CLAIMS

What is claimed is:

1. A system for manufacturing semiconductors comprising:

a central controller comprising a processor, a memory, and a communication module;

a plurality of fluid supplies;

a plurality of apparatus for controlling flow, each of the plurality of apparatus for controlling flow comprising:

an inlet fluidly coupled to one of the plurality of fluid supplies;

an outlet;

a fluid pathway connecting the inlet to the outlet;

a sensor fluidly coupled to the fluid pathway;

an active component fluidly coupled to the fluid pathway; and

a device controller comprising a communication module, a memory, a sensor circuit operably coupled to the sensor, and an active component drive operably coupled to the active component; and

a processing chamber fluidly coupled to the outlets of the plurality of apparatus for controlling flow, the processing chamber configured to contain an article to be processed;

wherein the central controller is configured to receive sensor data from the sensor circuit of a first one of the plurality of apparatus for controlling flow and transmit an active component command to the active component drive of the first one of the plurality of apparatus for controlling flow, the active component command computed based on the sensor data.

2. The system of claim 1 wherein the central controller provides closed loop control of the active component of the first one of the plurality of apparatus for controlling flow.

3. The system of claim 1 wherein the memory of the first one of the plurality of apparatus for controlling flow stores calibration data.

4. The system of claim 1 wherein the sensor is one of a pressure sensor or a temperature sensor.

5. The system of claim 1 wherein the active component is a proportional valve.

6. The system of any one of claims 1 to 5 wherein the central controller implements a feedback control loop using the sensor data to control the active component of the first one of the plurality of apparatus for controlling flow; and wherein the central controller implements a feedback control loop for each of the plurality of apparatus for controlling flow.

7. The system of any one of claims 1 to 5 wherein the memory of the central controller stores a setpoint, the setpoint corresponding to a target operating parameter of the first one of the plurality of apparatus for controlling flow.

8. The system of any one of claims 1 to 5 wherein the device controller of the first one of the plurality of apparatus for controlling flow is configured to transmit a sensor data message comprising the sensor data.

9. The system of any one of claims 1 to 5 further comprising a communication bus operatively connecting the communication module of the central controller and the communication module of the device controller of the first one of the plurality of apparatus for controlling flow.

10. The system of claim 9 wherein the plurality of apparatus for controlling flow communicate with the central controller via the EtherCAT protocol.

11. The system of claim 9 wherein the plurality of apparatus for controlling flow communicate with the central controller via one of Ethernet, Modbus, Profibus, Profinet, DeviceNet, CANbus, Fieldbus, OPC, MQTT, or BACnet.

12. The system of any one of claims 1 to 5 wherein the central controller is configured to receive sensor data from the sensor circuit of a second one of the plurality of apparatus for controlling flow and transmit an active component command to the active component drive of the second one of the plurality of apparatus for controlling flow; and wherein the active component command transmitted to the first one of the plurality of apparatus for controlling flow

is computed at least in part based on sensor data of the second one of the plurality of apparatus for controlling flow.

13. The system of any one of claims 1 to 5 wherein the active component command is computed based on a setpoint stored in the memory of the central controller.

14. A system for manufacturing semiconductors comprising:

a central controller comprising a processor, a memory, and a communication module;

a fluid supply;

a first apparatus for controlling flow comprising:

an inlet fluidly coupled to the fluid supply;

an outlet;

a fluid pathway connecting the inlet to the outlet;

a sensor fluidly coupled to the fluid pathway;

an active component fluidly coupled to the fluid pathway; and

a device controller comprising a communication module, a memory, a sensor circuit operably coupled to the sensor, and an active component drive operably coupled to the active component;

a processing chamber fluidly coupled to the outlet of the first apparatus for controlling flow, the processing chamber configured to contain an article to be processed; and

a communication bus operatively connecting the communication module of the central controller and the communication module of the device controller;

wherein the device controller is configured to transmit a sensor data message comprising sensor data to the central controller via the communication bus; and

wherein the central controller is configured to transmit an active component message to the device controller via the communication bus, the active component message comprising an active component command determined at least in part based on a setpoint stored in the memory of the central controller and on the sensor data of the sensor data message.

15. The system of claim 14 wherein the central controller is configured to receive sensor data from a sensor circuit of a second apparatus for controlling flow and transmit an active component command to an active component drive of the second apparatus for controlling flow.

16. A system for manufacturing semiconductors comprising:

a central controller comprising a processor, a memory, and a communication module;

a fluid supply;

a first apparatus for controlling flow comprising:

an inlet fluidly coupled to the fluid supply;

an outlet;

a fluid pathway connecting the inlet to the outlet;

a sensor fluidly coupled to the fluid pathway; and

an active component fluidly coupled to the fluid pathway; and

a device controller comprising a communication module, a memory, a sensor circuit operably coupled to the sensor, and an active component drive operably coupled to the active component;

a processing chamber fluidly coupled to the outlet of the first apparatus for controlling flow, the processing chamber configured to contain an article to be processed; and

a communication bus operatively connecting the communication module of the central controller and the communication module of the device controller;

wherein the central controller implements a feedback control loop utilizing sensor data from the first apparatus for controlling flow to control the active component of the first apparatus for controlling flow.

17. The system of claim 16 wherein the memory of the first apparatus for controlling flow stores calibration data.

18. A method of manufacturing semiconductors comprising:

a) transmitting a first sensor data message comprising first sensor data from a device controller of a first apparatus for controlling flow to a central controller, the first apparatus for controlling flow comprising a sensor operably coupled to the device controller, the sensor sensing a characteristic of a fluid within a fluid pathway of the first apparatus for controlling flow;

b) computing a first active component command using a setpoint stored in a memory of the central controller and the first sensor data of the first sensor data message;

c) transmitting a first active component message from the central controller to the device controller of the first apparatus for controlling flow, the first active component message comprising the first active component command;

d) controlling an active component of the first apparatus for controlling flow in accordance with the first active component command to deliver the fluid to a processing chamber comprising an article to be processed;

e) transmitting a second sensor data message comprising second sensor data from the device controller of the first apparatus for controlling flow to the central controller;

f) computing a second active component command using the setpoint and the second sensor data;

g) transmitting a second active component message from the central controller to the device controller of the first apparatus for controlling flow, the second active component message comprising the second active component command;

h) controlling the active component in accordance with the second active component command to deliver the fluid to the processing chamber.

19. The method of claim 18 further comprising steps i), j), k), and l), step i) comprising transmitting a third sensor data message comprising third sensor data from a device controller of a second apparatus for controlling flow to the central controller, step j) comprising computing a third active component command using the setpoint and the third sensor data, step k) comprising transmitting a third active component message from the central controller to the device controller of the first apparatus for controlling flow, the third active component message comprising the third active component command, and step l) comprising controlling the active component in accordance with the third active component command to deliver the fluid to the processing chamber.

20. The method of claim 18 further comprising steps i), j), k), and l), step i) comprising transmitting a fourth sensor data message comprising fourth sensor data from a device controller of a second apparatus for controlling flow to the central controller and transmitting a fifth sensor data message comprising fifth sensor data from the device controller of the first apparatus for controlling flow to the central controller, step j) comprising computing a fourth active

component command using the setpoint and the fourth and fifth sensor data, step k) comprising transmitting a fourth active component message from the central controller to the device controller of the first apparatus for controlling flow, the fourth active component message comprising the fourth active component command, and step l) comprising controlling the active component in accordance with the fourth active component command to deliver the fluid to the processing chamber.