

DELTA™ IV EtherCAT®

DLT4B - 4 Zone Flow Ratio Controller

Enabling Process Optimization for Critical Deposition and Etch Processes



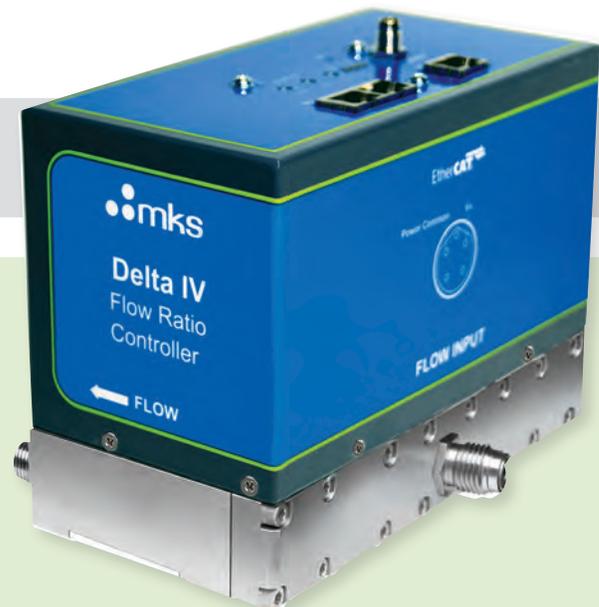
The DELTA™ IV Flow Ratio Controller is a critical process control instrument in the MKS line of digital control, browser-enabled products. These devices provide the latest in gas flow ratio measurement and control technology necessary to meet the demands of multi-channel flow distribution for semiconductor, 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.

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 N₂ 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 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 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 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. 6,668,642, No. 6,766,260, No. 7,007,707, No. 7,673,645 or International Patents and Patents pending.

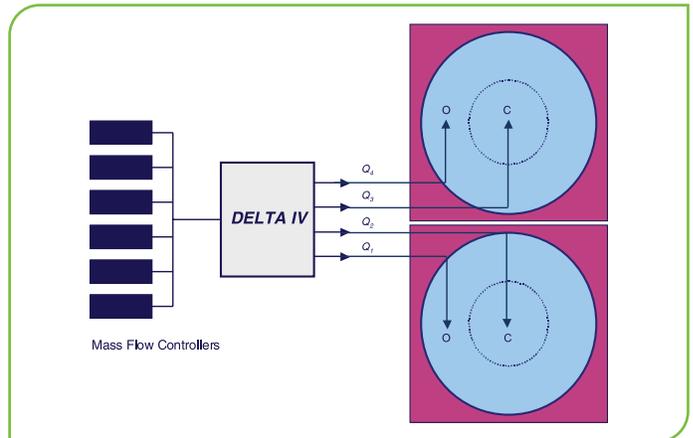


Figure 1 — The DELTA IV flow ratio controller is shown here with its four flow outputs providing flow to center (C) and outer (O) zones within a process chamber for a dual wafer chamber or a dual chamber configuration.

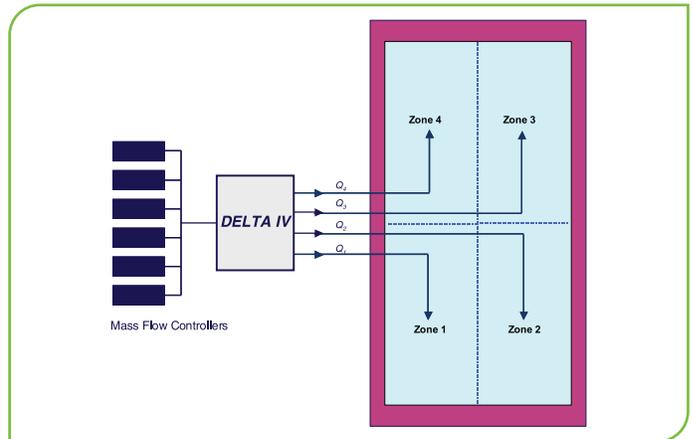


Figure 2 — The DELTA IV flow ratio controller is shown here with its four flow outputs being used to distribute gas flow over four zones within a flat or solar panel process chamber.

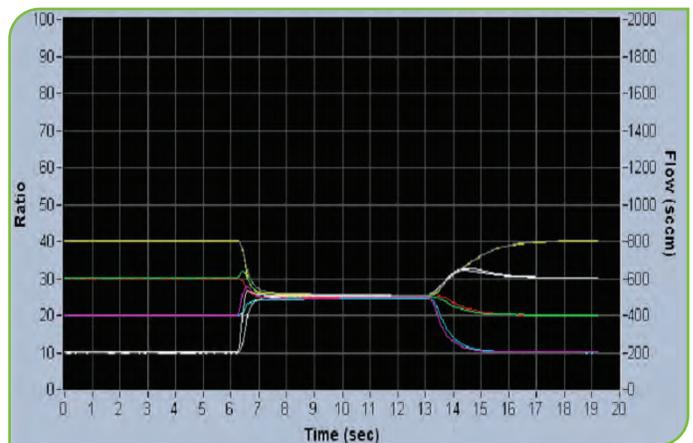
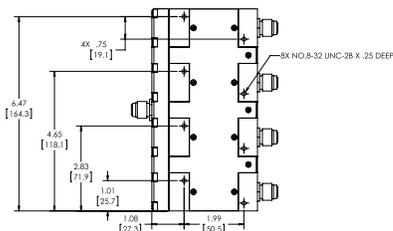
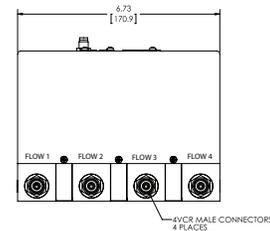
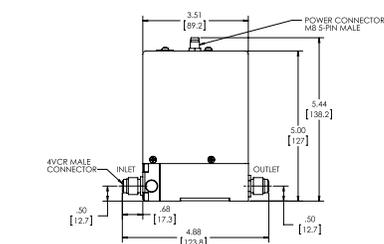
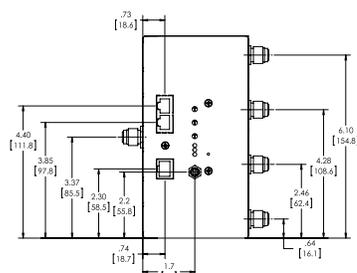
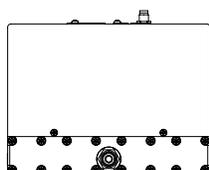
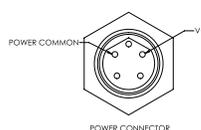


Figure 3 — The DELTA IV ratio controller provides control for four channels of flow. Above the device starts with flows of 20, 30, 10 and 40% in channels, Q1, Q2, Q3 and Q4 respectively. The flow then transitions to 25% in each channel followed by a transition to 10, 20, 30 and 40% in each channel.

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 (@ 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 Span <ul style="list-style-type: none"> <0.05% Full Scale/°C (500 ppm) <0.08% of Reading/°C (800 ppm)
Warmup Time	60 minutes
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	Inlet <ul style="list-style-type: none"> Swagelok® 4 VCR® Male (non-rotatable) Outlet <ul style="list-style-type: none"> Male (non-rotatable)
Leak Integrity	External (scc/sec He) Through Closed Valve <ul style="list-style-type: none"> <1x10⁻¹⁰ <2% of Channel Full Scale at 500 Torr differential to <10 Tor
Wetted Materials	316 S.S. VAR (equivalent to 316 S.S. SCQ for semiconductor quality); 316 S.S., Inconel®, KM-45, PTFE, Hastelloy®
Surface Finish	5 microinch average Ra
Electrical Communications	
EtherCAT®	
Input Power Required	+24 VDC ±10% (15 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 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 Code: DLT4B0AAAA8R11	Code	Configuration
Model		
DELTA IV 4-Channel Flow Ratio Controller	DLT4B	DLT4B
Reserved		
Reserved	0	0
Channel Full Scale Flow Ranges	4 channel	
500 sccm 1000 sccm 2000 sccm 3000 sccm 5000 sccm 10000 sccm All channels must be the same and are N ₂ equivalent.	AAAA BBBB CCCC DDDD EEEE FFFF	AAAA
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).