The component side of the TIO circuit board. The J2 input and output jumpers are at the bottom right (Input and output jumpers (p. 13)); J1, the terminal block of the optically isolated outputs, is at the top; the 9-pin D-connector is on the left.

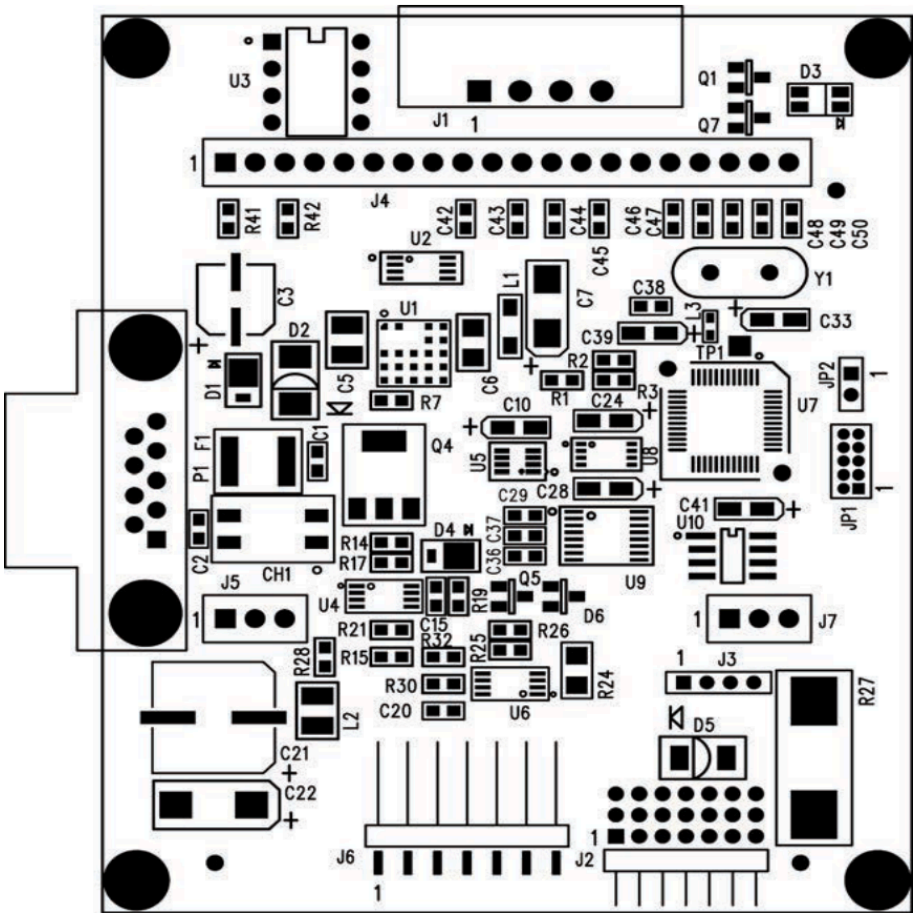


Figure C-1. Circuit layout, top side.

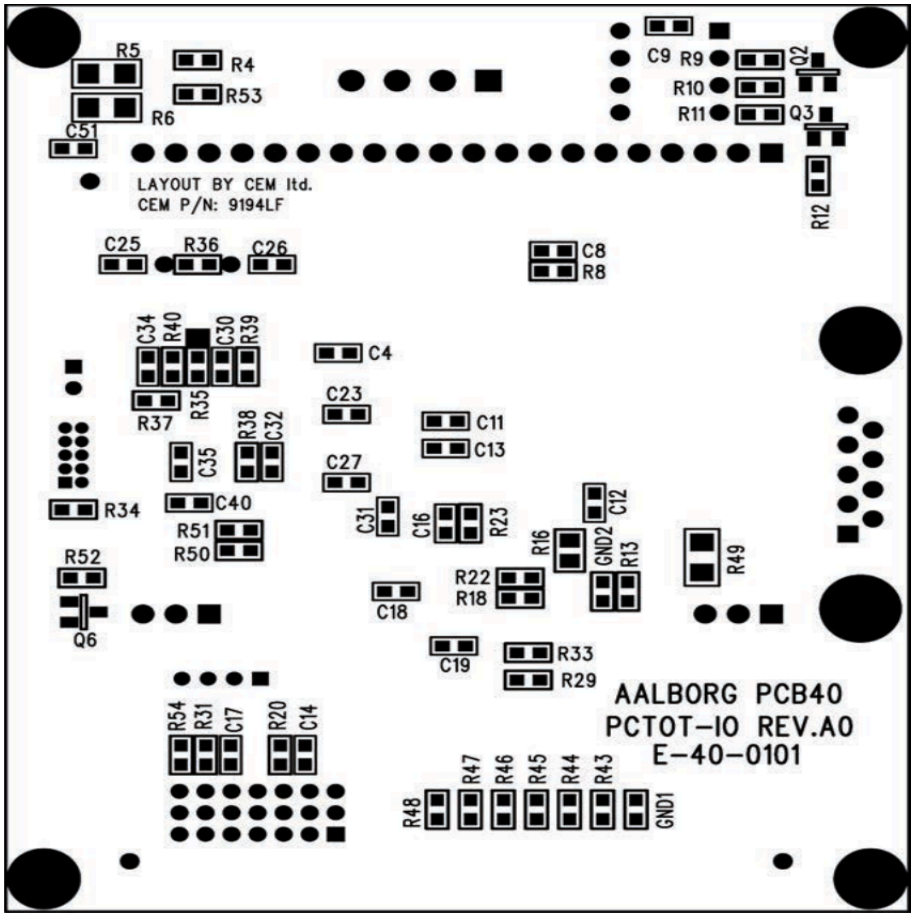


Figure C-2. Circuit layout, bottom side.

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