IoP hardware infrastructure

thoughts on form and function

20180708

Outline

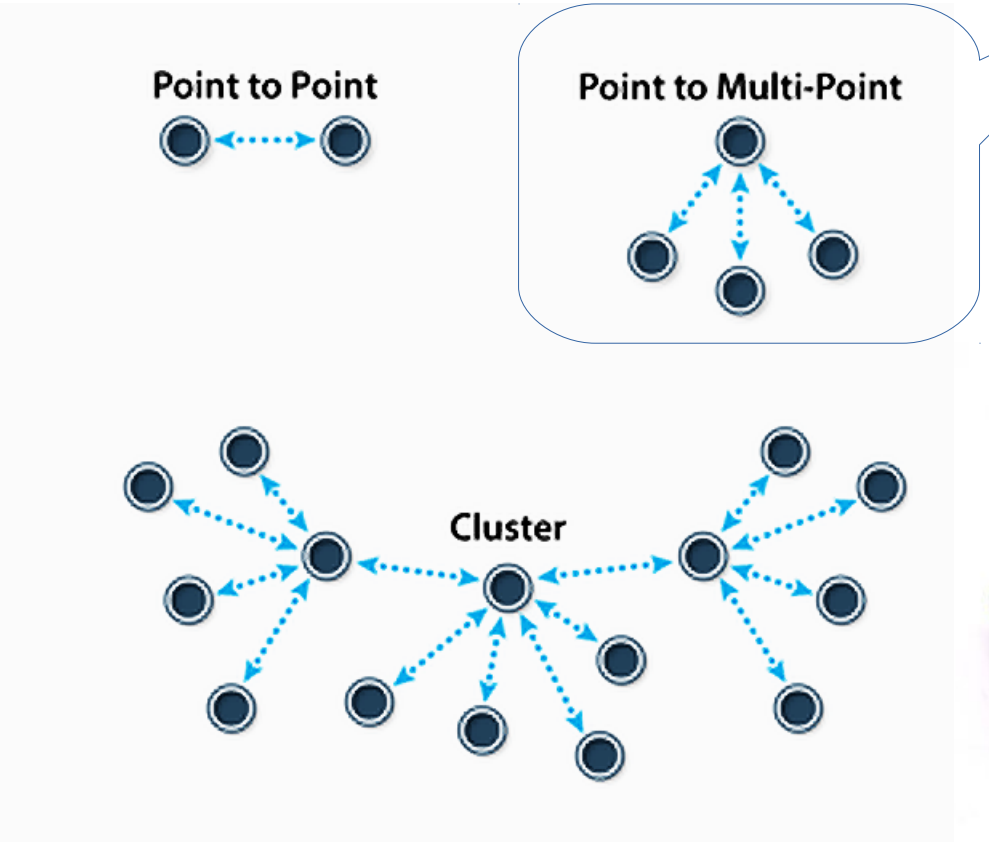
distribution topologies

usage scenarios and trade-offs

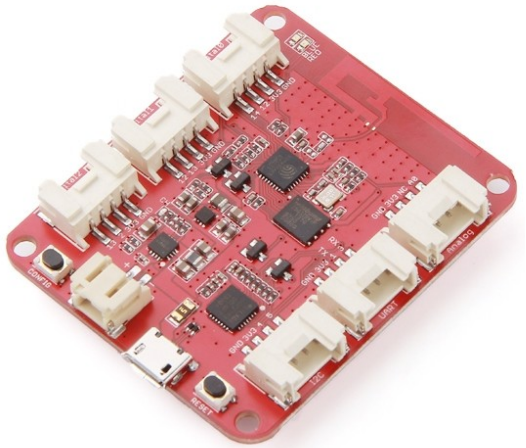
modular building block: mux8-1B

Distribution – sensor power / data return

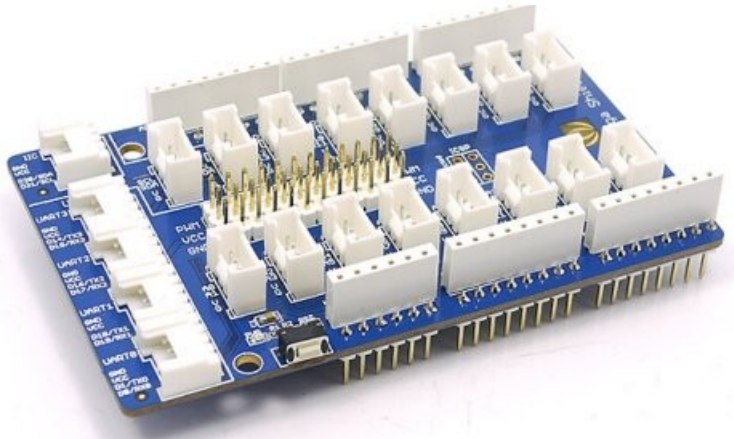
- scenarios vary with number of plants
- sensors with bus interface (I2C) can have daisy-chain cable; vs. analog output that need star / point-multipoint configuration to multiplexer



Seeed Studio Wio Link - ESP8266



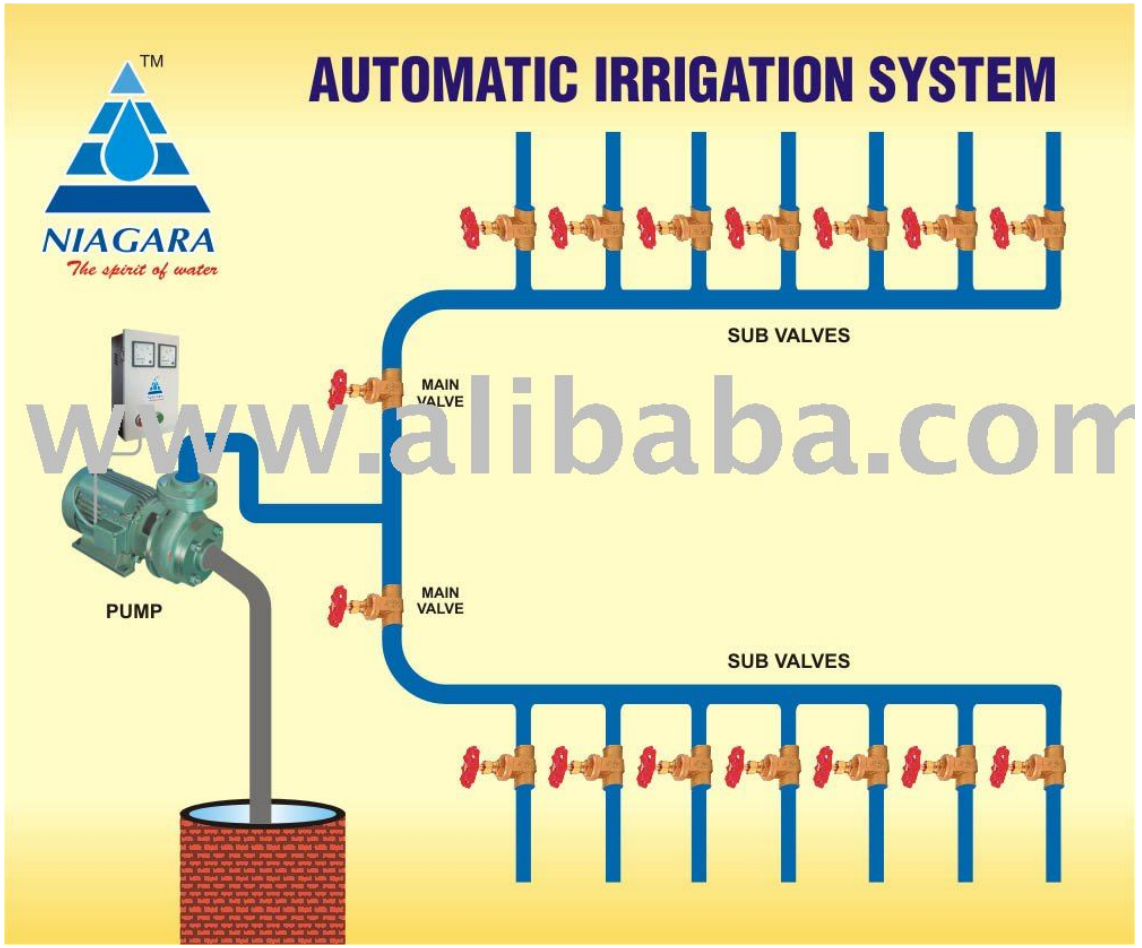
Grove - Mega Shield v1.2



Daisychaining?

Distribution – water

- water distribution topology depends upon availability / price / feasibility of 2-way (solenoid valve) vs. N-way diverters (motor actuated)



SAILFLO 12V Normally Open Electric Control Solenoid

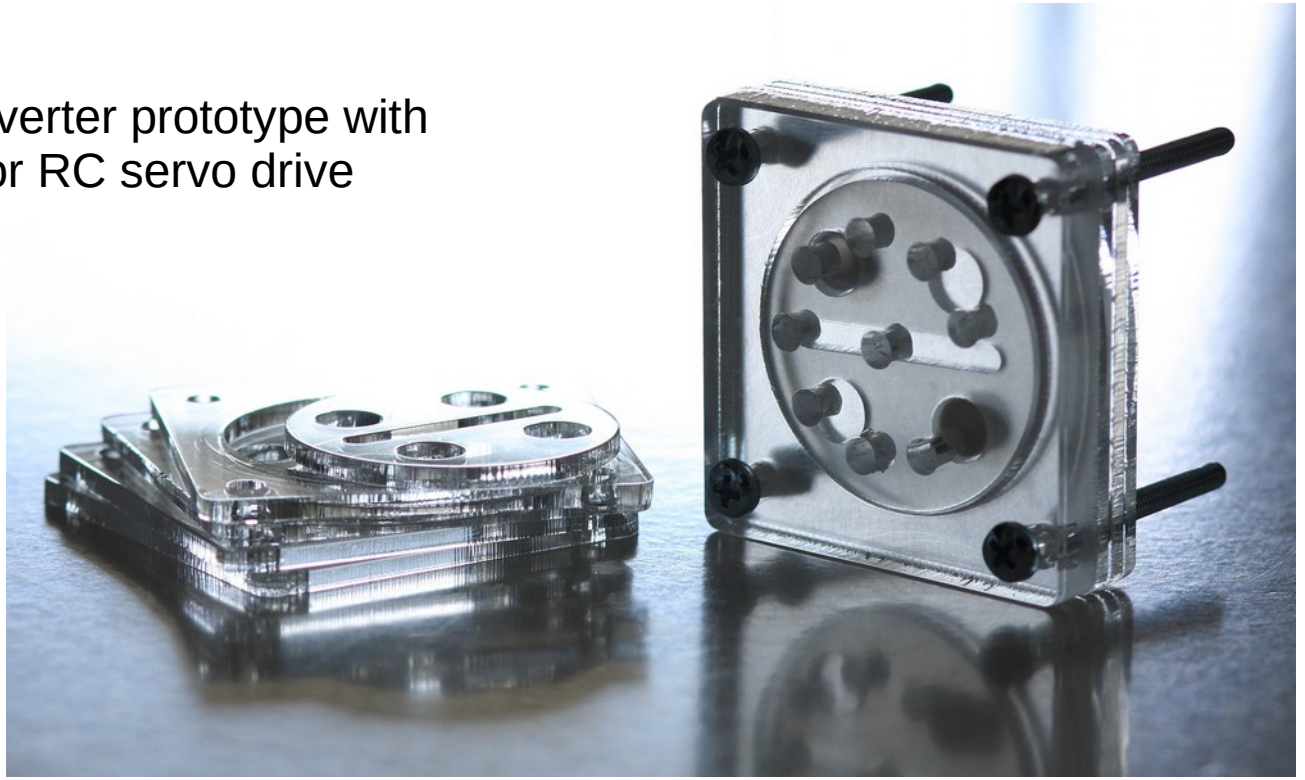
US $2.47 / piece

(115) | Orders (207)

Distribution – water

- N-way diverters (motor actuated): bistable low power operation, break-even for single valve vs. RC servos (2-4 ports) or stepper motors (8-16 ports) make N-way arrangements a matter of getting working plastic parts designed and manufactured cheaply.
- consider SLA printing 8-port tube manifolds (Shapeways), cheaper than buying bags of Y fittings from china but more compact, combine with RC servo / stepper pinch valve assembly

laser cut 8-way diverter prototype with magnetic clutch for RC servo drive



Scenarios and Practicability

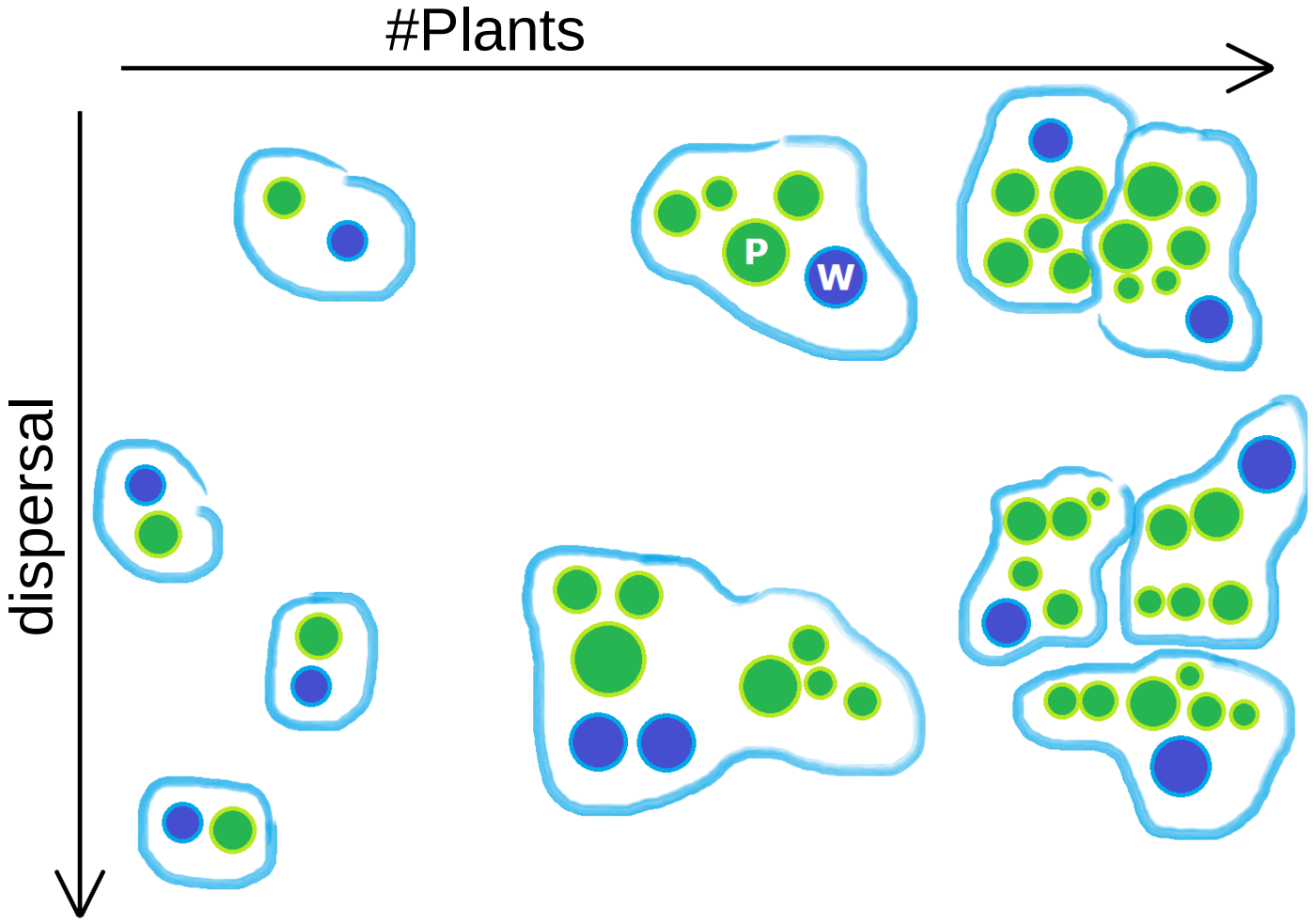
single-plant solution is either stripped down or comes with unused functionality

many-plant solution: need to figure out the basic building blocks to achieve modularity, flexibility – possibly also works for single plants

P:
plant (pot or root mass in container)

W:
water reservoir with pump

blue lines:
watering groups



Scenarios and Practicability

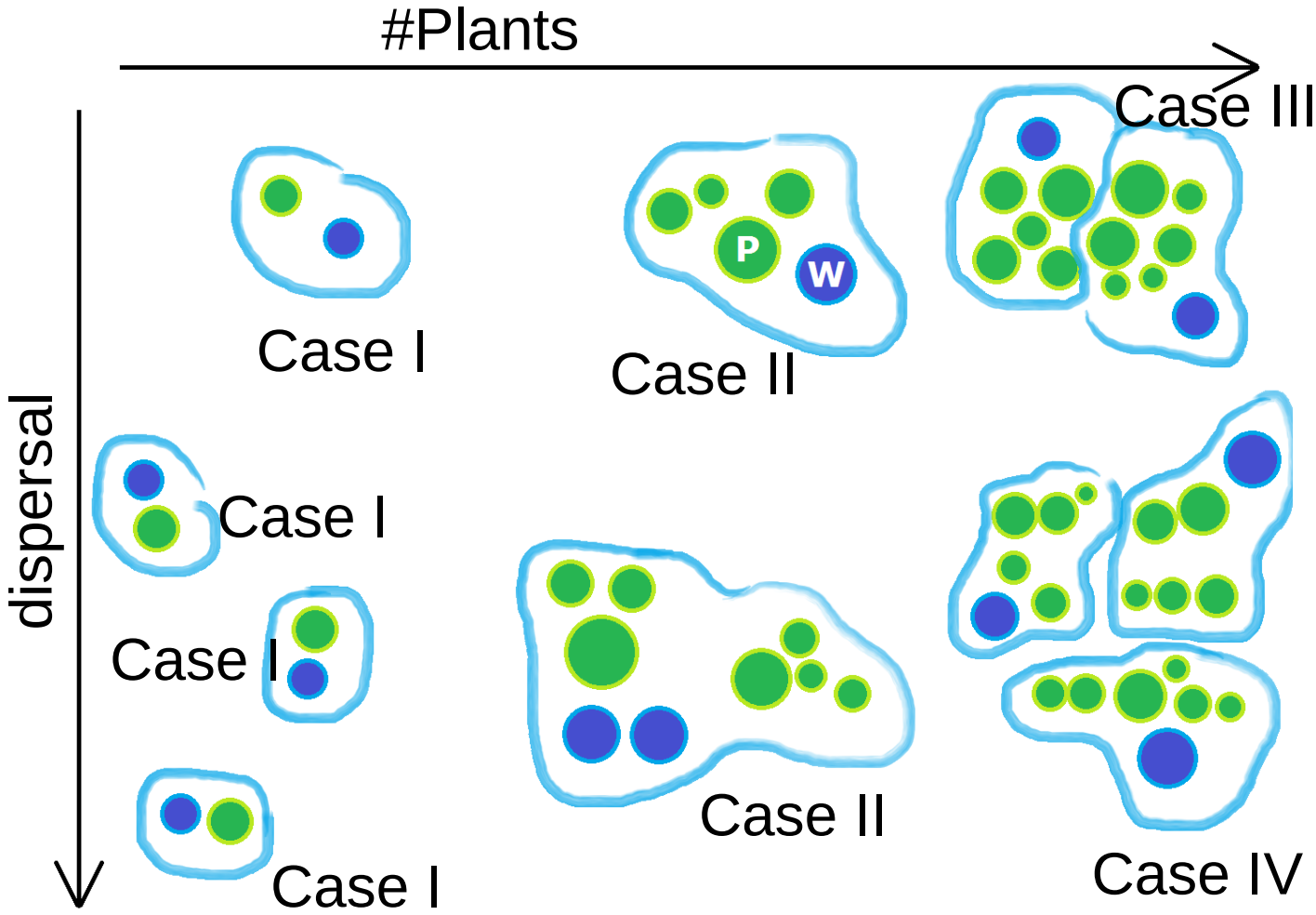
single-plant setup as a typical scenario not excluded

clusters of plants (also spatially separate): mostly scenarios for one controller shown, no shared water reservoirs → multi-controller setup, just more of the same

P:
plant (pot or root mass in container)

W:
water reservoir with pump

blue lines:
watering groups



Scenarios and Practicability

strategy seems to be:

- focus on multiple-plant setup, make cheap enough so one can have a few around the house re-purposed for single plants
- don’t bundle controller with multiplexer, reservoir control and power supply
- minimize overhead for connection to controller PCB (e.g. provide dedicated convenience header for an ESP8266 board)
- reservoir electronics: essentially a pump driver / DCDC converter, at most add some level gauging / weighing capability
- multiple reservoirs allow scaling, improve flexibility
- don’t merge reservoir and battery electronics; controller board may already be able to supply the setup, multiple reservoirs don’t need redundant supplies

Case I - single plant, single location

reservoir: 1x 1-3L

hardware: preferably single PCB, single controller (ESP8266?)

enclosure: integrated, aesthetically pleasing, inconspicuous

power: battery powered / power supply

flexibility and extensibility: more than one sensor desirable, rest optional

Case II – a few plants, multiple locations

reservoir: 1-2x 3-5L

hardware: single multiplexer with piggybacked SoC

enclosure: distribution / muxing separate from bulky reservoirs

power: battery+solar powered / power supply

flexibility and extensibility: many sensors, many watering positions

Case III - many plants, clustered

reservoir: 1-2x 3-5L or 1x 10-20L tank with scale

hardware: >1 mux, piggybacked SoC on first mux, cascaded

enclosure: distribution / muxing separate from bulky reservoirs

power: battery+solar powered / power supply

flexibility and extensibility: many sensors, many watering positions, high water manifold port count (8-16x)

Case IV - many plants, delocalized

reservoir: 2x 3-5L or 1x 10-20L tank with scale

hardware: >1 mux, piggybacked SoC on first mux, cascaded

enclosure: distribution / muxing separate from bulky reservoirs

power: battery+solar powered / power supply

flexibility and extensibility: many sensors, many watering positions, preference for lower water manifold and sensor mux port count to reduce tubing and cable bundles, 4-6x seems attractive

primary functions (w/o controller / sensors)

1) dispense water in one or several locations
    1) 5+ L reservoir (ideally with level meter / gauging)
    2) (peristaltic) pump with housing (mitigate acoustic noise)
    3) route water
2) sample analog values and acquire data from sensors
    1) multiplexing for processor on-chip ADC, provisions for ext ADC
    2) serial interface(s) – I2C, SPI?
3) easily interface with a microcontroller/SoC/SoM
    1) power
    2) interfaces
    3) convenience socket
4) ideally do some energy harvesting as well (PV)

mux8-1B

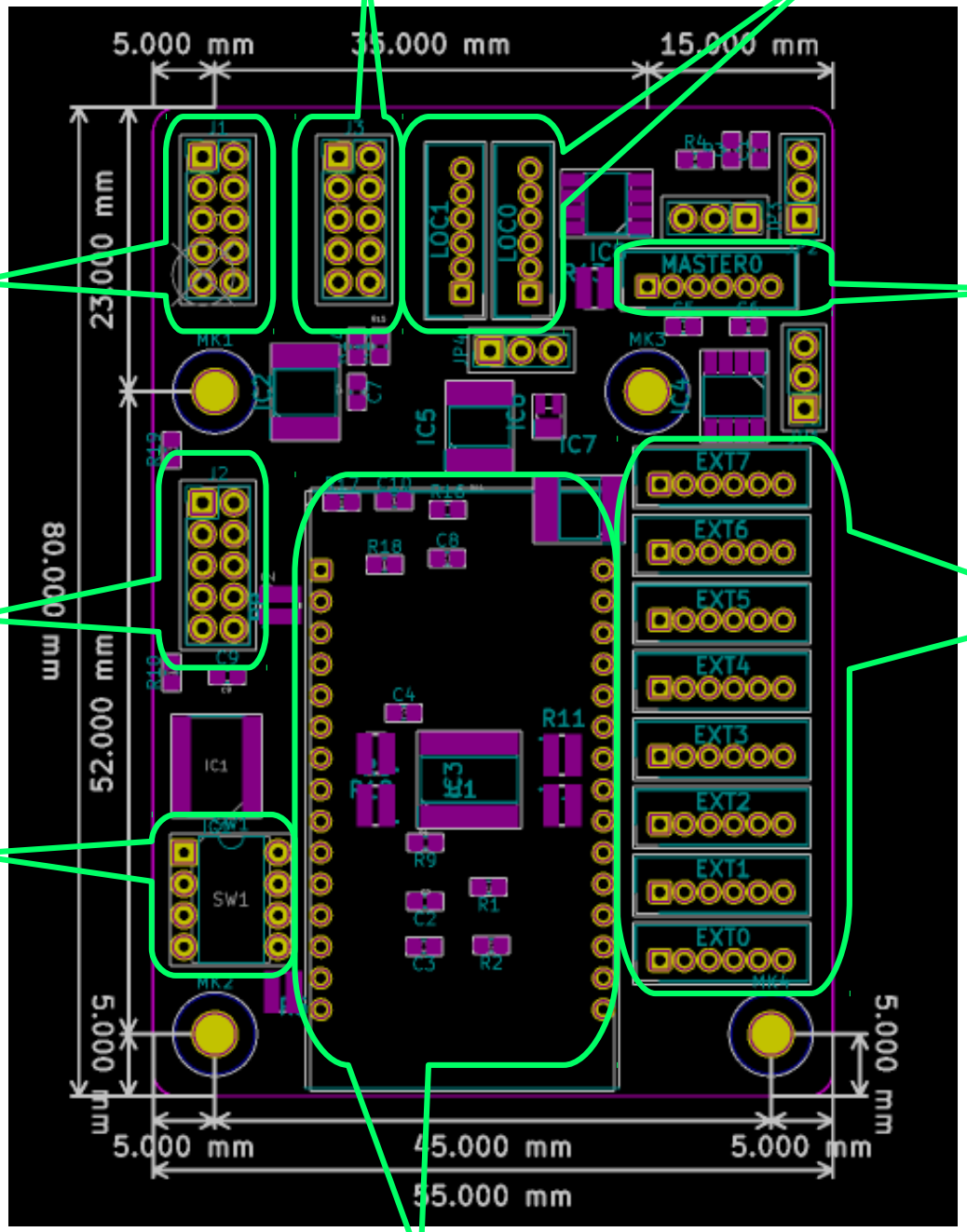
8 local analog ports (1-2 shared with local connectors)

local connectors for I2C periphery that occurs only once (RTC, ext. ADC, display, …), continuous or switched power independent from extension ports

4-5 NMOS switches for devices running off VBAT

master port is
- power in/out
- muxed analog out
- or digital control out

convenience control for pump DCDC
or just upstream connector for cascading



5+5 GPIOs (partially shared with NMOS switch group)

8 extension ports: each
1x dedicated I2C IF
1x analog input

the bank of extension ports has switched VBAT and switched 3.3Vreg power

configurable device address allows up to 8 layers of daisychaining and thus thousands of sensors without address collisions (e.g. 4 sensors and 4 more mux8-1B per board = over 21000 sensors… more than you'll ever need :)

convenience socket for an ESP8266 NodeMCU v2 w/ USB power → VBAT

mux8-1B

multiplexer module scenarios:

1) one plant, two analog soil moisture sensors, one temperature + humidity sensor, one RTC: use NodeMCUv2 in dedicated socket, connect pump to simple DCDC and hook up to MASTER0, hook up BME280 and RTC to local ports, connect sensors to extension ports.

2) multiple plants: e.g. use 2 mux-1B where one has the NodeMCUv2 and the other is connected to an extension port of the first one via its MASTER0. Connect a valve controller and sensors to remaining extension ports.

Digital reservoir control: When more than one reservoir is needed, I2C reservoir slave devices should be implemented and connected to the extension ports.

External SoC: the root mux8-1B is yet another multiplexer connected to and supplied from an external SoC board, MASTER0 provides I2C and analog out.

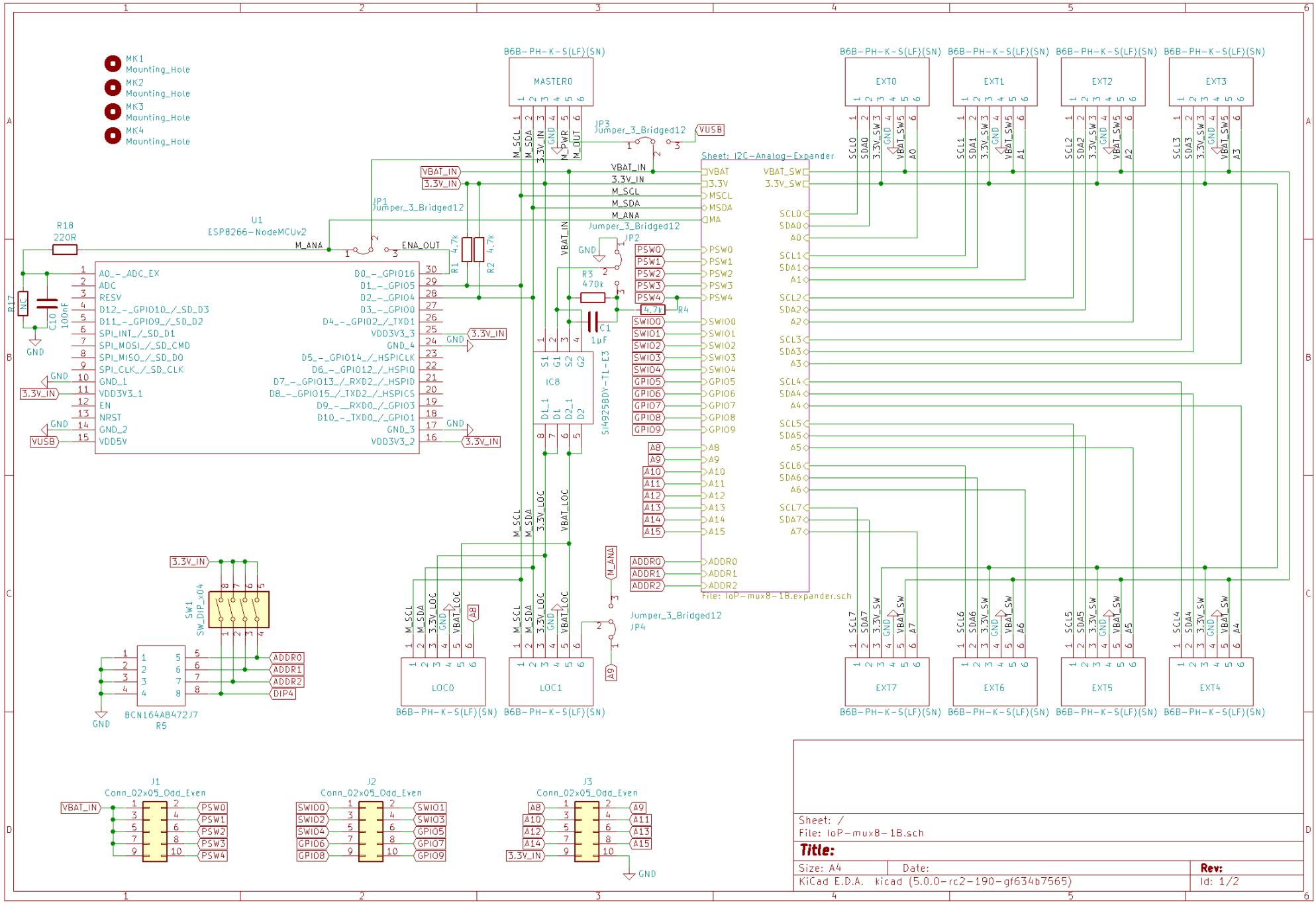
mux8-1B

supply considerations:

using the convenience socket for NodeMCUv2, the 3.3V is supplied by the add-on board LDO and powered via its micro USB port.

A dedicated supply module comprising LiIon battery protection, USB charger, MPPT photovoltaic charger, high efficiency 3.3V DCDC converter and connector for the pump boost converter located in the same housing is thought to cover the needs for few-plant systems with a single reservoir.

mux8-1B


MK1 Mounting_Hole
MK2 Mounting_Hole
MK3 Mounting_Hole
MK4 Mounting_Hole
B6B-PH-K-S(LF)(SN)
MASTER0
EXT0
EXT1
EXT2
EXT3
EXT4
EXT5
EXT6
EXT7
LOC0
LOC1
JP1 Jumper_3_Bridged12
JP2 Jumper_3_Bridged12
JP3 Jumper_3_Bridged12
JP4 Jumper_3_Bridged12
U1
ESP8266-NodeMCUv2
R18 220R
R1 4.7k
R2 4.7k
R3 470k
R4 4.7k
C1 1µF
C10 100nF
R17 NC
IC8
SI4925BDY-T1-E3
SW1 SW_DIP_x04
R5 BCN164AB472J7
J1 Conn_02x05_Odd_Even
J2 Conn_02x05_Odd_Even
J3 Conn_02x05_Odd_Even
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VBAT_IN
3.3V_IN
M_SCL
M_SDA
M_ANA
ENA_OUT
VUSB
GND
PSW0
PSW1
PSW2
PSW3
PSW4
SWI00
SWI01
SWI02
SWI03
SWI04
GPIO5
GPIO6
GPIO7
GPIO8
GPIO9
ADDR0
ADDR1
ADDR2
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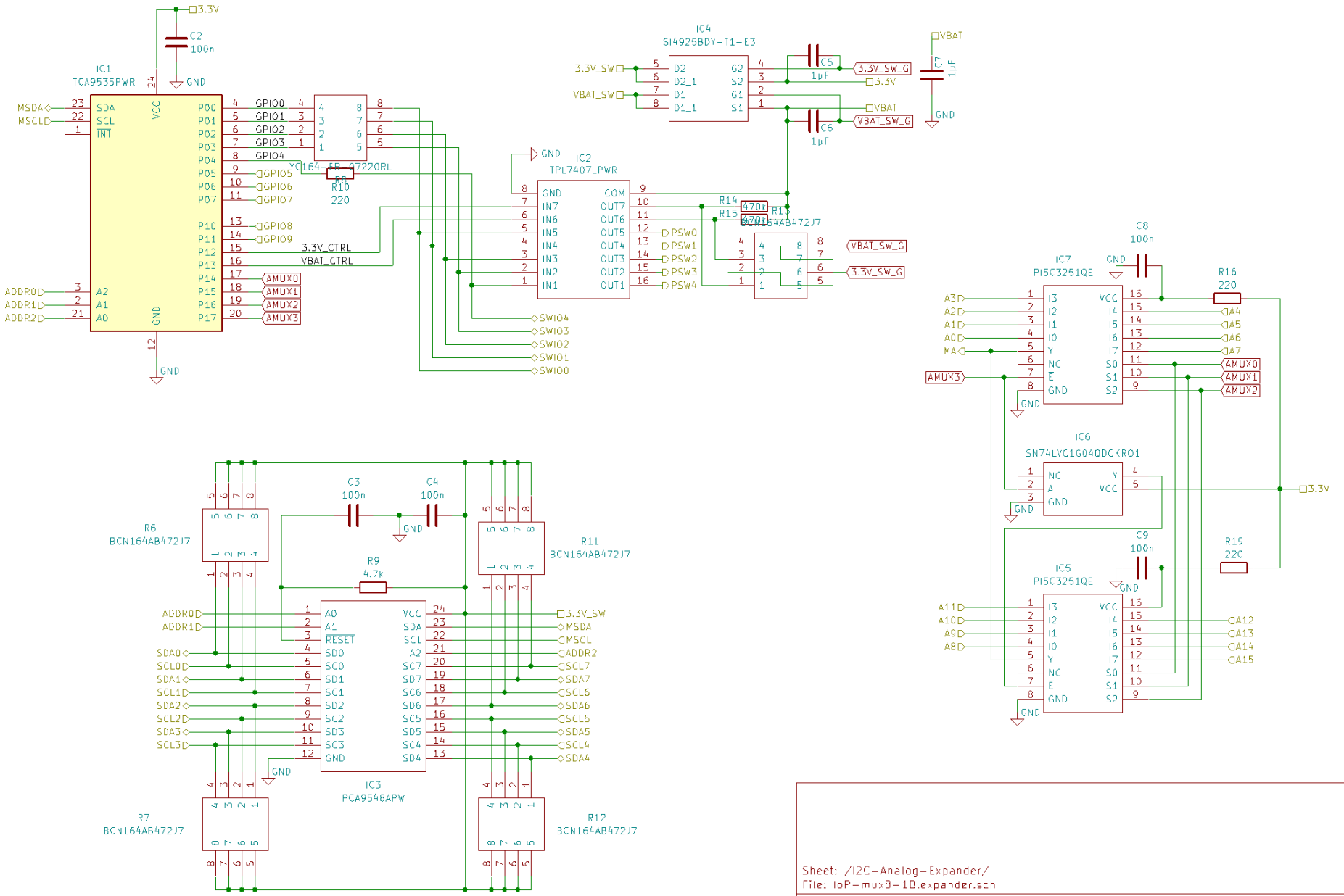
mux8-1B



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