

Flexim F601 Ultrasonic Flow Meter



Figure 1 Flexim F601 parts

- 1) Control console
- 2) Ultrasonic transducers
- 3) Magnetic transducer mounting rails
- 4) RTD temperature probes (PT100)

Not shown:

- 5) Power supply
- 6) Pipe diameter tape measure
- 7) Chain extensions
- 8) Pipe wall thickness gauge

Overview

The Flexim F601 Ultrasonic Liquid Flow Meter measures liquid and energy flow in a pipe. It has clamp-on sensors for non-intrusive installation and measurement, without requiring probes be physically inserted into the pipe. The F601 has data logging capabilities and a digital display for instantaneous flow measurements.

In mechanical systems, ultrasonic liquid flow meters are most commonly used for HVAC chilled and hot water applications but are also useful in industrial processes. All applications require that no gas-phase substance is present.

Applications

The F601 Flow Meter is often used for:

- liquid and/or thermal energy flow
- Water demand analysis, including leaks. The portable flow meter can serve as a sub-meter to measure cumulative amount of water used by a device or a sub-system of a larger metered system.
- Diagnosing system performance issues like variation in flow and flow direction

Thermal Flow Monitoring

The F601 kit includes two precision RTD temperature probes whose outputs are integrated with flow measurements at the meter. Thus it is well suited for energy flow measurements. Thermal flow is calculated in the meter using the flow rate and the associated supply and return fluid temperatures.

Note: All **FUM** citations in this document refer to the **Fluxus F601 User Manual (UMFLUXUS_F6V4-2EN** dated 2011-03-29) unless otherwise noted.

Theory of transit-time flow measurement

Flow Transducers

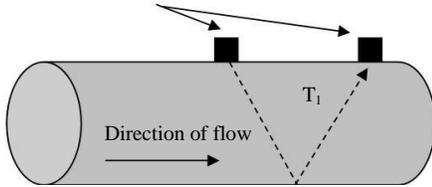


Figure 2a The ultrasonic signal takes time **T1** to travel downstream between transducers

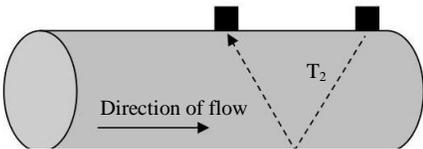


Figure 2b The ultrasonic signal takes time **T2** to travel upstream between transducers

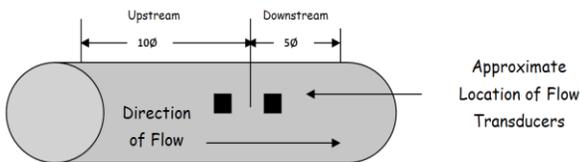


Figure 3a Locate sensors following the 2/3 – 1/3 rule with a minimum distance of 15x pipe diameters between flow obstructions (pipe fittings, probes, etc.)

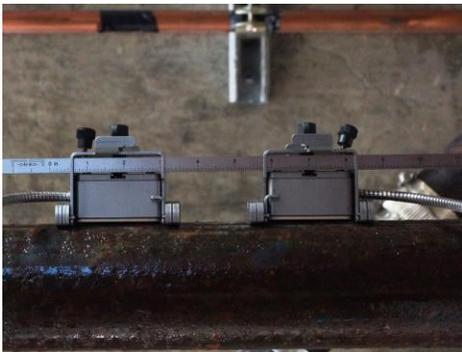
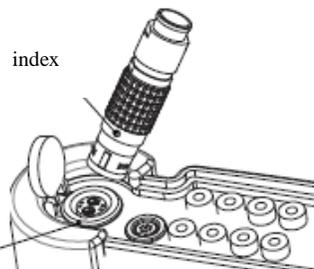


Figure 3b Pipe mounting using magnetic attachments



Channel "A"

Figure 4 Insert transducer cable end into meter channel "A". Observe index key and conductor pins during insertion.

How it Works (Figures 2a&b)

The flow meter uses a pair of ultrasonic wave transducers, with each transducer sending and receiving coded ultrasonic signals through the fluid. In **Transit time mode**, when the fluid is flowing, signal transit time in the downstream direction (Figure 2a) is shorter than in the upstream direction (Figure 2b). The flow meter measures this time difference (ΔT), which is proportional to the flow velocity. It then calculates velocity based on ΔT and other conditions provided by the user including liquid temperature, pipe characteristics, and fluid characteristics. See **Fluxus F601 User Manual (FUM)** chapter 3 page 15 for more information on theory of operation.

If particulates or entrained bubbles prevent good transit time measurements, the meter can be configured to use Flexim's Doppler technology (called **NoiseTrek mode**) instead of transit time. See **FUM "3.2.2 Determination of the Volumetric Flow Rate in the NoiseTrek Mode"** on pages 17 – 18 for theory of operation.

HybridTrek is the same as NoiseTrek, but it automatically switches between Transit time and Doppler. It is set in the **SYSTEM settings\Measuring** branch of the menu system. See **FUM "13.3 Settings of the HybridTrek Mode"** on p.83-4 for details.

Operation

Installation and Setup

1. If you plan to integrate the Flexim flow data with data from other sources taken at the same time, you should synchronize all data to a common clock. See Appendix C, Downloading data, for more information before proceeding further.
2. Select pipe monitoring point for transducer mounting (**FUM ch5 p23**). See figure 3a.
3. Prepare the pipe surface at the monitoring point (**FUM ch8.1 p51**). Observe the 3 o'clock/9 o'clock orientation if mounting on horizontal pipe runs.
4. Connect the flow transducer cable to the meter (**FUM ch6.3 p30**). See figure 4.
5. Mount the flow transducer set on the pipe at the selected monitoring point without couplant. See figure 3b. Observe the correct positioning of the transducers by noting the embossed flow direction arrow (see figure 7 on page 4 of this document, and **FUM chs 8.2 and 8.3, p51-4**).

6. Review keypad operation before proceeding (**FUM** ch 4.4 p21). See figure 5.



Figure 5 Turn meter on and off (UM10.1 p61).

MENU Navigation:

- #8 and #2 keys to scroll up and down
- #4 and #6 keys to scroll left or right
- Press ENTER to make a selection
- Clear Key (“C”) to clear/delete an entered value
- Break key (“BRK”) to interrupt measurement OR Jump to Main Menu at any time during setup or operation

7. Turn meter on (**FUM** ch 10.1 p61). See figure 5. The meter will briefly display a message saying “CLAMPON DETECTED ON A:” (or B if channel B is used for transducer input), followed by a brief meter ID message. Then the main menu appears in the meter’s digital display with one of 4 options selected: **par** (parameters), **mea** (measuring), **opt** (output options), or **sf** (special functions). See figure 6.

8. **Note:** If you plan to integrate flow data with data from other sources, please follow the steps in **Appendix C: Synchronize F601 to PC clock from the FluxData application** and skip this step. Otherwise, Using the keypad → and ← keys, move the cursor to the **SF** branch and press [ENTER]. Press the ↑ or ↓ keys to select System Settings [ENTER], then select Set Clock [ENTER]. Select OK to accept or NEW to update the displayed time. Press [ENTER] to accept changes. Repeat this process for the Date value. Then press the [BRK] key to return to the top menu.

9. Unless you are logging at 5 second intervals or faster, set SF menu\Special Function\System Settings\storing\Storage Mode = Average (**FUM** ch 14.1.3 p95).

Refer to the laminated **Quick Start (QS) Guide** card to continue with setup steps 10, 11, and 12 below. Begin with the **Parameter Input** menu branch, then turn the card over and continue with **Output Options** and **Measuring** branches.

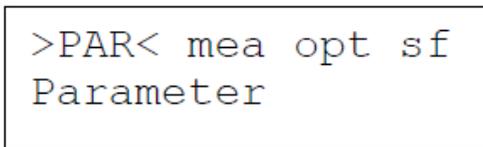


Figure 6 Meter’s Main Menu display with PAR selected.

10. Move cursor to the **PAR** branch (**FUM** ch 11.1 pp 65-70) and enter parameter values indicated in the **QS Guide** at the prompts. As you proceed, note the following:

- Measure outside pipe diameter with the pipe diameter tape measure provided with the meter.
- If the pipe material is known, use the pipe materials data sheet to look up wall thickness based on the pipe diameter for that material. If pipe material is unknown, use the thickness gage to measure the pipe wall thickness (see **Appendix B** in this document).
- For pipe roughness value, use the meter’s default value, or see **FUM** Appendix C-2, p234 (.0005” - .002” for carbon steel).
- After all values are entered, press the **BRK** key to return to the main menu.

11. Follow QS guide for **OPT** values (**FUM** ch 12.1 p76). Data logging is activated in this branch if desired (**FUM** ch 14 p93). If temperature logging is desired, turn T1 and T2 on when prompted, and refer to Appendix A for more information.

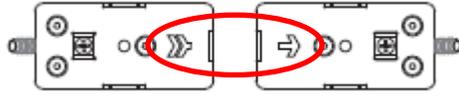


Figure 7 Arrow indicates flow direction when transducers are properly placed

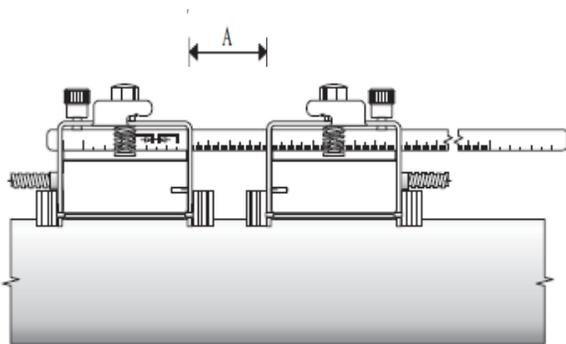


Figure 8 magnetic rail mounted transducers. Spacing is indicated by distance "A", and is provided by the meter.

12. If logging, go to SF/System settings/storing for additional settings such as ringbuffer, storage mode and other logging parameters (**FUM** ch 14.1.3 p94-7). Pay particular attention to the storage mode parameter, which should usually be set to "average" when logging at intervals of 5 seconds or more.
13. Follow **QS guide** for **MEA** values (**FUM** ch 11.4 p70). This is the branch where measurements (and logging if selected) are initiated. If logging, provide a value (e. g, "1") for Measuring Points when prompted (**FUM** ch 11.5 p71). Select "2" or "4" for the sound paths (number of traverses) value (**FUM** ch 11.5 p71). If a negative value is displayed, increase the number of traverses to the next even number (e.g., from "2" to "4").
14. Transducers should be oriented on the pipe observing the correct flow direction indicated by the embossed arrow on top of the transducer. See figure 7.
15. Transducer spacing should first be set to the value recommended by the meter in the **MEA** menu. See figure 8. If the signal strength is below 1 bar with no coupling paste, adjust the flow transducer spacing to maximize signal strength (number of bars on the console display) and achieve a constant green LED status indicator (**FUM** ch 11.6 p72 and **QS guide**). For adjusting transducer spacing for optimum accuracy see **Consistency Check** (**FUM** ch 11.6.2 p73-4). Be sure to enter any spacing changes into the meter as explained in the manual.
16. When proper spacing is achieved, remove the transducers to apply the coupling paste then re-install the transducers. Using fingers only, tighten them snugly against the pipe but NOT "gorilla tight". DO NOT USE TOOLS TO TIGHTEN. Only 3-5 bars of signal strength are needed for a reliable signal. Trying for more than 5 bars has no effect on accuracy and has no other benefit.
17. If recording a running total flow is desired, set Totalizers with the "8" key after measurements have begun (**FUM** ch 13.2 p80). Press "8" 1 time to set totalizers, or 3 times to reset them. Press "2" 3 times to turn off totalizer.
18. Measurement (flow, velocity, etc.) is in progress when the active channel's LED is green. However, it is NOT necessarily logging! In its default configuration the meter also beeps each time data is logged to signify that logging is in progress (**SYSTEM settings\Storing\Beep on Storage = on**). The channel LED must be green for logging to continue. Please note that hitting the BRK key halts logging and real time flow display.
19. Press the "3" and "9" keys to cycle through selected measurement and diagnostic values such as volume, flow, totalizers, temperature, sound speed, log file fill date, measurement status values (S, Q, c, RT, F), and battery level (**FUM** ch 12.3, 12.4 and 12.5, p78-9).
20. Note the F601 batteries will support up to 11 hours of logging, depending on logging interval and battery condition. For longer logging periods, use the power supply to provide reliable operation for the duration of the logging period.

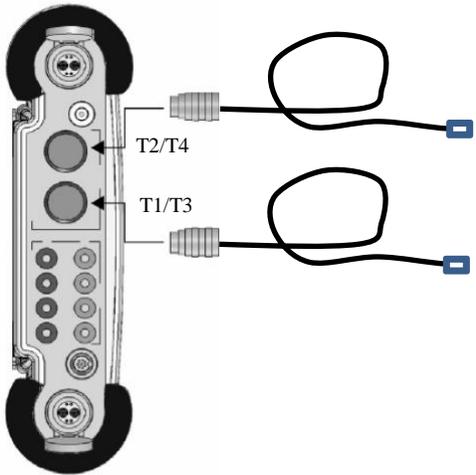


Figure 9a (Optional) Insert RTD sensor cable ends into meter T1 and T2 inputs. These are threaded connections.



Figure 9b (Optional) Properly mounted RTD sensor with insulating pad and chain clamp

Appendix A: temperature monitoring with 100Ω RTD probes

Refer to **FUM** ch20 p138 for more information on thermal flow measurement setup.

Connect the RTD temperature transducers to the meter (**FUM** ch 6.3 p30). See figures 9a and 9b.

Mount the probes at properly selected prepared temperature monitoring points (**FUM** ch 9.3 and 9.4, p57-58). Use temperature conductive paste (“heat sink compound”) if available for the most accurate temperature data.

As noted in Operation step 10 on page 3 of this document, temperature logging is activated by turning T1 and T2 on in the OPT branch (**FUM** ch 14 p93). Using the ↑ or ↓ and [ENTER] keys, select the desired channel (typically “A”)

From the special functions (SF) menu, use the arrow keys to navigate to Special Funct.\SYSTEM settings\Proc. Inputs. Using the ↑ or ↓ and [ENTER] keys, select Link Temperature then configure the following parameters:

- Link temperature = heat or chill
- thermal energy = heat or chill
- transducer location = return or supply
- thermal energy = absolute or sign
- T-Supply = Input T1 (typical)
- T-Return = Input T2 (typical)
- T(3) and T(4) = no measuring

Return to the Proc. inputs menu option above. Using arrow and ENTER keys, select PT100 / PT1000 and configure the following parameters:

- Input T1 = pt100
- Input T2 = pt100

Select T-Supply = T1 and T-Return = T2 (be sure the RTD placement is reflected in your selections).

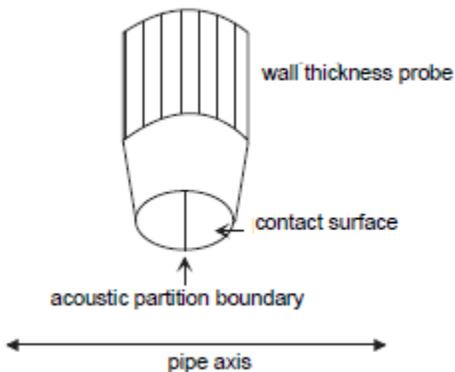
For more information on temperature Inputs see **FUM** ch21 p148-153.



Pipe thickness gage



Close-up of probe's acoustic partition boundary



Boundary should be perpendicular to pipe axis when measuring thickness

Appendix B: Using the Thickness Gage

If the pipe wall thickness is unknown and cannot be determined by look up charts, use the ultrasonic thickness gage provided to measure its thickness. More information on the thickness gauge can be found in the **F601 User Manual (FUM ch 19 p133)**.

1. Plug the gage in the console's B channel and watch for the message identifying the device.
2. Push **BRK** key to go to top menu if necessary
3. Go to **PAR** menu [ENTER]
4. Select Channel B [ENTER]
5. Select Pipe material [ENTER]
6. Write down C-long value if desired [ENTER]
7. Hit **BRK**, then go to **MEA** menu [ENTER]
8. At "wall T-inch?" prompt, make measurement (e.g., .211 for steel pipe)
9. Confirm measurement and record for later use [ENTER]. You may wish to compare the measurement with values found in the pipe size data sheet for comparable pipe material.
10. At "Transfer Data?" select **yes** [ENTER], but note that the value transfers only to current B channel and must be re-entered in the A channel PAR values (see below).
11. Remove thickness gage probe from channel B (to avoid damage, do NOT pull on the cable, and pull only on the LEMO style connector!)
12. Hit **BRK**, then go to **PAR** menu [ENTER]
13. Select **channel A** [ENTER]
14. Find wall thickness parm and enter value recorded in step 9 above [ENTER]
15. Hit **BRK**, then go to **MEA** menu [ENTER] and begin measurements.

Appendix C: Downloading data

Please note:

Historically, the Tool Lending Library has seen instability in the Fluxdata application.

Recent releases appear stable, nevertheless **we recommend saving files and closing applications before downloading Flexim data as a precaution to safeguard any work-in-progress in other applications.**

Synchronize F601 to PC clock from the FluxData application (optional):

If you plan to integrate the Flexim flow data with data from other sources taken at the same time, you should synchronize all data to a common clock. This is best accomplished from the FluxData application instead of the console keypad, but in either case must be done BEFORE logging is started for any data source you intend to synchronize. Follow the first 3 steps below. Then, in the FluxData application, select menu option DUT / Date & Time, and click "Select Actual Time", then OK. The meter and PC clocks now agree, and data from any other loggers also synchronized to the same PC will be easily integrated using spreadsheet or database software.

1. Install FluxData software on your PC from the software diskette provided.
2. Connect meter to your PC with RS232 cable into a COM port or a USB RS232 serial port adapter (e.g., Keyspan). If using a USB adapter, make a note of the COM port assigned to the connection.
3. Start FluxData.exe
4. Confirm the proper COM port from step 2 is set in the application (options/serial interface, select COM port in dropdown listbox). Click Save (BTW, "Abbrechen" is German for "Cancel"), then OK (**FUP 14.2.7 p101-2**)
5. The Protocol button displays the connection parameters and will match the meter's default values (9600 baud/8 bits/even parity/2 stop bits). Leave them and block size at their default values (**FUP p99 sect 14.2.4**). These values must agree with the PC's Device Manager COM port settings.
6. To assure that all logged data is downloaded at the end of the logging period, stop logging with the BRK key before downloading. If you only need a data sample to verify operation, you may leave the meter logging and avoid interrupting the log file.
7. Click File/Receive to download data (or the leftmost icon in the toolbar).
8. Downloading data during data logging interrupts but does not stop logging. Logging resumes after download is complete (1 or more minutes).
9. Neither downloading data nor interrupting logging deletes previously logged data. To delete stored records set Special Funct.\Delete Meas. Values\Really Delete = yes (**FUP p97 sect 14.1.5**).
10. By default, totalizers do not reset between logging sessions. Set Special Funct.\SYSTEM settings\Measuring\Quantity recall=OFF to reset totalizers on any interruption. During logging the totalizers can be reset by pressing C three times (**FUP p131 sect 18.8**).

Other interesting and helpful information

- See **HotCodes** handout for more information on HotCodes p63 sect 10.3
- For **imperial/SI** units selection go to sf\system settings\dialogs menus\
- For more **imperial/SI** units selection use HotCode 007020
- If setting **display contrast** and display goes blank, reset with HotCode 555000 (system settings\miscellaneous\contrast)
- For **programming tree** see p62 sect 10.2.2
- For **BTU Mode** p143 sect 20.3
- If **medium temperature** varies more than +/- 20 degrees, consider RTD input p69 sect 10.3
- **Memory capacity:** When logging only one physical quantity (e.g., GPM) on one measuring channel, use the following table to estimate logging duration based on logging interval and use of totalizers:

	1 sec	10 sec	1 min
no totalizers	31 hrs	13 days	78 days
one totalizer	13 hrs	5.4 days	31 days

- To review **remaining memory** (for log files), see p97 sect 14.1.6 (sf\special functions\instrument inform.\free=112493)
- To reset the meter to factory inputs, restart the meter and enter HotCode 909000 at the home screen immediately after turning on the meter. Follow the prompts. Next, simultaneously press the ENTER, BRK and C keys, releasing first the ENTER key, then the BRK key one second later, then finally the C key. Follow the prompts.

If signal strength is good at zero flow but diminishes when flow is present, it may be a sign of entrained air bubbles preventing a good signal. Consider configuring the meter for direct (one traverse) measurement.