NOTE: The LM334 devices must receive 5 VDC or greater due to their own operating voltage range. Their functional range will be substantially limited if powered by the 3 or 3.3 VDC of many MCUs. Provide a dedicated positive power supply to them if 5 VDC is not otherwise available, then carefully ensure the output levels from them are prevented from exceeding the input range of the remaining circuitry. Alternative: use non-LM334 legs (AKA "bare" legs) & adjust macros – POW/B will then connect +5V to DUT or R1

*NOTE: U5 only used for larger numbers of DPots, useful with "bare" legs or part availability limitations. U5's outputs drive DPot CS lines. U4 only used for even larger numbers of DPots. U4's outputs drive E1 or E2 of U5, U6, U7, etc. See sketch preprocessor macros and comments for more complete pin assignments and requirements.
U5 pin E1/E2 may instead be driven by an MCU Digital Pin. Again, see sketch comments.

Electrodes_contacting_plant_leaf_surfaces

-LEAF-

Opt_SW

Twisted pair with optional 4-way switch inserted to flip polarity

(Switch wiring overlaps straight-through wiring for drawing purposes only. Do not wire both ways simultaneously, of course)

Unused_leaf

Off-board_coaxial_cable

J1
Conn_Coaxial

GNDA

NOTE: If convenient polarity flipping is desired, a 4-way house light switch may be placed in the electrode circuit between the electrodes and the coaxial cable, assuming you hook it up correctly.

U1
LM334Z

+5V

DPot1-LSB
MCP4162-502(0-5KΩ)

DPot1-MSBs...
MCP4162-104(0-100KΩ)

VCC VDD POW POB VSS SDI SDO SCK CS GNDD

NOTE: Additional matching MSB-level DPots are allowed in this POW-POB loop. Only a single LSB-level Dpot is allowed which must be of a resistance lower than or equal to MSB-level DPots. Pins 5 and 6 are interchangeable, so the actual connect order will be layout-dependent. SDO currently unused by sketch to save MCU pins.

NOTE: Capacitor banks 1 & 2 each consist of a 2-10 µF tantalum plus a low-ESR sub-µF capacitor which gets located in direct-as-practical path between Vcc of one device to GND of the other device. NOT SHOWN: One decoupling capacitor bank of same values for all digital parts combined.

U4
74LV138 only needed with larger numbers of DPots

U5...
74LV138 only for large numbers of DPots

A0 A1 A2 E3 E2 E1 GND O0 O1 O2 O3 O4 O5 O6 O7

*See note

<Drives_DPot_CS_pins_when_required

<From_MCU_Digital_pins_alternate_method_to_DPot_CS_pins

<From_MCU_Digital_Pin[s]_driving_this-these_CS[s]

<From_MCU_Digital_Pin_driving_this_CS

<From_MCU_MOSI(to_SDI)_and_SCLK(to_SCK)

<From_MCU_Digital_Pin_driving_this_PD_SCK

>To_MCU_Digital_Pin_receiving_this_data

MCU
Some_Arduino_MCU

VIN 3V3 +5V
D0/RX D1/TX D2 D3 D4 D5 D6 D7 D8 D9 D10 D11 D12 D13
RESET IOREF AREF A0 A1 A2 A3 A4/SDA A5/SCL SDA SCL
GND GND GND

*See note

C2_bank
2.05 µF total

U3-A U3-B U3-C U3-D
IN_A IN_B IN_C IN_D Vdd+ Vss-

U3_AD8244ARMZ

C1_bank
2.05 µF total

ADC1
HX711, etc.

IN_A+ IN_A- D_VDD A_GND PD_SCK DOUT

U2
LM334Z

R1
1 MΩ

DPot2-LSB
MCP4162-502(0-5KΩ)

DPot2-MSBs...
MCP4162-104(0-100KΩ)

*See note for the above DPot set

DUT stem

Device Under Test (DUT)

NOTE: Unfortunately, the devices shown do not all share common data protocols except the DPots. Define the Digital Pin functions in preprocessor macros for all the disparate protocols. Thus, some flexibility remains for driving an additional device or two that may have inflexible pin assignments.

NOTE: Arduino also gets power rails and a serial connection to a computer

*NOTE FOR MCU ANALOG PINS: Low-numbered Analog Input pins are reserved for all existing DPOT-controlled leg outputs. Unused Analog Pins above them may be used to display additional plotter traces when so defined in preprocessor macros.

This system is shown using:
1 – LM334 bridge
1 – Uno Arduino
1 – HX711 24-bit ADC
1 – LSB DPot/leg
1 – MSB DPot/leg

Shown not being used:
2 – 74LV138; useful with high DPot count

Non-LM334 configuration options include bridged and single leg to replace or augment LM334 option.

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File: GWAAM-Sea Training Aid.sch

Title: GWAAMC Training Aid – System Diagram

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