7-channel multi-tester

This simple device features an Ohm-meter, a diode-meter and a voltmeter with the (+) and (-) leads switched to several pin positions of a built-in DB-15 and HIROSE HR10A-10R-12P(73) connectors. The switching is done automatically by implementing seven internal relays controlled by a ESP32 device.

The operation guide for each function is listed below.

OHM-METER

The resistance referenced to DRAIN pin is measured sequentially for Hirose pins 9, 11 and 12. The operating range for this function is the interval [0, 17.11] kΩ. The following illustration shows how this measurement is performed.

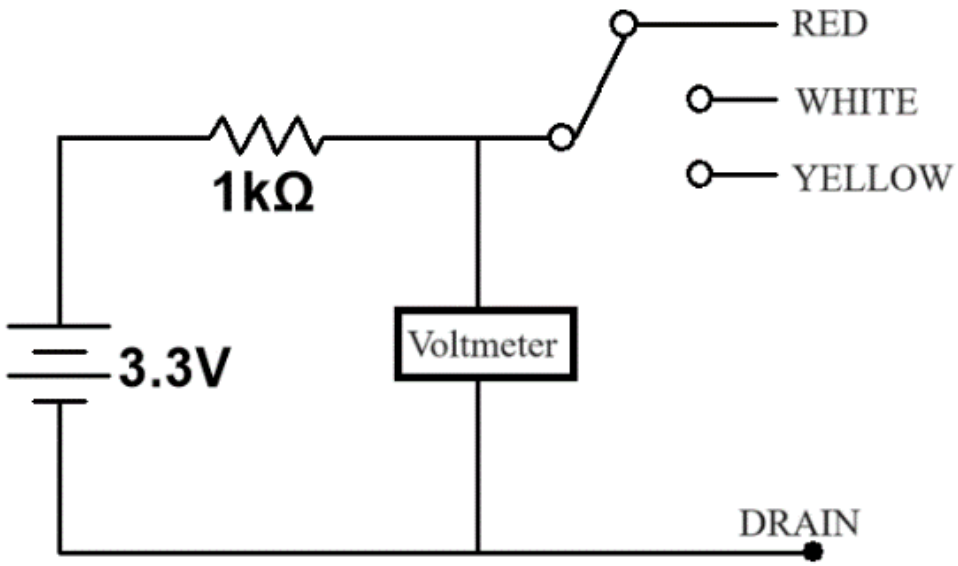


Figure 1. Schematic of the connections during the OHM-METER operation. The resistance is calculated through Ohm's Law using the indicated measured voltage.

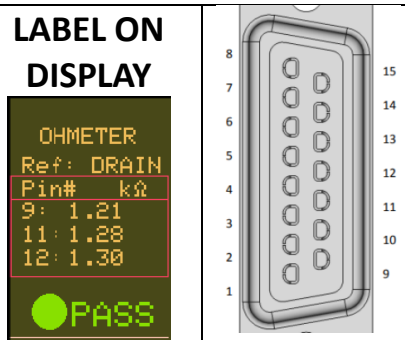
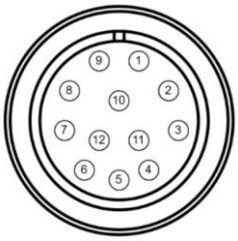
LABEL ON DISPLAY	 DB15 -PIN	 HIROSE PIN	PIN LABEL
PIN#9	5	9	RED /VCC /+CE_V
	13	10	DRAIN
PIN#11	6, 7	11	WHITE /CRYOGND /CRYOSTAT GND
	13	10	DRAIN
PIN#12	14	12	YELLOW/VEE/+CE_V_RET
	13	10	DRAIN

Table 1 Correspondence between the displayed results and the connector pins. For Example when measuring PIN#12, the instrument shows the resistance between pins "14"(+) and "13"(-) of the DB-15 connector as well as the resistance between pins "12" and "10" of the Hirose connector.

DIODE-METER

The diode-meter is implemented by connecting in series an internal 3.3 V power supply, an internal 1 kΩ resistor and the device connected to the pins under test. The voltage drop between the pins of each channel is measured sequentially for channels CH1 to CH4. The operating range for this function is the interval [0, 3090] mV. The following illustrations show how this measurement is performed.

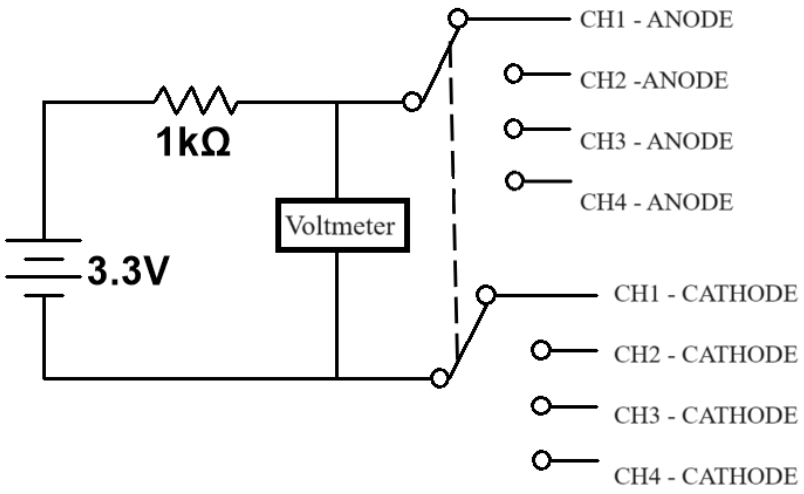


Figure 2 Schematic of the connections during the DIODE-METER operation. The voltage drop is calculated using the indicated measured voltage.

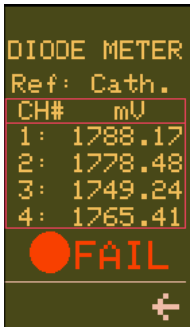
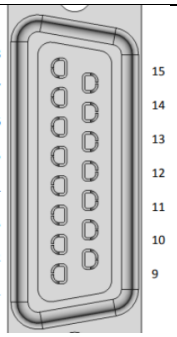
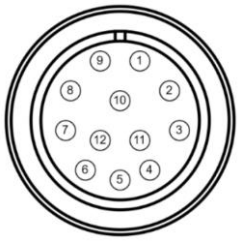
LABEL ON DISPLAY 	 DB15 -PIN	 HIROSE PIN	PIN LABEL
CH#1	1	1	CH1-Anode
	9	2	CH1-Cathode
CH#2	2	3	CH2-Anode
	10	4	CH2-Cathode
CH#3	3	5	CH3-Anode
	11	6	CH3-Cathode
CH#4	4	7	CH4-Anode
	12	8	CH4-Cathode

Table 2 Correspondence between the displayed results and the connector pins. For Example when measuring CH#3, the instrument shows the diode voltage between pins "3"(+) and "11"(-) of the DB-15 connector as well as the diode voltage between pins "5" and "6" of the Hirose connector.

VOLTMETER

The voltage meter is implemented by measuring the floating voltage between the anode and the cathode pins of each channel. The voltage is measured sequentially for channels CH1 to CH4. The operating range for this function is the interval [21.59, 430.8] mV. The following illustrations show how this measurement is performed.

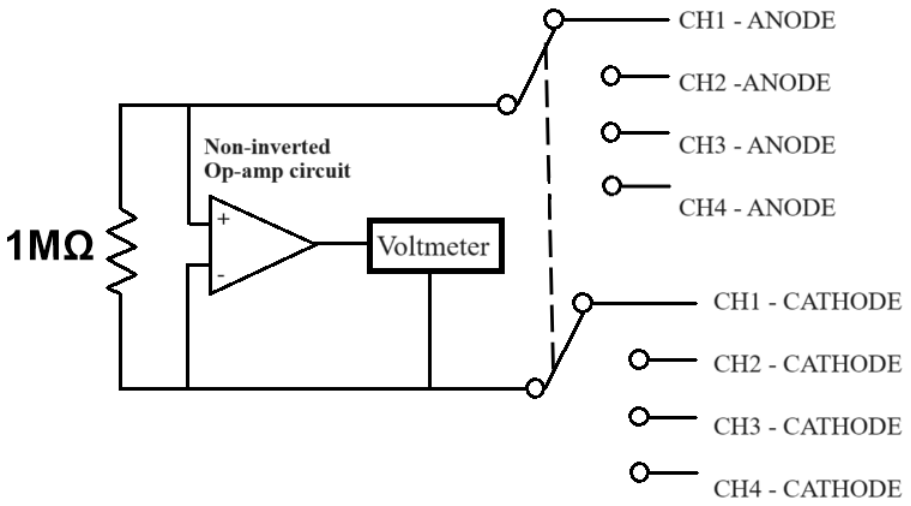
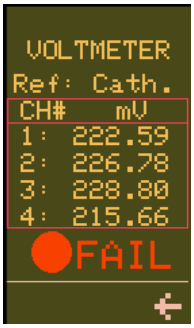
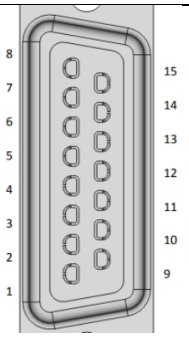
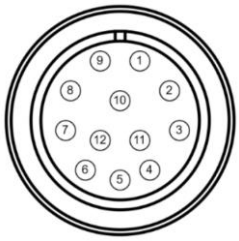


Figure 3 Schematic of the connections during the VOLTMETER operation. The voltage between the selected pins is coupled through an non-inverted operational amplifier circuit (resistors omitted). The input impedance is 1 MΩ.

LABEL ON DISPLAY 	 DB15 -PIN	 HIROSE PIN	PIN LABEL
CH#1	1	1	CH1-Anode
	9	2	CH1-Cathode
CH#2	2	3	CH2-Anode
	10	4	CH2-Cathode
CH#3	3	5	CH3-Anode
	11	6	CH3-Cathode
CH#4	4	7	CH4-Anode
	12	8	CH4-Cathode

INTERVALS OF ACCEPTANCE

For each function, at the end of the test, a visual indicator prompts the message **FAIL** or **PASS** if all the measured values are inside (**PASS**) or outside (**FAIL**) the interval listed in the following table.

FUNCTION	LOWER LIMIT TO PASS	HIGHER LIMIT TO PASS
Ohm-meter	0 kΩ	3.2 kΩ
Diode-meter	100 mV	380 mV
Voltmeter	300 mV	3300mV

Table 3. Interval of acceptance for all the functions of the instruments.

Note: If you need to change the intervals of acceptance, the file (limits.C) inside the Arduino Project has to be changed and the ESP32 reprogrammed.

ERROR OF THE MEASUREMENTS

All the voltages used in the results calculation were calibrated using a UNI-T UT61C multimeter and 12 bit DAC MCP4725DAC. The calibration was saved in the Look Up Table (LUT) located in the Arduino project (file

LUT_ADC.C). The voltage measurement is then obtained by reading the corresponding analog port (ports 27 and 26 of the ESP32 board) and converting the 12 bit value to voltage using the LUT.

The error between the multimeter value and the internal ESP32 analog value is computed for all the 4095 possible input voltages of the ESP32 ADC. The results are shown in the plots below:

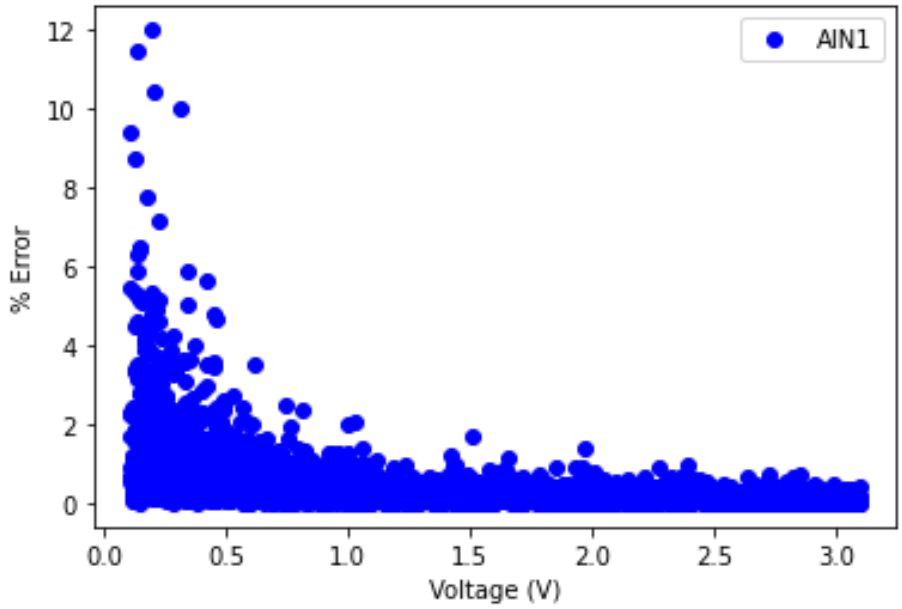


Figure 4. Error percentage for the measured voltage using the port #27 of the internal ESP32 board.

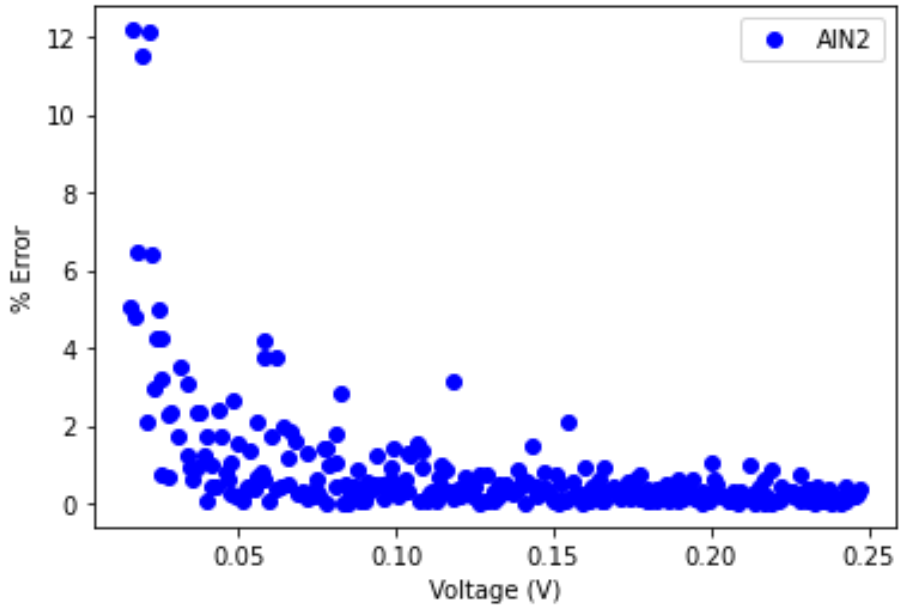


Figure 5. Error percentage for the measured voltage using the port #26 of the internal ESP32 board.

Controller Board used: LILYGO® TTGO T-Display ESP32 Development Board

Internal battery: Model 523450 3.7 V / 1000mAh Li Battery (To charge it, please turn ON the instrument first).

Firmware version: v1.3

Date: 09/11/2023

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Github of the project (in progress):

Github of the project (under construction): https://github.com/GICM-UdeA/seven-ch-multimeter