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User's Guide

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FTB790 SERIES **Turbine Flowmeters**



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The information contained in this document is believed to be correct, but OMEGA Engineering, Inc. accepts no liability for any errors it contains, and reserves the right to alter specifications without notice.

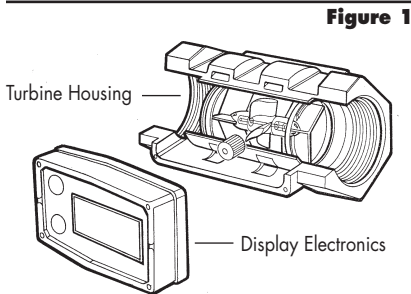
WARNING: These products are not designed for use in, and should not be used for, patient-connected applications.

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GENERAL INFORMATION

This manual will assist you in installing and maintaining your FTB790 Series turbine meter and associated display electronics. The turbine meters can be purchased with or without the display electronics. (See Figure 1)



When purchased with the display electronics, optional accessory modules are available for field installation. Information on these accessories is contained in separate manuals. Calibration details using the display electronics are given in this manual.

When purchased without the display (Suffix - ND) an optional field installable Pulse Output Module (FLSC790-P-ND) is available and described in a separate manual.

For best results, take the time to fully acquaint yourself with all information about all components of your FTB790 Series Turbine Meter System prior to installation and use. If you need assistance, contact the Omega Flow Application Department.



This symbol is used throughout the manual to call your attention to safety messages.

Warnings alert you to the potential for personal injury.

Cautions call your attention to practices or procedures which may damage your equipment.

Notes give information that can improve efficiency of operations.

It is your responsibility to make sure that all operators have access to adequate instructions about safe operating and maintenance procedures.

Read Me!

For your safety, review the major warnings and cautions below before operating your equipment.

1. This equipment is approved to handle only fluids which are compatible with all wetted materials.
2. When measuring flammable liquids, observe precautions against fire or explosion.
3. When handling hazardous liquids, always follow the liquid manufacturer's safety precautions.
4. When working in hazardous environments, always exercise appropriate safety precautions.
5. Always dispose of used cleaning solvents in a safe manner according to the solvent manufacturer's instructions.
6. During turbine removal, liquid may spill. Follow the liquid manufacturer's safety precautions for clean up of minor spills.
7. Do not blow compressed air through the turbine.
8. Do not allow liquids to dry inside the turbine.

9. Handle the rotor carefully. Even small scratches or nicks can affect accuracy.
10. When tightening the turbine, use a wrench only on the wrench flats.
11. For best results, always verify accuracy before use.

PRODUCT DESCRIPTION

FTB790 Series Turbines are identified by the internal diameter of the inlet and outlet.

- FTB791 – 1/2 inch (Mid Flow)
- FTB792 – 3/4 inch (Mid Flow)
- FTB793 – 1 inch (Mid Flow)
- FTB794 – 1-1/2 inch (High Flow)
- FTB795 – 2 inch (High Flow)

Each of these turbines are designed to work with on-board display electronics and/or with one of several accessory modules that can interface to a wide variety of reporting and collecting devices.

The CMOS microprocessor-based electronics have extremely low power requirements and data retention capabilities in both RAM and ROM. Information is clearly displayed on a large 6-digit LCD readout with two-point floating decimal for totals from .01 to 999,999. All operations are easily accessed with the two buttons on the front panel.

Liquids flow through the turbine housing causing an internal rotor to spin. As the rotor spins, an electrical signal is generated in the pickup coil. The electrical signal provides the output necessary to operate the on-board display electronics for local indication directly on the turbine or one of several accessory modules that transmit the signal to external equipment.

Upon receipt, examine your meter for visible damage. The turbine is a precision measuring instrument and should be handled as such. Remove the protective plugs and caps for a thorough inspection. If any items are damaged or missing, contact OMEGA Customer Service.

Make sure the turbine model meets your specific needs. Refer to the Specifications Section and confirm the following:

1. The flowrate is within the limits of your model.
2. The liquid is compatible with the turbine's wetted components.
3. The system's pressure does not exceed the turbine's maximum pressure rating.

Information specific to your particular turbine, including serial number, model number, manufacturing date, and K-factor is etched into the surface of the turbine. On Models FTB791, FTB792, and FTB793 find the etched information on the side of the turbine. On Models FTB794 and FTB795 the information is etched on a wrench flat.

SN = Serial Number, a 7-8 digit number that identifies this particular turbine.

MOD = Model number.

KF = K-Factor given in pulses per gallon (PPG).

MFD = Manufacturing Date indicating the week and year of manufacture.

For your future reference, it might be useful to record this information in the manual in case it becomes unreadable on the turbine.

INSTALLATION

All Series FTB790 turbines are designed to measure flow in only one direction. The direction is indicated by the arrow cast-molded in the turbine outlet. If the opposite direction is desired, and you are using on-board display electronics, rotate the display electronics 180 degrees prior to installation.

Flow altering devices such as elbows, valves, and reducers can affect accuracy. The following recommended guidelines are given to enhance accuracy and maximize performance. Distances given here are minimum requirements; double them for desired straight pipe lengths.

Upstream from the turbine, allow a minimum straight pipe length at least 10 times the internal diameter of the turbine. For example, with the FTB793 turbine, there should be 10 inches (25.4cm) of straight pipe immediately upstream. The desired upstream straight pipe length is 20 inches (50.8cm).

CONNECTIONS

Downstream from the turbine, allow a minimum straight pipe length at least 5 times the internal diameter of your turbine. For example, with the FTB793 turbine, there should be 5 inches (12.7cm) of straight pipe immediately downstream. The desired downstream distance is 10 inches (25.4cm).

A typical back pressure of 5 to 50 PSI (0.34 to 3.4 bar) will prevent cavitation. Create back pressure by installing a control valve on the downstream side of the meter at the proper distance detailed above.

Foreign material in the liquid being measured can clog the turbine's rotor and adversely affect accuracy. If this problem is anticipated or experienced, install screens to filter impurities from incoming liquids.

Models FTB791, FTB792, FTB793

Maximum Particulate Size	
Inches:	0.005
Microns:	125
Mesh:	55
Standard Sieve:	125 μm
Alternative Sieve:	No. 120

Models FTB794 and FTB795

Maximum Particulate Size	
Inches:	0.018
Microns:	500
Mesh:	28
Standard Sieve:	500 μm
Alternative Sieve:	No. 35

All Series FTB790 turbines are Factory Mutual Approved and carry a Class 1, Division 1 Approval for hazardous environments. They are tested and calibrated at the factory using state-of-the-art calibration procedures and test equipment.

To ensure accurate measurement, remove all air from the system before use. To purge the system of air:

1. Ensure some back pressure on the turbine.
2. Open the discharge valve or nozzle and allow fluid to completely fill the system. Make sure the stream is full and steady.
3. Close the discharge valve or nozzle.
4. Start normal operations.

Each turbine contains a removable back coverplate. Leave the coverplate installed unless accessory modules specify removal.

1. To protect against leakage, seal all threads with an appropriate sealing compound. Make sure the sealing compound does not intrude into the flow path.
2. Make sure the arrow on the outlet is pointed in the direction of the flow.
3. Tighten the turbine onto the fittings. Use a wrench only on wrench flats.

NOTE: If connecting to new male threads, burrs and curls can adversely effect accuracy. Correct the problem prior to turbine installation.

It is strongly recommended that accuracy be verified prior to use. To do this, remove all air from the system, measure an exact known volume into an accurate container, and verify the volume against the readout or recording equipment. If necessary, use a correction factor to figure final volume. For best results, accuracy should be verified periodically as part of a routine maintenance schedule.

The display electronics is normally installed on the turbine housing at the factory unless ordered without it.

If for any reason the display electronics need to be mounted on your turbine, simply mount the display on the turbine with the four screws at the corners of the faceplate. Make sure the seal is fully seated before tightening the screws.

If you ordered the FTB790 Series turbine with an accessory module, please review and thoroughly understand all installation instructions before proceeding.

Avoid electronically "noisy" environments. Install at least 6 inches (15.2cm) away from motors, relays, or transformers.

OPERATIONS

All operations are reflected in the LCD readout. The top line identifies the calibration curve. The middle line reflects flow information. The bottom line shows information from the totalizer. Words or “flags” display on the top and bottom line to further identify specific information.

The display electronics is powered by field replaceable batteries. When the readout becomes dim or faded, the batteries need to be replaced. Reference the Maintenance Section for details.

NOTE: Operations can be practiced prior to installation. To simulate flow conditions, blow gently through the turbine.

Turn On

The meter is on when any display is present. It turns on automatically when liquid flows through the meter. It can be turned on manually by pressing and releasing the DISPLAY button.

Turn Off

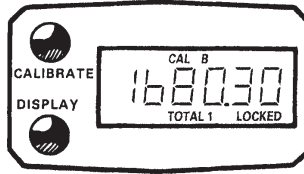
The meter turns off automatically approximately four minutes after flow stops. When the meter is off, the readout is blank.

Batch and Cumulative Totals

Total flags are displayed on the bottom line. A Batch Total indicates flow during a single use. It is labeled with TOTAL 2. To zero a batch total, make sure it is displayed and hold down DISPLAY for three seconds until the display changes to zeros.

The Cumulative Total is the total of all liquid measured since the meter’s power was connected. At your first use, the Cumulative Total is not zero because of calibration at the factory. The Cumulative Total is labeled as TOTAL LOCKED indicating it cannot be manually zeroed. (See Figure 2) The Cumulative Total is zeroed only when batteries are removed or go dead or when the Cumulative Total reaches the maximum value of 999,999.

Figure 2



To change between totals, press and release DISPLAY.

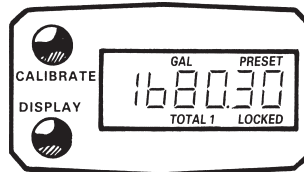
NOTE: Generally, readout displays change when buttons are released.

Factory and Field Calibration Curves

All calibration information is visible to the user as words in the upper part of the display, above the numeric digits.

All units will be configured with a “factory” calibration curve, for which units of gallons or litres may be selected by the user (“GAL” or “LTR” will be visible). This curve is NOT user adjustable: the word “PRESET” is displayed to show this. (See Figure 3) The factory calibration is stored permanently in the computer’s memory.

Figure 3



The “field” calibration curve(s) may be set by the user, and can be changed or modified at any time using the calibration procedure described below in the CALIBRATION section. Totals or flowrate derived from the field calibration are visible when the field calibration setting is selected “CAL B”.

Selecting a Different Calibration Setting

You can switch between GAL and LTR modes at will without “corrupting” totalizer contents. For example, the computer can totalize 10.00 gallons. If the user switches to LTR mode, the display will immediately change to “37.85” (the same amount in units of litres). GAL/LTR switching also works in FLOWRATE mode.

To select a different calibration setting, first press and hold the CALIBRATE button. Continue to hold it while also briefly pressing and releasing the DISPLAY button (you may then also release the CALIBRATE button). The flag indicators in the upper area of the display will change to show the newly selected calibration setting. Calibration settings change in this order: GAL, LTR, CAL B, GAL (etc.). While fluid is flowing only the GAL and LTR selections may be made, however, when NO fluid flow is occurring, any setting may be selected.

Flowrate

When this feature is activated, the word FLOWRATE displays to the left on the bottom line. (See Figure 4) When this flag is displayed, the numbers on the middle line reflect the rate of flow. To activate this feature, press and release DISPLAY until FLOWRATE appears to the left on the bottom line.

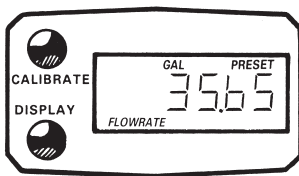


Figure 4

Propeller

A small propeller displays to indicate liquid is flowing through the meter.

CALIBRATION

Factory Calibration settings are programmed into each flowmeter during production, and are correct for light fluids such as water, gasoline, or diesel fuel. Factory Calibration is completed with stoddard test solvent solvent (on 1" and smaller flowmeters) or water (on 1-1/2" and larger flowmeters) at 70°F (21°C). Readings using the standard factory calibration curves may not be accurate in some situations – for example, if the unit measures a “heavy” fluid such as motor oil, especially under extreme temperature conditions.

For improved accuracy under such conditions, the flow computer allows for “field” calibration, that is, user entry of custom calibration parameters. A “single point” calibration may yield acceptable accuracy with light liquids, however, heavy liquids may require five or more calibration points to achieve a high level of accuracy. Up to 15 custom calibration points can be entered.

NOTE: A Field Calibration below the minimum flowrate can adversely effect accuracy.

The use of a uniformly dependable, accurate calibration container is highly recommended for the most accurate results. Due to high flowrate, it is strongly recommended that Field Calibration of 1-1/2" and 2" meters be completed with a combination of volume and weight using fine resolution scales.



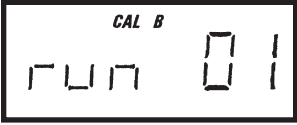
For the most accurate results, dispense at a flowrate which best simulates your actual operating conditions. Avoid “dribbling” more fluid or repeatedly starting and stopping the flow – these actions will result in less accurate calibrations.





Make sure you meet the meter’s minimum flowrate requirements.

1/2 inch meters -	1 GPM (3.8 LPM)
3/4 inch meters -	2 GPM (7.6 LPM)
1 inch meters -	5 GPM (19 LPM)
1-1/2 inch meters -	10 GPM (38 LPM)
2 inch meters -	20 GPM (76 LPM)


For best results, the meter should be installed and purged of air prior to Field Calibration.

Dispense-Display Field Calibration Procedures

Your Actions	Notes
<p>1. Hold down CALIBRATE while pressing and releasing DISPLAY until the Field Calibration curve appears (“CAL B” or “CAL C” message will be displayed). Release both buttons.</p> 	<p>Remember that Field Calibration curves are not preset.</p>
<p>2. To calibrate, press and hold the CALIBRATE button. While continuing to hold CALIBRATE, also press and hold the DISPLAY button. Hold both buttons for about 3 seconds until you see a blinking “dd-CAL” message. Once the “dd-CAL” message appears, release both buttons. You are now in field calibration mode.</p> 	<p>This step puts the unit in dispense-display field calibration mode (“dd-CAL”).</p>
<p>3. Once the buttons have been released from Step 2, the display will show the blinking message “run 01.”</p> 	<p>The computer is waiting for you to make a decision to either exit from field calibration mode or to begin a dispense run. If you want to exit the calibration now, go to Step 11.</p>
<p>4. If you want to continue with the calibration, but have not dispensed any fluid yet, make your final preparations to your pumping system, but don't start pumping yet.</p>	
<p>5. Start your pumping system so that fluid flows through the meter. The display will stop blinking and show the “run 01” message. Dispense into a container that allows you to judge the amount of fluid pumped. When you have pumped the desired amount (for example, 10 gallons), stop the fluid flow quickly.</p>	<p>When the computer displays a non-blinking “run 01” message, it is sensing fluid flow. For the most accurate results, dispense at a flow rate which best simulates your actual operating conditions. Avoid “dribbling” more fluid or repeatedly starting and stopping the flow - these actions will result in less accurate calibrations.</p>

Your Actions	Notes
<p>6. Once the flow has stopped, briefly press and release both buttons. At this point the computer display will change to “0000.0” with the left-hand digit blinking.</p> 	<p>When the display shows “0000.0” the computer has stopped “watching” for fluid flow and is now waiting for you to enter some numbers.</p>
<p>7. Enter the volume (amount) of fluid that you dispensed (for example, if your 10-gallon container is full, enter “10.0” for gallons or “37.5” for litres). To enter numbers use the CALIBRATE button to change the value of the digit that is blinking and use the DISPLAY button to shift the “blink” to the next digit.</p> 	
<p>8. Once the correct number has been entered, briefly press and release both buttons. The display will now change to a blinking “run 02” message.</p> 	<p>You have installed the new cal-curve point. You are ready to end calibration (Step 10) or enter another new calibration point (Step 9).</p>
<p>9. To enter another calibration point, go back and repeat Steps 3 through 8.</p>	<p>It is possible to set up to 15 cal-curve points, and the “run ##” message will increment each time you repeat the calibration process (run 01, run 02, run 03, etc., up to run 15).</p>
<p>10. To end calibration, press and hold both buttons for about 3 seconds until you see the “CAL End” message.</p> 	<p>After you release the buttons, the computer will resume normal operations with the new cal point(s) active.</p>

Dispense-Display Field Calibration Procedures - cont'd.

Your Actions	Notes
<p>11. If you HAVE NOT dispensed any fluid, you can exit calibration without changing the cal curve. If the message “run 01” is showing and you have not dispensed any fluid, hold both buttons for about 3 seconds until you see a “CAL End” message.</p> 	<p>After you release the buttons, the computer will resume normal operation and the old curve (if you have entered one in the past) is still intact.</p>

MAINTENANCE

Verify Accuracy

Before use, check the turbine's accuracy and verify calibration.

1. Make sure there is no air in the system.
2. Measure an exact known volume into an accurate container.
3. Verify the volume against the readout or recording equipment.

NOTE: If necessary, use a correction factor to figure final volume.

For best results, accuracy should be verified periodically as part of a routine maintenance schedule.

Remove the Turbine

!!! WARNING !!!

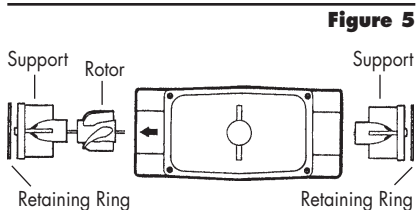
During turbine removal, liquid may spill. Follow the liquid manufacturer's safety precautions for clean up of minor spills.

1. Ensure all liquid is drained from the turbine. Wear protective clothing as necessary.
2. Loosen both ends of the turbine. Use a wrench only on the turbine's wrench flats.
3. If the turbine is not immediately installed again, cap lines as necessary.

Replace Internal Parts

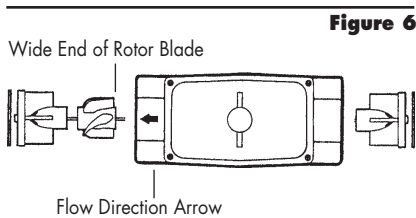
1. Remove the turbine from the system as detailed above.

NOTE: Carefully notice the orientation of all internal parts as they are removed, especially the orientation of the rotor to the flow direction arrow. (See Figure 5)



2. Carefully clean residue off all parts. Remove internal parts as detailed above. Note orientation carefully for correct assembly. Internal parts can be soaked for 10-15 minutes in compatible cleaning solutions. Use a soft brush or small probe to *carefully* remove residue from the rotor.
3. Using a small tool such as a screw driver or awl, gently pry one retaining ring from its groove. Remove the support. If necessary, use needle nose pliers. Little or no force should be required.
4. Carefully remove the rotor.

- CAUTION:** Handle the rotor carefully. Even small scratches or nicks can affect accuracy.
- Turn the turbine over and remove the other retaining ring. Remove the other support.
 - Clean, as detailed below, or discard as necessary.
 - Replace one support and retaining ring. Parts should drop easily into place with little or no force.
 - Install the rotor. Make sure the wide end of the rotor's blades faces the flow direction. (See Figure 6)



- Turn the turbine over and drop the second support into place. Put the final retaining ring into position.
- Reinstall the turbine, purge the system of air, and verify accuracy before use.

Clean the Turbine

During use, the turbine should be kept full of liquid to ensure that drying does not occur inside the turbine. If drying or caking should occur, the rotor will stick or drag, affecting accuracy. To determine if the rotor is stuck or dragging, gently blow air through the meter and listen for the quiet whir of the rotor.

CAUTION: Never blow compressed air through the meter. It could damage the rotor.

- Remove the turbine from the system following the directions above.

- When the rotor turns freely, assemble and install it again following the instructions above.

Display Electronics

The display electronics are powered by lithium batteries which provide at least 4,000 hours of actual use. If the meter's readout should become dim or blank, the batteries should be replaced. Replacement batteries can be ordered from the factory. See details in the Parts Section.

When batteries are disconnected or fail, the Batch and Cumulative Totals return to zero. Factory and Field Calibration Curves are retained in the meter's computer when power is lost.

It is strongly recommended that battery check and terminal cleaning be a part of a routine maintenance schedule. Battery terminals should be cleaned annually. Batteries can be replaced without removing the meter from the piping system.

Replacing the Batteries

- Remove the corner screws from the meter face and lift the display electronics from the turbine.
- Remove the batteries.
- Check the battery terminals and remove any corrosion.
- Install the new batteries and make sure the positive posts are positioned correctly. When the batteries are installed correctly, the computer powers on automatically and the readout displays information.
- Make sure the seal is fully seated before placing the computer electronics on the turbine. Tighten the four screws.

!!! WARNING !!!

Follow the liquid manufacturer's instructions for the disposal of contaminated cleaning solvents.

TROUBLESHOOTING

Symptom	Probable Cause	Corrective Action
Meter is not accurate	<ol style="list-style-type: none"> 1. Field Calibration not performed properly 2. Factory Calibration not suitable for liquid being measured 3. Meter operated below minimum flowrate 4. Meter partially clogged with dried liquid 5. Turbine bearings partially clogged with dried liquid 6. Sealant material wrapped around rotor 7. Installed too close to fittings 8. Installed too close to motors or electrically “noisy” environment 9. Improper connections to recording device 10. Accuracy needs verification 	<p>Field calibrate again or select Factory Calibration.</p> <p>Perform a Field Calibration according to Calibration Section.</p> <p>Increase flowrate.</p> <p>Remove meter. Clean carefully. Make sure rotor spins freely.</p> <p>Remove meter. Clean carefully. Make sure rotor spins freely.</p> <p>Remove meter. Make sure rotor spins freely.</p> <p>Install correctly.</p> <p>Install correctly.</p> <p>Check all electrical connections. Reference appropriate installation instructions.</p> <p>Complete normal accuracy verification procedures. Repeat periodically.</p>
Readout faded or blank	<ol style="list-style-type: none"> 1. Batteries weak, dead, or not connected 2. Display electronics defective 	<p>Remove display electronics. Check and replace batteries if necessary.</p> <p>Contact the factory.</p>
Normal flowrate but meter does not count (Meter comes on when DISPLAY button pushed)	<ol style="list-style-type: none"> 1. Field Calibration not performed correctly 2. Rotor stuck or damaged 3. Sealant material wrapped around rotor 4. Display electronics defective 	<p>Field Calibrate again or select Factory Calibration.</p> <p>Remove meter. Make sure rotor spins freely.</p> <p>Remove meter. Make sure rotor spins freely.</p> <p>Contact the factory.</p>
Reduced flowrate and meter does not count (Meter comes on when DISPLAY button pushed)	<ol style="list-style-type: none"> 1. Meter clogged with dried liquids 2. Below minimum flowrate 	<p>Remove meter. Clean carefully. Make sure rotor spins freely.</p> <p>Increase flow.</p>
Cannot get meter into field calibration	<ol style="list-style-type: none"> 1. Factory Calibration (PRESET) curve active 2. Display electronics circuit board defective 3. Button defective 	<p>Hold down CALIBRATE and push and release DISPLAY until PRESET flag goes off. Proceed with calibration according to the Calibration Section.</p> <p>Replace display electronics. Contact the factory.</p> <p>Replace display electronics. Contact the factory.</p>
Display electronics blinks “NO” after field calibration	<ol style="list-style-type: none"> 1. Flowrate too low 2. Rotor not spinning freely 	<p>Try again and increase flowrate to minimum calibration rate. See Calibration Section.</p> <p>Remove meter. Clean carefully. Make sure rotor spins freely.</p>

SPECIFICATIONS - STAINLESS STEEL

All data on Models FTB791, FTB792, and FTB793 determined with 1 centipoise stoddard solvent test fluid at 70°F (21°C). Data on Models FTB794 and FTB795 is determined with water at 70°F (21°C).

Models Size	FTB791 1/2 in.	FTB792 3/4 in.	FTB793 1 in.	FTB794 1-1/2 in.	FTB795 2 in.
Linear Flow Range					
Gallons/minute (GPM)	1-10	2-20	5-50	10-100	20-200
Liters/minute (LPM)	3.8-37.9	7.6-75.7	18.9-190	38-380	76-760
Extended Flow Range					
Gallons/minute (GPM)	0.5-10	1-20	2.5-50	5-100	10-200
Liters/minute (LPM)	1.9-37.9	3.8-75.7	9.5-190	19-380	38-760
Maximum Flow					
Gallons/minute (GPM)	15	30	75	150	300
Liters/minute (LPM)	56.8	113.6	284	568	1,136
Fluid Velocity in Extended Range					
Feet/second	0.5-10.6	0.6-12.1	0.93-18.6	0.8-15.9	0.96-19.1
Meters/second	0.2-3.2	0.2-3.7	0.28-5.7	0.24-4.8	0.29-5.8
Maximum Pressure Drop in 10:1 Range					
PSIG	8	7.5	5	4	4
bar	0.55	0.5	0.34	0.28	0.28
Frequency Range in Linear Flow Range	45-450 Hz	37-370 Hz	45-475 Hz	35-350 Hz	33-330 Hz
Connections					
NPT Female Inlet/Outlet Size	1/2 in.	3/4 in.	1 in.	1-1/2 in.	2 in.
Wrench Size:					
Inch	1-1/16 in.	1-5/16 in.	1-5/8 in.	2-3/8 in.	3 in.
Millimeter	27mm	33mm	41mm	60mm	75mm
Weight*					
Pounds	1.8 lbs.	2.0 lbs.	2.4 lbs.	4.0 lbs.	6.3 lbs.
Kilograms	0.8 kg	1.0 kg	1.1 kg	1.8 kg	2.9 kg

* Display electronics add 0.2 lbs. (0.1 kg) to total weight.

SPECIFICATIONS - STAINLESS STEEL *continued*

Performance

Linear Range for 1/2 in. and 3/4 in.: 10:1 @ $\pm 2.0\%$ of reading
 Linear Range for 1 in.: 10:1 @ $\pm 1.5\%$ of reading
 Linear Range for 1-1/2 in. and 2 in.: 10:1 @ $\pm 1.0\%$ of reading
 Extended Range: 20:1 @ $\pm 5.0\%$ of reading
 Repeatability: $\pm 0.1\%$

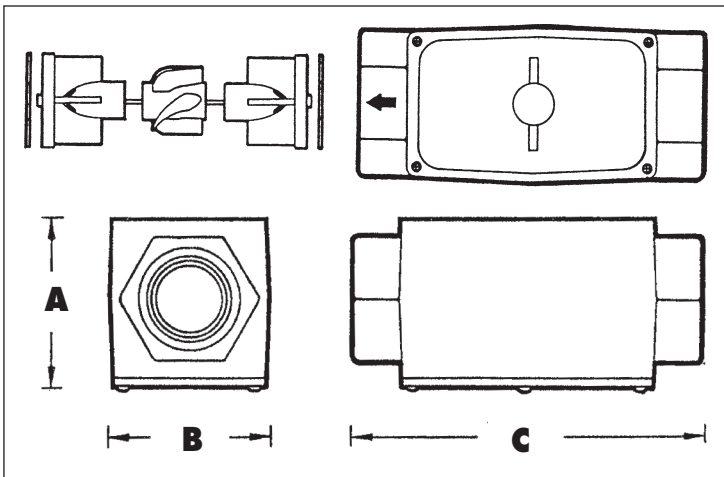
Pressure Rating 1,500 PSIG (103 bar)

Wetted Components

Housing: 316 Stainless Steel
 Journal Bearings: Ceramic (96% Alumina)
 Shaft: Tungsten Carbide
 Rotor and Supports: PVDF
 Retaining Rings: 316 Stainless Steel

Temperature Range

Turbine only without computer: -40° to $+250^{\circ}\text{F}$ (-40° to $+121^{\circ}\text{C}$)
 Turbine with display electronics: $+14^{\circ}$ to $+140^{\circ}\text{F}$ (-10° to $+60^{\circ}\text{C}$)
 (Display electronics or accessory modules determine final operational temperature.)



Dimensions

Models	FTB791	FTB792	FTB793	FTB794	FTB795
Size	1/2 in.	3/4 in.	1 in.	1-1/2 in.	2 in.
A = Height:					
Inches	1.8 in.	2.0 in.	2.2 in.	2.8 in.	3.2 in.
Centimeters	4.6cm	5.1cm	5.6cm	7.1cm	8.2cm
B = Width					
Inches	2.0 in.	2.0 in.	2.0 in.	2.7 in.	3.3 in.
Centimeters	5.1cm	5.1cm	5.1cm	6.9cm	8.4cm
C = Length					
Inches	4.2 in.	4.3 in.	4.5 in.	5.3 in.	6.3 in.
Centimeters	10.7cm	10.9cm	11.4cm	13.5cm	16.0cm

Display electronics add 0.7 in. (1.8cm) to height of turbine.

SPECIFICATIONS - BRASS

All data on FTB791-BRASS, FTB792-BRASS, and FTB793-BRASS determined with 1 centipoise stoddard solvent test fluid at 70°F (21°C). Data on FTB794-BRASS and FTB795-BRASS is determined with water at 70°F (21°C).

Models	FTB791- BRASS	FTB792- BRASS	FTB793- BRASS	FTB794- BRASS	FTB795- BRASS
Size	1/2 in.	3/4 in.	1 in.	1-1/2 in.	2 in.
Linear Flow Range					
Gallons/minute (GPM)	1-10	2-20	5-50	10-100	20-200
Liters/minute (LPM)	3.8-37.9	7.6-75.7	18.9-190	38-380	76-760
Extended Flow Range					
Gallons/minute (GPM)	0.5-10	1-20	2.5-50	5-100	10-200
Liters/minute (LPM)	1.9-37.9	3.8-75.7	9.5-190	19-380	38-760
Maximum Flow					
Gallons/minute (GPM)	15	30	75	150	300
Liters/minute (LPM)	56.8	113.6	284	568	1,136
Fluid Velocity					
in Extended Range					
Feet/second	0.5-10.6	0.6-12.1	0.93-18.6	0.8-15.9	0.96-19.1
Meters/second	0.2-3.2	0.2-3.7	0.28-5.7	0.24-4.8	0.29-5.8
Maximum Pressure Drop					
in 10:1 Range					
PSIG	8	7.5	5	4	4
bar	0.55	0.5	0.34	0.28	0.28
Frequency Range in					
Linear Flow Range	45-450 Hz	37-370 Hz	45-475 Hz	35-350 Hz	33-330 Hz
Connections					
NPT Female Inlet/Outlet Size	Yes	Yes	Yes	Yes	Yes
Female	Yes	Yes	Yes	Yes	Yes
Inlet/Outlet Size	1/2 in.	3/4 in.	1 in.	1-1/2 in.	2 in.
Wrench Size:					
Inch	1-1/16 in.	1-5/16 in.	1-5/8 in.	2-3/8 in.	3 in.
Millimeter	27mm	33mm	41mm	60mm	75mm
Weight*					
Pounds	2.0 lbs.	2.3 lbs.	2.7 lbs.	6.0 lbs.	9.6 lbs.
Kilograms	0.9 kg	1.0 kg	1.2 kg	2.7 kg	4.3 kg

* Computer electronics add 0.2 lbs. (0.1 kg) to total weight.

SPECIFICATIONS - BRASS *continued*

Performance

Linear Range for 1/2 in. and 3/4 in.: 10:1 @ $\pm 2.0\%$ of reading
 Linear Range for 1 in.: 10:1 @ $\pm 1.5\%$ of reading
 Linear Range for 1-1/2 in. and 2 in.: 10:1 @ $\pm 1.0\%$ of reading
 Extended Range: 20:1 @ $\pm 5.0\%$ of reading
 Repeatability: $\pm 0.1\%$

Pressure Rating

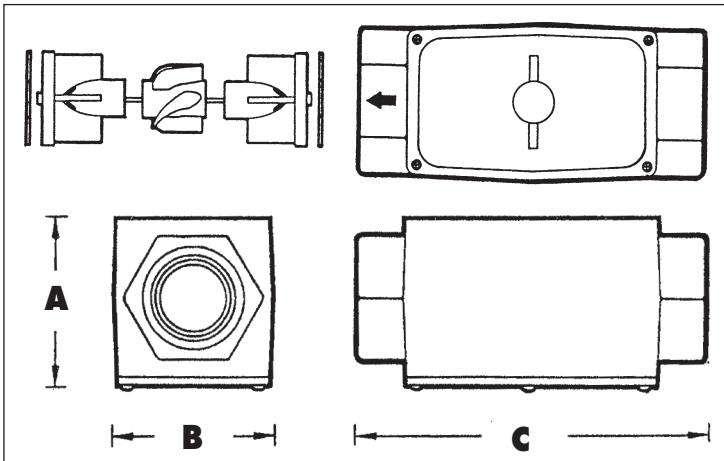
300 PSIG (21 bar)

Wetted Components

Housing: Brass
 Journal Bearings: Ceramic (96% Alumina)
 Shaft: Tungsten Carbide
 Rotor and Supports: PVDF
 Retaining Rings: 316 Stainless Steel

Temperature Range

Turbine only without computer: -40° to $+250^{\circ}\text{F}$ (-40° to $+121^{\circ}\text{C}$)
 Turbine with display electronics: $+14^{\circ}$ to $+140^{\circ}\text{F}$ (-10° to $+60^{\circ}\text{C}$)
 (Display electronics or accessory modules determine final operational temperature.)



Dimensions

Models	FTB791- BRASS	FTB792- BRASS	FTB793- BRASS	FTB794- BRASS	FTB795- BRASS
Size	1/2 in.	3/4 in.	1 in.	1-1/2 in.	2 in.
A = Height:					
Inches	1.8 in.	2.0 in.	2.2 in.	2.8 in.	3.2 in.
Centimeters	4.6cm	5.1cm	5.6cm	7.1cm	8.2cm
B = Width					
Inches	2.0 in.	2.0 in.	2.0 in.	2.7 in.	3.3 in.
Centimeters	5.1cm	5.1cm	5.1cm	6.9cm	8.4cm
C = Length					
Inches	4.2 in.	4.3 in.	4.5 in.	5.3 in.	6.3 in.
Centimeters	10.7cm	10.9cm	11.4cm	13.5cm	16.0cm

Computer electronics add 0.7 in. (1.8cm) to height of turbine.

SPECIFICATIONS *continued*

Display Specifications

Input Pulse Rate:

Minimum Pulse In:	DC
Minimum Coil Input:	10 Hz
Maximum Raw:	1,000 Hz

K-Factor:

Minimum:	0.1 pulses/unit
Maximum:	999,999 pulses/unit

Field Calibration:

Minimum Time:	10 seconds
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Readout Totals:

Minimum Display:	0.01
Maximum Display:	999,999

Temperatures:

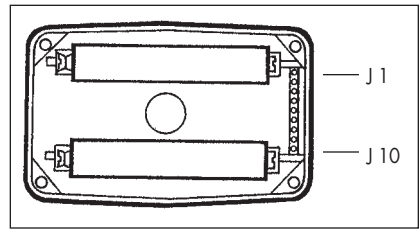
Operational:	+14° to +140°F (-10° to +60°C)
Storage:	-40° to +158°F (-40° to +70°C)

If wider operating temperature ranges are desired, reference information on Remote Kits.

Power:

Internal Power Supply:	2 Lithium Batteries at 3 volts each
Minimum Battery Life:	4,000 operational hours
Optional External Power:	7-30 VDC $\pm 5\%$

Display Electronics Terminal Connections



J-1 Reset

When connected by a jumper wire to Ground (J1-6), this has the same effect as initial power up and zeroes out all totalizers.

J-2 Pulse Signal Output

This supplies a high-level amplified open collector signal. Output will withstand a maximum open-circuit voltage of 60 volts DC and a maximum closed-circuit of 100 mA.

J-3 Not Used

J-4 Pulse Signal Input

Requires a sine or square wave with open-circuit voltage of 3-30 volts P-P, a maximum rise/fall rate of 0.01 V/ μ second and a maximum frequency of 750 Hz.

J-5 Power Input

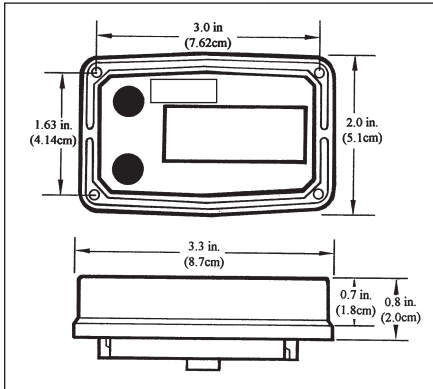
When used with Ground (J1-6), this has reverse polarity protection, but no on-board voltage regulation. Supplied voltage must be 5.75 volts DC $\pm 5\%$.

J-6 Ground

J-7, 8, 9, 10 Programming interfaces. Not accessible to user.

NOTE: Safety approvals are void if any external connections are made to computer electronics.

SPECIFICATIONS continued



MODEL NUMBERS - STAINLESS STEEL

Model No. w/Display	Model No.* w/o Display	Range GPM (LPM)	Extended Range Low Flow†	FNPT Size
FTB791	FTB791-ND	1-10	0.5 (3.8-37.9)	1/2" (1.9)
FTB792	FTB792-ND	2-20	1 (7.6-75.9)	3/4" (3.8)
FTB793	FTB793-ND	5-50	2.5 (19-190)	1" (9.5)
FTB794	FTB794-ND	10-100	5 (38-380)	1-1/2" (9.0)
FTB795	FTB795-ND	20-200	10 (76-760)	2" (38)

* Requires signal output module P/N - FLSC790-P-ND ordered separately.

† Extended low flow range and field calibration for viscosity available on - ND units w/o display.

MODEL NUMBERS - BRASS

Model No. w/Display	Model No.* w/o Display	Range GPM (LPM)	Extended Range Low Flow†	FNPT Size
FTB791- BRASS	FTB791-ND- BRASS	1-10 (3.8-37.9)	0.5 (1.9)	1/2"
FTB792- BRASS	FTB792-ND- BRASS	2-20 (7.6-75.9)	1 (3.8)	3/4"
FTB793- BRASS	FTB793-ND- BRASS	5-50 (19-190)	2.5 (9.5)	1"
FTB794- BRASS	FTB794-ND- BRASS	10-100 (38-380)	5 (9.0)	1-1/2"
FTB795- BRASS	FTB795-ND- BRASS	20-200 (76-760)	10 (38)	2"

* Requires signal output module P/N - FLSC790-P-ND ordered separately.

† Extended low flow range and field calibration for viscosity available on - ND units w/o display.

PARTS & ACCESSORIES

Order Replacement Kits with the part numbers given here.

Part Number	Description
FTB890-ORING	O-Ring
FTB791-RK	(1/2 inch) Rotor/Support Replacement Kit
FTB792-RK	(3/4 inch) Rotor/Support Replacement Kit
FTB793-RK	(1 inch) Rotor/Support Replacement Kit
FTB794-RK	(1-1/2 inch) Rotor/Support Replacement Kit
FTB795-RK	(2 inch) Rotor/Support Replacement Kit
FTB791-RETAINING	(1/2 inch) Retaining Ring
FTB792-RETAINING	(3/4 inch) Retaining Ring
FTB793-RETAINING	(1 inch) Retaining Ring
FTB794-RETAINING	(1-1/2 inch) Retaining Ring
FTB795-RETAINING	(2 inch) Retaining Ring

Field Installable Options and Accessories

Model Number	Description
FLSC790-MA	4-20 mAdc Output Module
FLSC790-P	Pulse Output Module (open collector output)
FLSC790-P-DC	External Power Module for FLSC790-P (9-30Vdc)
FTB790-RK	Remote Display Kit Module
FTB790-RK-FM	FM Approved Remote Display Kit Module
FLSC790-BATT	Replacement Batteries
FLSC790-P-ND	Pulse Output for Models without Displays (-ND suffix)(open collector output)

Except as noted, Options and Accessories are for Display Models only and only one Module may be installed per unit. All models are supplied with 10 ft. cable. Cable may be cut or extended as required. Customer supplied pull-up resistor required, 820 ohm (min).



WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's Warranty adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by it will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESS OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

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RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please use the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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