

## DELTA™ IV DeviceNet™

### DLTNA4 - 4 ZONE FLOW RATIO CONTROLLER ENABLING PROCESS OPTIMIZATION FOR CRITICAL DEPOSITION AND ETCH PROCESSES

The DELTA™ IV Flow Ratio Controller is a critical process control instrument in the MKS line of digital control, browser-enabled products. These devices provide 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.

### Features & Benefits

- Accurately and repeatably control flow ratio providing for better process optimization
- 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  $N_2$  equivalent flow of the gas
- Digital control loop provides rapid response to channel set point independent of the gas mix
- 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
- Uses standard web browser – no special software required
- Bright LED display provides easy viewing of flow ratio, temperature and Ethernet address

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

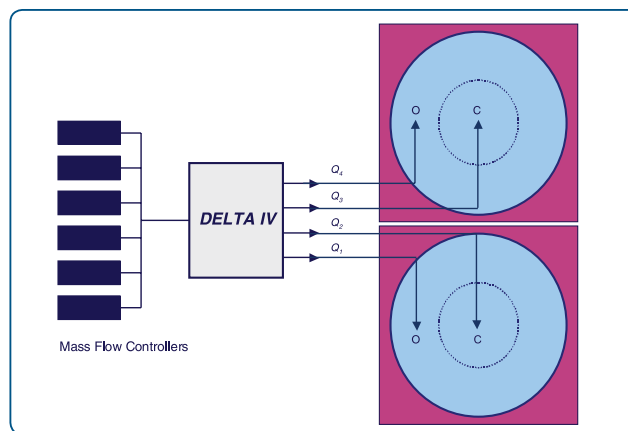


Maintaining or improving critical etch and CVD process uniformity continues to be a critical need of the semiconductor process industry as line-widths continue to shrink. The ability to control process uniformity over increasing panel size for both the solar and flat panel industries is also critical. The DELTA IV, four 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 IV 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.

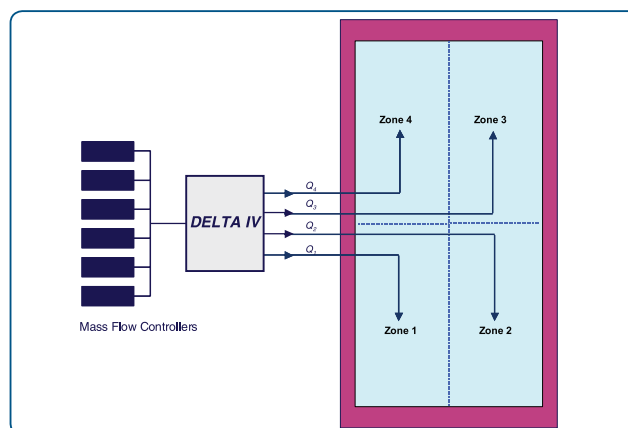
The DELTA IV has a wide dynamic ratio control range and fast development of chamber flow while being adaptive to different tool and process conditions. MKS has developed a unique patent pending ratio control logic enabling rapid ratio and flow response times. This control logic enables the total input 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 10, 20, 30 and 40% of total flow input going to channels Q1, Q2, Q3 and Q4, 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.

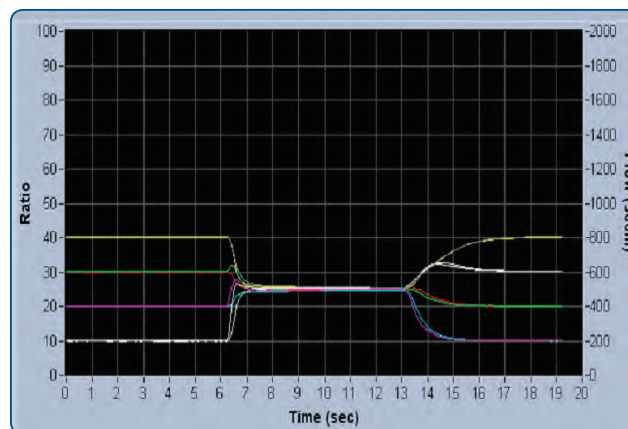
Protected under one or more of the following U.S. patents: No. 6,418,954, No. 6,766,260, No. 7,007,007, No. 7621290, No. 7673645 or International Patents and Patents pending.



**Figure 1 —**  
The DELTA IV flow ratio controller is shown here with its four flow outputs providing flow to center (C) and outer (O) zones within a process chamber for a dual wafer chamber or a dual chamber configuration.



**Figure 2 —**  
The DELTA IV flow ratio controller is shown here with its four flow outputs being used to distribute gas flow over four zones within a flat or solar panel process chamber.



**Figure 3 —**  
The DELTA IV ratio controller provides control for four channels of flow. Above the device starts with flows of 20, 30, 10 and 40% in channels, Q1, Q2, Q3 and Q4 respectively. The flow then transitions to 25% in each channel followed by a transition to 10, 20, 30 and 40% in each channel.



# Specifications

## Performance

Full Scale Ranges (each channel) (nitrogen equivalent – Q)	500, 1000, 2000, 3000, 5000 and 10000 sccm
Percentage Accuracy <sup>1</sup>	±2% set point (for percent set points above 10%)
Input Ratio Range	0, 2 to 100% of total flow within flow channel control range
Channel Flow Control Range	0, 5 to 100% Full Scale
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 (@ 4K split 25%) 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	
Zero	<0.05% Full Scale/°C (500 ppm)
Span	<0.08% of Reading/°C (800 ppm)
Warm Up Time	60 minutes (minimum with device powered and at equilibrium with ambient)
Normal Operating Temperature	10 to 40°C
Storage Temperature	-20 to 65°C
Storage Humidity	0 to 95% relative humidity, non-condensing
Temperature Display	0 to 100°C
Temperature Readout Units	°C
Temperature Accuracy	+2°C
Temperature Resolution	0.1°C
Compliance <sup>2</sup>	CE

<sup>1</sup> Includes non-linearity, hysteresis, and non-repeatability.

<sup>2</sup> An overall metal braided, shielded cable, properly grounded at both ends, is required during use.

## Mechanical

Fittings	Swagelok® 4 VCR®
Inlet	Male (non-rotatable)
Outlet	Male (non-rotatable)
Display	4 digits for value, 4 characters for unit
Leak Integrity	
External (scc/sec He)	<1x10 <sup>-10</sup>
Through closed valve	<2% of channel Full Scale at 500 Torr differential to <10 Torr
Wetted Materials	316 S.S. VAR (equivalent to 316 S.S. SCQ for semiconductor quality) 316 S.S. nickel, Inconel®, KM-45, PTFE
Surface Finish	5 microinch average Ra

## Electrical/Communications

	<b>Digital I/O</b>
Connector	5 pin microconnector (DeviceNet™)
Input Voltage	11-25 VDC
Power Consumption	<20 Watts
Set Point and Output Signal	Digital

The DELTA IV 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.

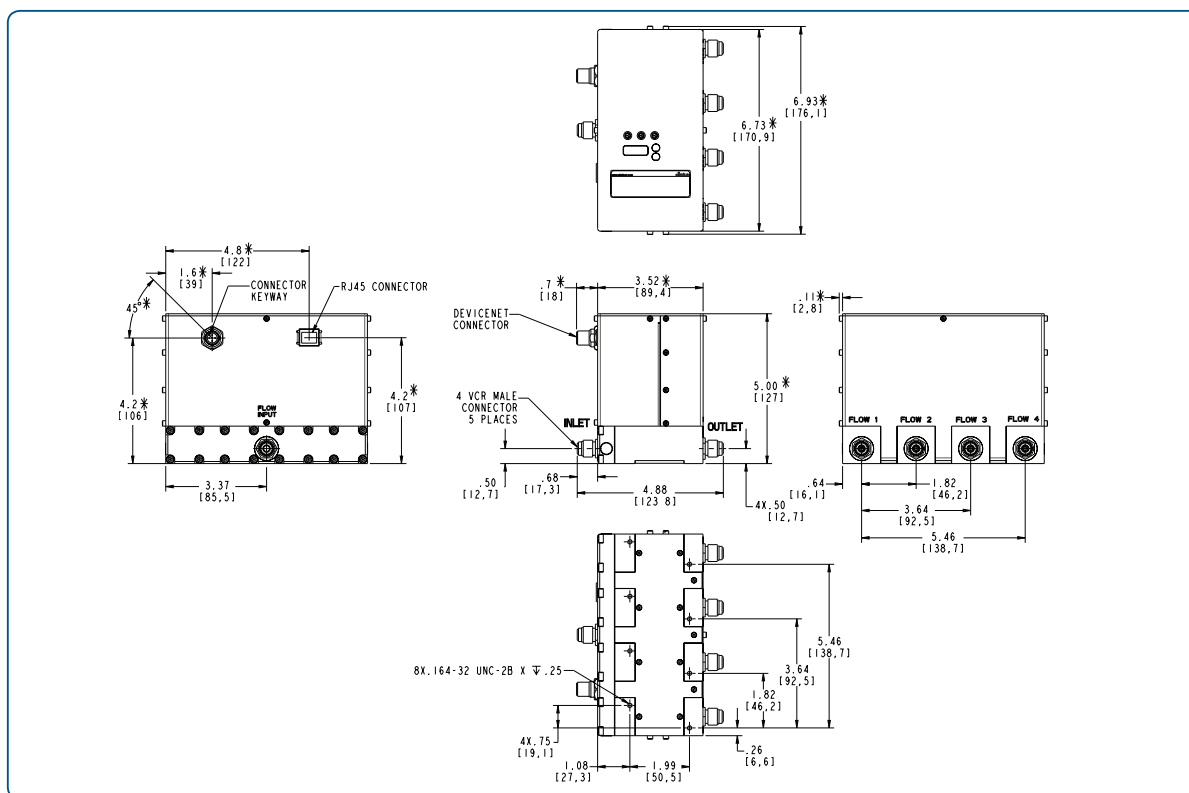
The DELTA IV Flow Ratio Controller uses thermal sensors which add heat energy to the gas (and gas mixture) which may cause the gas to decompose and a mixture to react. Please consult MKS Applications Engineering if this is a concern for the intended application of the device.

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



# Ordering Information

Ordering Code Example: DLTNA4BBBB6R21	Code	Configuration
<b>DELTA IV 4-channel Flow Ratio Controller</b>	<b>DLTNA4</b>	<b>DLTNA4</b>
<b>Channel Full Scale Flow Ranges (YYYY)</b>	<b>4 channel</b>	
500 sccm	AAA	<b>BBBB</b>
1000 sccm	BBB	
2000 sccm	CCC	
3000 sccm	DDD	
5000 sccm	EEE	
10000 sccm	FFF	
All channels must be the same and are N <sub>2</sub> equivalent.		
<b>Interface Electronics (Z)</b>		
DeviceNet	6	<b>6</b>
<b>Fittings (A)</b>		
4 VCR male, non-rotatable on inlet and outlet	R	<b>R</b>
<b>Firmware (BB)</b>		
Firmware Revision	21	<b>21</b>



## Dimensional Drawing —

Note: Unless otherwise specified, dimensions are nominal values in inches [mm] (for reference only).



### MKS Instruments, Inc. Global Headquarters

2 Tech Drive, Suite 201  
Andover, MA 01810  
Tel: 978.645.5500  
Tel: 800.227.8766 (in U.S.A.)  
Web: www.mksinst.com

### MKS Instruments, Inc. Flow Solutions

Six Shattuck Road  
Andover, MA 01810  
Tel: 978.975.2350

DELTA IV DeviceNet - 7/18  
© 2012-2018 MKS Instruments, Inc.  
All rights reserved.

MKS products provided subject to the US Export Regulations. Diversion or transfer contrary to US law is prohibited. Specifications are subject to change without notice. mksinst™ and DELTA™ are trademarks of MKS Instruments, Inc., Andover, MA. Swagelok® and VCR® are registered trademarks of Swagelok Marketing Co., Solon, OH. DeviceNet™ is a trademark of the Open DeviceNet Vendor Association, Coral Springs, FL. Inconel® is a registered trademark of Inco Alloy International, Huntington, WV.