

# DELTA™ III EtherCAT®

## DLT3B - 3 Zone Flow Ratio Controller

Enabling Process Optimization for Critical Deposition and Etch Processes



The DELTA™ III Flow Ratio Controller is a critical process control instrument in the MKS line of digital control, web-browser products. This device provides the latest in gas flow ratio measurement and control technology necessary to meet the demands of multi-channel flow distribution for semiconductor, flat panel, and solar panel process uniformity control.

The DELTA series mass flow ratio controllers divide and control mixed process gas flows to either multiple chambers or zones within a process chamber at proportions specified by the user to optimize process uniformity and repeatability. The DELTA series flow ratio controllers with their superior performance and compact design, are the latest offering from MKS, the industry leader in DELTA flow ratio controllers.

### Product Features

- Host control tuning without the need for manual intervention to change or adjust components and the additional capability to adjust flow between process steps
- Control flow proportion independent of the process gas mix based on N<sub>2</sub> equivalent flow of the gas
- Increases tool uptime through reduction of "No Problem Found": product replacements
  - Included embedded diagnostics and software allowing users to check functionality without removing the controller
  - E-diagnostics through embedded Ethernet interface allows monitoring performance parameters during operation

Protected under the following U.S. patent: US07673645B2 International Patents and Patents pending.



### Key Benefits

- Accurately and repeatably control flow ratio providing for better process optimization
- Digital control loop provides rapid response to channel set point independent of the gas mix
- Uses standard web browser – no special software required

Maintaining or improving critical etch and CVD process uniformity continues to be a critical need of the semiconductor process industry as line-widths continue to shrink. The ability to control process uniformity over increasing panel size for both the solar and flat panel industries is also critical. The DELTA III, three channel ratio controller provides a needed "knob" to tune process gas flows over the substrate surface or gas dispersion head to help achieve these uniformities. The DELTA III ratio controller provides closed loop control over the flow proportion that is not available with typical metering valve or flow orifice setups that have often been used. The DELTA ratio controllers provide the added advantage of tuning the process from the tool controller as opposed to manual valve adjustment necessary with metering valve and manual changeout which is impractical with fixed flow orifices.

The DELTA III has a wide dynamic ratio control range and fast development of chamber flow while being adaptive to different tool and process conditions. MKS has developed a unique patented ratio control logic enabling rapid ratio and flow response times. This control logic enables the total input flow to be split with channel flows ranging from 2 to 100% of the channel Full Scale for measurement and control purposes. The total of all channel flows shall be split in such a way that their sum equals 100%. For example the flows may be split to 20, 30 and 50% of total flow input going to channels Q1, Q2, and Q3, respectively. The dynamic control also allows for individual channels to be given 0% set points which closes the valve, effectively closing off flow to this output. All this in a more compact package with the additional features of web enabled setup and diagnostics.

The DELTA's diagnostic feature allows the user to check the DELTA's performance in-situ, lowering costs through reduced removal of No Problem Found devices. This feature is enabled through a web browser utility accessed through the device's Ethernet port. This utility uses a standard web browser and requires no special software. The diagnostic input includes the ability to control the device locally, operate the device, open and close valves along with collecting and saving data for later analysis.

Protected under one or more of the following U.S. patents: No. 6,418,954, No. 6,668,642, No. 6,766,260, No 7,007,707, No. 7,673,645 or International Patents and Patents pending.

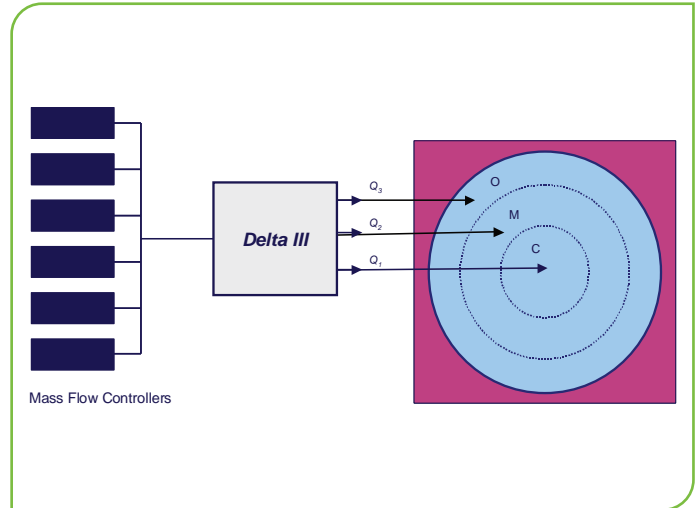


Figure 1  
The above schematic shows how the DELTA III Flow Ratio Controller can be used to control flow to three zones (Center (C), Middle (M) & Outer (O)) within a chamber to optimize process uniformity.

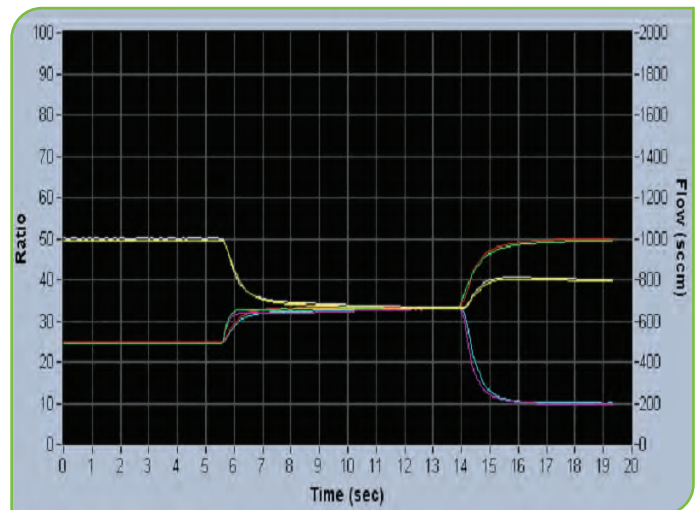


Figure 2  
The DELTA III ratio controller provides control for three channels of flow. Above the device starts with flows of 25, 25 and 50% in channels Q1, Q2, and Q3, respectively. The flow then transitions to 33.3% in each channel followed by a transition to 10, 50 and 40% in each channel, respectively.

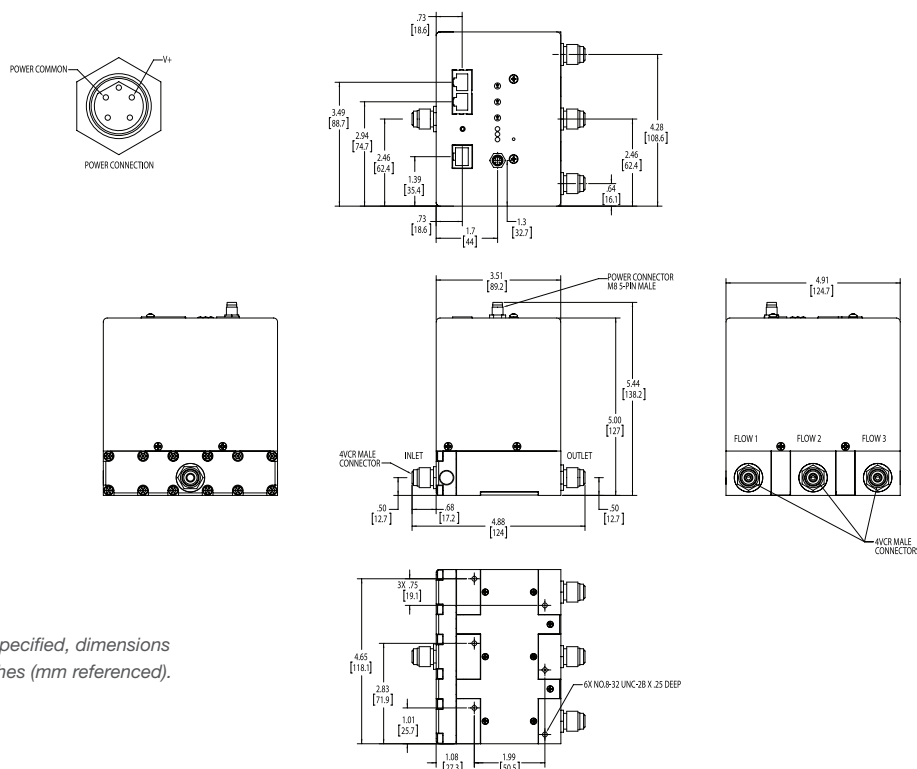
| Performance   |  |
|---|--|
| Full Scale Ranges (each channel nitrogen equivalent - Q)                            | 500, 1000, 2000, 3000, 5000 and 10000 sccm   |
| Percentage Accuracy (includes non-linearity, hysteresis, and non-repeatability)     | ±2% set point (for flow ≥10% of channel Full Scale)  |
| Channel Flow Control Range  | 0, 5 to 100% Full Scale  |
| Input Ratio Range   | 0, 2 to 100% of total flow within flow channel control range   |
| Percentage Repeatability  | ±0.3% of set point   |
| Resolution  | 0.02% of channel Full Scale  |
| Maximum Operating Outlet Pressure   | 200 Torr at maximum flow rate through all channels   |
| Maximum Allowable Outlet Pressure Differential (highest to lowest pressure channel) | 50 Torr with the same percentage flow through all channels   |
| Normal Operating Pressure Differential  | <150 Torr @ 3K split 33.3%; Except, <450 Torr for 10K/10K  |
| Percentage Settling Time  | <3 seconds (typical dependent on downstream conductance matching)  |
| Maximum Inlet Pressure  | 150 psig (non-operational)   |
| Temperature Coefficients  | <b>Zero Span</b> <ul style="list-style-type: none"> <li>• &lt;0.05% Full Scale/°C (500 ppm)</li> <li>• &lt;0.08% of Reading/°C (800 ppm)</li> </ul>  |
| Warmup Time   |  |
| Normal Operating Temperature  | 10 to 60°C   |
| Storage Temperature   | -20 to 65°C  |
| Storage Humidity  | 0 to 95% relative humidity, non-condensing   |
| Temperature Accuracy  | +2°C   |
| Temperature Resolution  | 0.1°C  |
| Compliance  | CE (an overall metal braided, shielded cable, properly grounded at both ends, is required during use).   |
| Mechanical  |  |
| Fittings  | <b>Inlet Outlet</b> <ul style="list-style-type: none"> <li>• Swagelok® 4 VCR®</li> <li>• Male (non-rotatable)</li> <li>• Male (non-rotatable)</li> </ul>   |
| Leak Integrity  | <b>External (scc/sec He) Through Closed Valve</b> <ul style="list-style-type: none"> <li>• &lt;1x10<sup>-10</sup></li> <li>• &lt;2% of Channel Full Scale at 500 Torr differential to &lt;10 Torr</li> </ul> |
| Wetted Materials  | 316 S.S. VAR (equivalent to 316 S.S. SCQ for semiconductor quality); 316 S.S., Inconel®, KM-45, PTFE   |
| Surface Finish  | 5 microinch average Ra   |
| Weight  | 7.27 lbs (3300 g)  |
| Electrical Communications   | EtherCAT®  |
| Input Power Required  | +24 VDC ±10% (13 Watts)  |
| Connector   | 2 x RJ-45 (comm.) male, M8 male, 5 pin (power)   |
| Data Rate Switch/Selection  | No switch  |
| Comm. Rate(s)   | 100 Mbps   |
| Mac ID Switches/Addresses   | 3 switches, 16 positions   |
| Network Size  | Up to 4095 nodes   |
| Visual Indicators   | LED Power (green), LED Run (green), LED Error (red), LED Comm (green)  |

The MKS DELTA III Flow Ratio Controller shall not be used with any gas mixture which will react with each other as gas reactions are likely to affect the device flow measurements and may damage the device.

The MKS DELTA III Flow Ratio Controller uses thermal sensors which add heat energy to the gas (and gas mixture) which may cause the gas to decompose and a mixture to react. Please consult MKS Applications Engineering if this is a concern for the intended application of the device.

For channels with "0%" set points, a downstream shut-off valve is required to assure no flow through the channel.

| Ordering Code: DLT3B0BBB8R11   | Code                                   | Configuration |
|--|--|---------------|
| Model  |  |               |
| DELTA III 3-Channel Flow Ratio Controller  | DLT3B                                  | DLT3B         |
| Reserved   |  |               |
| Reserved   | 0                                      | 0             |
| Channel Full Scale Flow Ranges   | 3 channel                              |               |
| 500 sccm<br>1000 sccm<br>2000 sccm<br>3000 sccm<br>5000 sccm<br>10000 sccm<br>All channels must be the same and are N <sub>2</sub> equivalent. | AAA<br>BBB<br>CCC<br>DDD<br>EEE<br>FFF | BBB           |
| Interface Electronics  |  |               |
| EtherCAT   | 8                                      | 8             |
| Fittings   |  |               |
| 4 VCR male, non-rotatable on inlet and outlet  | R                                      | R             |
| Firmware   |  |               |
| Firmware Revision  | 11                                     | 11            |



**Dimensional Drawing**

Note: Unless otherwise specified, dimensions are nominal values in inches (mm referenced).