# List of components

| **PCB Position** | **Manufacturer** | **Part Number** | **Value** | **Units** | **Component type** |
| --- | --- | --- | --- | --- | --- |
| R1\* | Sparkfun | COM-10969 | 2.2\*  ± 5 | kΩ  % | Resistor |
| R2\* | Sparkfun | COM-10969 | 3.3\*  ± 5 | kΩ  % | Resistor |
| R3\* | Sparkfun | COM-10969 | 0\* | Ω | Resistor |
| R4\* | Sparkfun | COM-10969 | 2.2\*  ± 5 | kΩ  % | Resistor |
| R5\* | Sparkfun | COM-10969 | 3.3\*  ± 5 | kΩ  % | Resistor |
| R6\* | Sparkfun | COM-10969 | 0\* | Ω | Resistor |
| R7\* | Sparkfun | COM-10969 | 0\* | Ω | Resistor |
| R8\* | Sparkfun | COM-10969 | 0\* | Ω | Resistor |
| R9\* | Sparkfun | COM-10969 | 0\* | Ω | Resistor |
| R10\* | Sparkfun | COM-10969 | 0\* | Ω | Resistor |
| D1 | Vishay General Semiconductors | 1N4007E-E3/54 | Vf = 1.1  Vr = 1000 | V | Diode |
| D2 | Vishay General Semiconductors | 1N4007E-E3/54 | Vf = 1.1  Vr = 1000 | V | Diode |
| D3 | Vishay General Semiconductors | 1N4007E-E3/54 | Vf = 1.1  Vr = 1000 | V | Diode |
| D4 | Vishay General Semiconductors | 1N4007E-E3/54 | Vf = 1.1  Vr = 1000 | V | Diode |
| D5 | Vishay General Semiconductors | 1N4007E-E3/54 | Vf = 1.1  Vr = 1000 | V | Diode |
| D6 | Vishay General Semiconductors | 1N4007E-E3/54 | Vf = 1.1  Vr = 1000 | V | Diode |
| D7 | Vishay General Semiconductors | 1N4007E-E3/54 | Vf = 1.1  Vr = 1000 | V | Diode |
| D8 | Vishay General Semiconductors | 1N4007E-E3/54 | Vf = 1.1  Vr = 1000 | V | Diode |
| D10 | Vishay General Semiconductors | 1N4007E-E3/54 | Vf = 1.1  Vr = 1000 | V | Diode |
| D11 | Vishay General Semiconductors | 1N4007E-E3/54 | Vf = 1.1  Vr = 1000 | V | Diode |
| D12 | Vishay General Semiconductors | 1N4007E-E3/54 | Vf = 1.1  Vr = 1000 | V | Diode |
| H1 | Samtec Inc | TSW-105-07-T-S | Pitch = 2.54  Position = 5 | mm | Board to Board Header |
| H2 | Samtec Inc | TSW-105-07-T-S | Pitch = 2.54  Position = 5 | mm | Board to Board Header |
| H3 | Samtec Inc | TSW-108-07-T-S | Pitch = 2.54  Position = 8 | mm | Board to Board Header |
| H4 | Samtec Inc | TSW-110-07-T-S | Pitch = 2.54  Position = 10 | mm | Board to Board Header |
| H5 | Samtec Inc | TSW-105-07-T-S | Pitch = 2.54  Position = 5 | mm | Board to Board Header |
| H6 | Samtec Inc | TSW-105-07-T-S | Pitch = 2.54  Position = 5 | mm | Board to Board Header |
| JP1 | Samtec Inc | TSW-102-07-T-S | Pitch = 2.54  Position = 2 | mm | Board to Board Header |
| JP2 | Samtec Inc | TSW-102-07-T-S | Pitch = 2.54  Position = 2 | mm | Board to Board Header |
| JP3 | Samtec Inc | TSW-102-07-T-S | Pitch = 2.54  Position = 2 | mm | Board to Board Header |
| JP4 | Samtec Inc | TSW-102-07-T-S | Pitch = 2.54  Position = 2 | mm | Board to Board Header |
| JP5 | Samtec Inc | TSW-103-07-T-S | Pitch = 2.54  Position = 3  Rows = 2 | mm | Board to Board Header |
| JP6 | Samtec Inc | TSW-103-07-T-S | Pitch = 2.54  Position = 3 | mm | Board to Board Header |
| JP7 | Samtec Inc | TSW-103-07-T-S | Pitch = 2.54  Position = 3 | mm | Board to Board Header |
| CONN1 | Qibaok | XH-6A | Pitch = 2.54  Female  Position = 6 | mm | JST-XH Female Header |
| CONN2 | Qibaok | XH-6A | Pitch = 2.54  Female  Position = 6 | mm | JST-XH Female Header |
| CONN3 | Qibaok | XH-2A | Pitch = 2.54  Female  Position = 2 | mm | JST-XH Female Header |
| CONN4 | Qibaok | XH-2A | Pitch = 2.54  Female  Position = 2 | mm | JST-XH Female Header |
| CONN5 | Qibaok | XH-5A | Pitch = 2.54  Female  Position = 5 | mm | JST-XH Female Header |
| CONN6 | Qibaok | XH-5A | Pitch = 2.54  Female  Position = 5 | mm | JST-XH Female Header |
| CONN7 | Qibaok | XH-4A | Pitch = 2.54  Female  Position = 4 | mm | JST-XH Female Header |
| CONN8 | Qibaok | XH-4A | Pitch = 2.54  Female  Position = 4 | mm | JST-XH Female Header |
| CONN9 | Qibaok | XH-4A | Pitch = 2.54  Female  Position = 4 | mm | JST-XH Female Header |
| CONN10 | Qibaok | XH-4A | Pitch = 2.54  Female  Position = 4 | mm | JST-XH Female Header |
| CONN11 | Qibaok | XH-2A | Pitch = 2.54  Female  Position = 2 | mm | JST-XH Female Header |
| CONN12 | Qibaok | XH-2A | Pitch = 2.54  Female  Position = 2 | mm | JST-XH Female Header |
| SYNC1\* | Kingbright Company LLC | WP7113VBC/D | Vf = 3.3\*\*  Lens = 5 | V  mm | Light Emitting Diode (LED) |
| ACK1\* | Kingbright Company LLC | WP7113VBC/D | Vf = 3.3\*\*  Lens = 5 | V  mm | Light Emitting Diode (LED) |
| SYNC2\* | Kingbright Company LLC | WP7113VBC/D | Vf = 3.3\*\*  Lens = 5 | V  mm | Light Emitting Diode (LED) |
| ACK2\* | Kingbright Company LLC | WP7113VBC/D | Vf = 3.3\*\*  Lens = 5 | V  mm | Light Emitting Diode (LED) |

\* Components and values reflect what was used for our particular setup. These Values should be chosen according to each system’s requirements

\*\* Different LED forward voltages may be needed depending on each individual system. The LED should be able to turn on with its corresponding TTL signal voltages delivered by the microcontroller and voltage divider output. Voltage divider output is dependent on R1, R2, and R3 for SYNC1 and ACK1, as well as R4, R5, and R6 for SYNC2 and ACK2. Value shown is the typical operating voltage for the LED, see component datasheet for maximum and minimum forward voltages.

**Internal Connectors:**

| CONN7 | Qibaok | XH-4Y | Pitch = 2.54  Male  Position = 4 | mm | JST-XH Male Connector |
| --- | --- | --- | --- | --- | --- |
| CONN8 | Qibaok | XH-4Y | Pitch = 2.54  Male  Position = 4 | mm | JST-XH Male Connector |
| CONN9 | Qibaok | XH-4Y | Pitch = 2.54  Male  Position = 4 | mm | JST-XH Male Connector |
| CONN10 | Qibaok | XH-4Y | Pitch = 2.54  Male  Position = 4 | mm | JST-XH Male Connector |

# Microcontroller, Relay, and PCB Connections

### Connections for MCU 1

| **Signal** | **Position on MCU**  **(MSP430-FR2355)** | **Position on PCB** | **Position on Relay Shield** |
| --- | --- | --- | --- |
| Cost LED1 | P6.0 | H5.1 | - |
| Cost LED2 | P6.1 | H5.2 | - |
| Cost LED3 | P6.2 | H5.3 | - |
| Cost LED4 | P6.3 | H5.4 | - |
| Trial Indicator LED | P6.4 | H5.5 | - |
| Low-Voltage Supply\* | 3V3 or 5V\* | H1.1 | - |
| Ground | GND | H1.2 | - |
| SYNC | P3.5 or P3.6\*\*\* | H2.1 | - |
| ACK | P3.0\*\*\* | H2.2 | - |
| Trigger Signal for Relay 1 | P3.1 | H3.1 | - |
| Trigger Signal for Relay 2 | P3.2 | H3.2 | - |
| Trigger Signal for Relay 3 | P3.7 | H3.3 | - |
| Trigger Signal for Relay 4 | P3.4 | H3.4 | - |
| MCU to Relay 1 | - | H4.1 | IN1 |
| MCU to Relay 2 | - | H4.2 | IN2 |
| MCU to Relay 3 | - | H4.3 | IN3 |
| MCU to Relay 4 | - | H4.4 | IN4 |
| Relay VCC | - | H4.9 | VCC |
| Relay GND | - | H4.10 | GND |
| Relay 1 to Valve 1 | - | CONN7.1 | Relay 1, Normally Open Terminal |
| Relay 2 to Valve 2 | - | CONN7.2 | Relay 2, Normally Open Terminal |
| Relay 3 to Valve 3 | - | CONN7.3 | Relay 3, Normally Open Terminal |
| Relay 4 to Valve 4 | - | CONN7.4 | Relay 4, Normally Open Terminal |
| Common High-voltage supply for valves 1 - 4 | - | CONN9.1-4\*\* | Relay 1-4, COM Terminal |

\* Supplying low-voltage power to the PCB serves to route the voltage and ground to the relay shield. Make sure you are providing enough power to the relay shield and that the jumpers on JP5 are configured in the correct way to carry that voltage. The relay shield may be able to operate on 3.3V, however 5V is recommended.

\*\* Connector 9 simply supplies voltage to the relay. The COM terminal is shorted with the Normally Open terminal when the relay is activated. The order in which the pins on the connector are connected to each relay’s COM terminal has no effect on the function of the system.

\*\*\* This connection depends on the particular use-case scenario. P3.0 is the outgoing ACK signal that pulses every time a command is executed, P3.5 is an user-triggerable outgoing TTL signal, and P3.6 is for incoming TTL signals. Incoming TTL signals must be stepped down to 3.3V to not damage the system. Care must be taken when selecting what should be connected where.

### Connections for MCU 2

| **Signal** | **Position on MCU** | **Position on PCB** | **Position on Relay Shield** |
| --- | --- | --- | --- |
| Cost LED1 | P6.0 | H6.1 | - |
| Cost LED2 | P6.1 | H6.2 | - |
| Cost LED3 | P6.2 | H6.3 | - |
| Cost LED4 | P6.3 | H6.4 | - |
| Trial Indicator LED | P6.4 | H6.5 | - |
| Low-Voltage Supply\* | 3V3 or 5V\* | H1.3 | - |
| Ground | GND | H1.4 | - |
| SYNC | P3.5 or P3.6\*\*\* | H2.4 | - |
| ACK | P3.0\*\*\* | H2.5 | - |
| Trigger Signal for Relay 1 | P3.1 | H3.5 | - |
| Trigger Signal for Relay 2 | P3.2 | H3.6 | - |
| Trigger Signal for Relay 3 | P3.7 | H3.7 | - |
| Trigger Signal for Relay 4 | P3.4 | H3.8 | - |
| MCU to Relay 1 | - | H4.5 | IN5 |
| MCU to Relay 2 | - | H4.6 | IN6 |
| MCU to Relay 3 | - | H4.7 | IN7 |
| MCU to Relay 4 | - | H4.8 | IN8 |
| Relay VCC | - | H4.9 | VCC |
| Relay GND | - | H4.10 | GND |
| Relay 5 to Valve 1 | - | CONN8.1 | Relay 5, Normally Open Terminal |
| Relay 6 to Valve 2 | - | CONN8.2 | Relay 6, Normally Open Terminal |
| Relay 7 to Valve 3 | - | CONN8.3 | Relay 7, Normally Open Terminal |
| Relay 8 to Valve 4 | - | CONN8.4 | Relay 8, Normally Open Terminal |
| Common High-voltage supply for valves 1 - 4 | - | CONN10.1-4\*\* | Relay 5-8, COM Terminal |

\* Supplying low-voltage power to the PCB serves to route the voltage and ground to the relay shield. Make sure you are providing enough power to the relay shield and that the jumpers on JP5 are configured in the correct way to carry that voltage. The relay shield may be able to operate on 3.3V, however 5V is recommended.

\*\* Connector 10 simply supplies voltage to the relay. The COM terminal is shorted with the Normally Open terminal when the relay is activated. The order in which the pins on the connector are connected to each relay’s COM terminal has no effect on the function of the system.

\*\*\* This connection depends on the particular use-case scenario. P3.0 is the outgoing ACK signal that pulses every time a command is executed, P3.5 is an user-triggerable outgoing TTL signal, and P3.6 is for incoming TTL signals. Incoming TTL signals must be stepped down to 3.3V to not damage the system.