MeasureDAQ™ User Guide

Analog I/O, Digital I/O, with Integrated Relays and 24VDC Power Supply

Warranty

RT Automation warrants to the original purchaser that its products and any supplied component parts thereof, will be free from defects in workmanship and materials for a period of twelve (12) months from the date of purchase. We will, without charge, repair or replace (at OUR option) defective product or component parts.

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. RT Automation shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. If this exclusion provision is not acceptable then we require that you return the unit to us for a full refund within the first 30 days of purchase.

This warranty gives you specific rights and you may have other rights, which vary from state-to-state.

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I.   Introduction

Welcome to the MeasureDAQ™ User Guide. The User Guide will provide basic instructions on how to implement and use the Hardware. Use of this software is subject to the End Users License Agreement (EULA) which is located on our website at www.MeasureDAQ.com.

II.   Introducing MeasureDAQ™

The MeasureDAQ™ PCBA is a USB 2.0 data acquisition board that provides the following features:

- STM32 microprocessor based DAQ system
- Two 12 bit calibrated Analog Outputs (0-10VDC)
- Four 16 bit calibrated Analog Inputs (0-10VDC), Single Ended
- Two Digital Inputs and two Digital Outpus
- Four Integrated Relays
- Precision 5VDC output (+/- 0.5% @ 50 mA and/or +/- 0.2% @ 5 mA) – useful for voltage divider circuits
- 24VDC Power Supply sourced by a 120VAC/60 Hz fused input power. Depending on the part number ordered – the power supply will be:
  - Mean Well IRM-15-24, 24VDC output @ 0.6 amps
  - Mean Well IRM-30-24, 24VDC output @ 1.3 amps
- USB 2.0 COMM channel
- Sampling rate is 10 Hz
- A ten (10) position two row one level terminal barrier may be installed directly on the board (not included)

The MeasureDAQ™ PCBA is housed in a 160 mm x 160 mm (190 mm including mounting flange) ABS (grey) plastic enclosure that is included with your purchase (see Section V for dimensions). Three (3) PG9 terminal glands are provided for input 120VAC power and DAQ input/output signals.
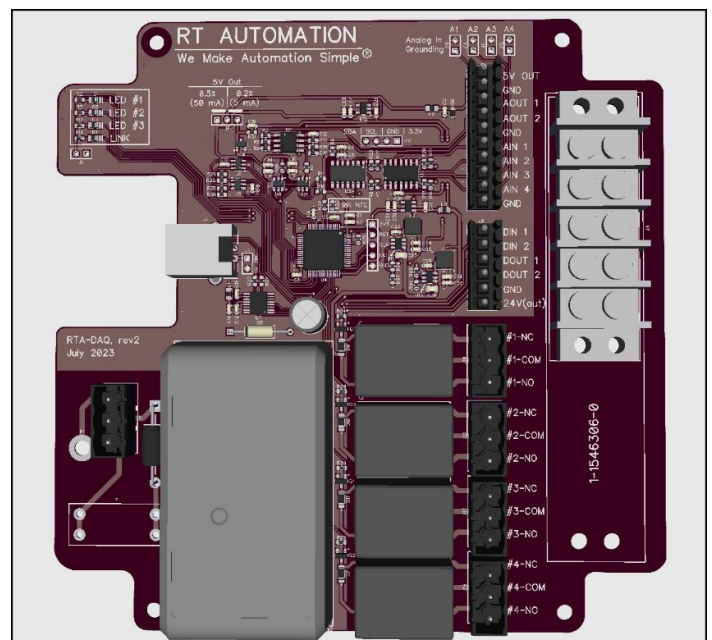
III. Functional Block Diagram

The device functions are illustrated in the block diagram illustrated below.
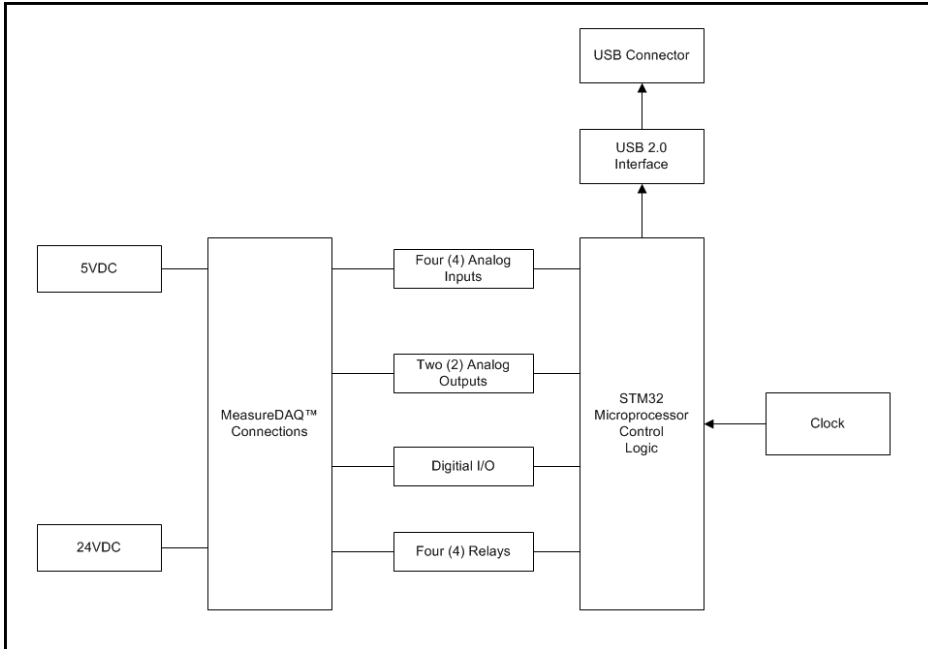
The terminal pinouts are provided per the figure below.
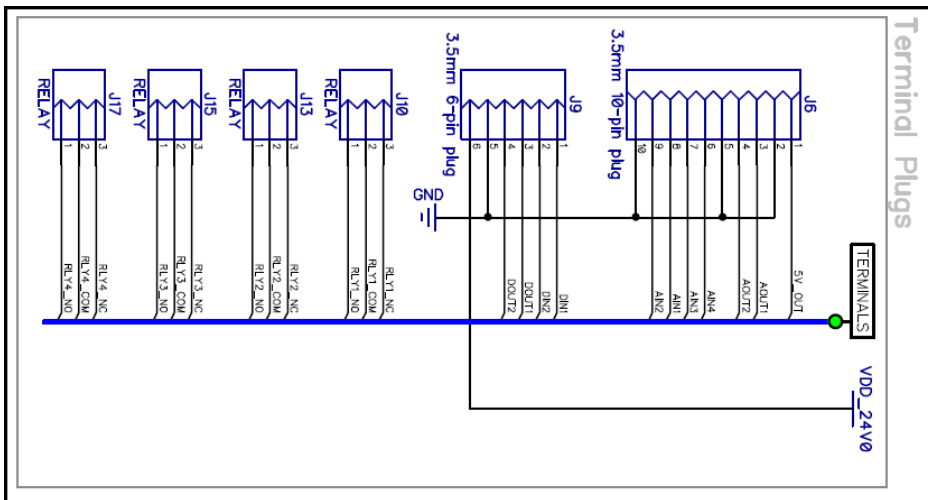
The connecting terminal blocks are as follow (one set provided installed in the PCBA)

- Amphenol TJ1011530000G Ten pin 3.5 mm spacing terminal block connector
- Amphenol TJ0611530000G Six pin 3.5 mm spacing terminal block connector
- Amphenol TJ0351560000G Three pin 5.08 mm spacing terminal block connector

IV.   Installng MeasureDAQ™

Making Connections

As with any electronic device you should take care when handling to avoid damage from static electricity. When making connections to the MeasureDAQ™ connection points, you should ground yourself using a wrist strap.

There is a significant technical (electrical) knowledge and requirement when making connections to the MeasureDAQ™ board. We make the assumption that the User is technical assitute and knows basic wiring knowledge involved with DAQ systems, input power, and relay systems.

Installing Software Device Driver

The MeasureDAQ™ board utilizes a FTDI PN FT230X chip for communcations.

- Our system supports the use of the Virtual COM Port (VCP) drivers AND D2XX DLL device drivers
  - The VCP driver emulates a standard PC serial port such that the USB device may be communicated with as a standard RS232 device.
  - The use of the D2XX driver allows direct access to a USB device via a DLL interface
- We provide the communication standard in Section VII of this document.
- We also provide a demo program that should connect and allow you to execute communications with your DAQ board.
- We provide sample code that illustrates COMM with the MeasureDAQ™ board
- We only support the Windows O/S. We understand that there are other O/S but we do not have any expertise in these systems.

You may download the latest FTDI driver directly from the FTDI website:
https://ftdichip.com/drivers/vcp-drivers/

You may also download the FTDI VCP driver from the MeasureDAQ website as well. We provide the latest FTDI driver supporting Windows O/S 64 bit only.
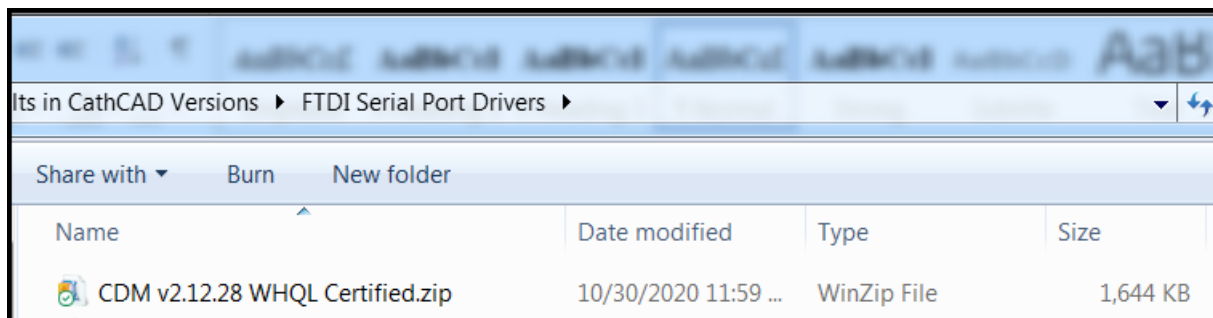
Installing the Hardware

After installing the Software driver (FTDI VCOM driver) you may connect the board to your Windows based computer.

- Connect the MeasureDAQ™ to an available USB port on the computer running the Windows Operating System.
- Connect the other end of the cable to the USB 2.0B connector on the device.
- Connect the 120VAC to the MeasureDAQ™ board via the integrated (supplied) power cord.

There is a significant advantage of providing 120VAC to the DAQ boards.
- This power supply provides power to the Mean Well 24VDC power supply mounted on the DAQ board.
- This power directly provides power to the DAQ board.
- It also provides a 24VDC output pin that may be used by the User for multiple purposes.

This system provides PLC type control for the User's application:
- The 24VDC source may be used (via the on-board relays) to control Tower Lights (PASS = Green, FAIL = Red).
- The 24VDC source may be used to energize coils used to control valves
- Many industrial pieces of equipment are equipped to interface to PLC systems (e.g. ATEQ F520 Leak Decay Testers). The MeasureDAQ™ board allows direct interfacing to this and other similar devices in a Windows O/S environment.
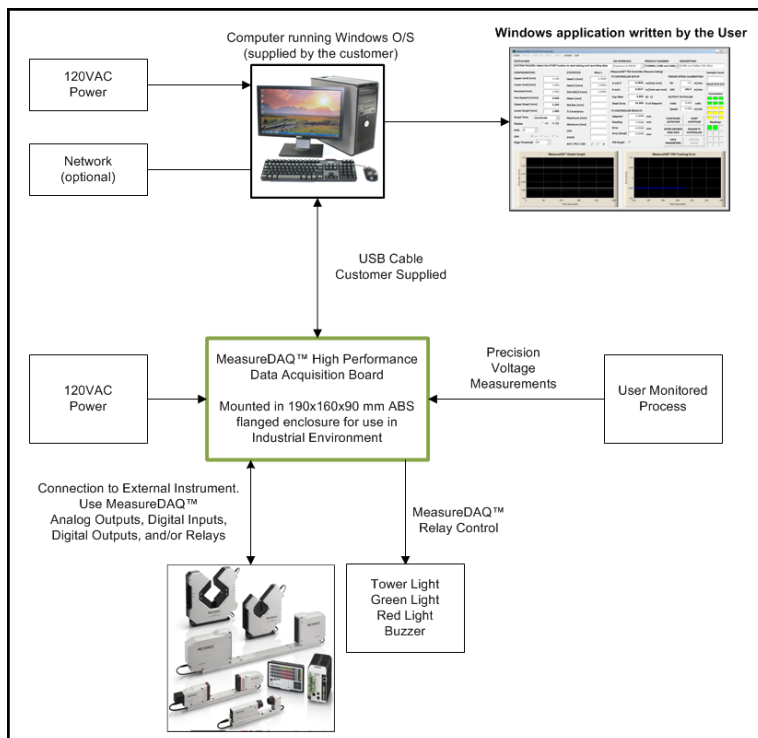
V.   Board Components

The overall board dimensions are provided per the following mechanical drawing (units = inches)
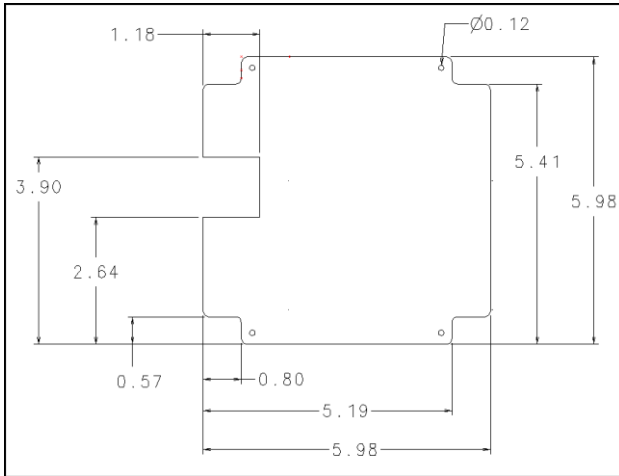
The MeasureDAQ™ PCBA is installed in an enclosure identified by CNXY PN M2-161609G. This enclosure has the following dimensions (units = mm). We provide logical penetrations in this enclosure supported by PG9 cable glands. This system does NOT provide any or meet any NEMA water proof standards.

VI.   Signal Connections

Analog Input

You may connect up to four (4) single-ended inputs to AIN1 – AIN4 and Analog Ground (AGND). The input voltage range is 0 to +10V. The figure below shows the analog input circuitry. The major circuitry blocks are as follows:

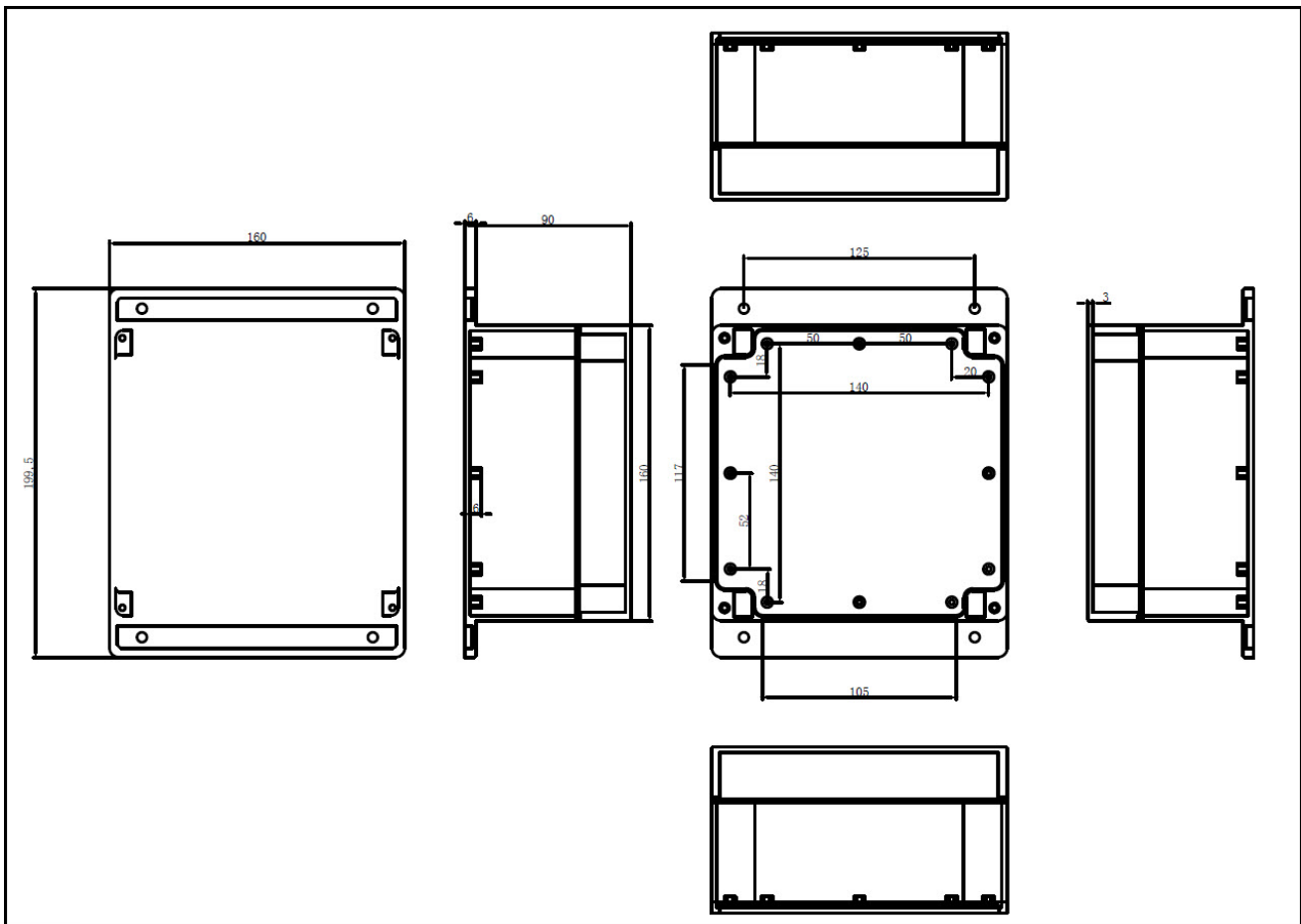- An instrumentation (precision) amplifier is provided individually for each analog input. This removes the common model signal and buffers the analog input signal before it is sampled by the analog to digital converter
- The ADC chip is a MCP3424 manufactured by Microchip. The ADC digitizes the AI signal by converting the analog voltage into a digital reading. The MCP3424 is set to 16 bit ADC resolution
- The ADC control circuitry sets the conversion rate of the ADC, sets the input configuration, drives the scanning sequence, and starts the acquisition sequence.
- The max sampling rate is 10 Hz
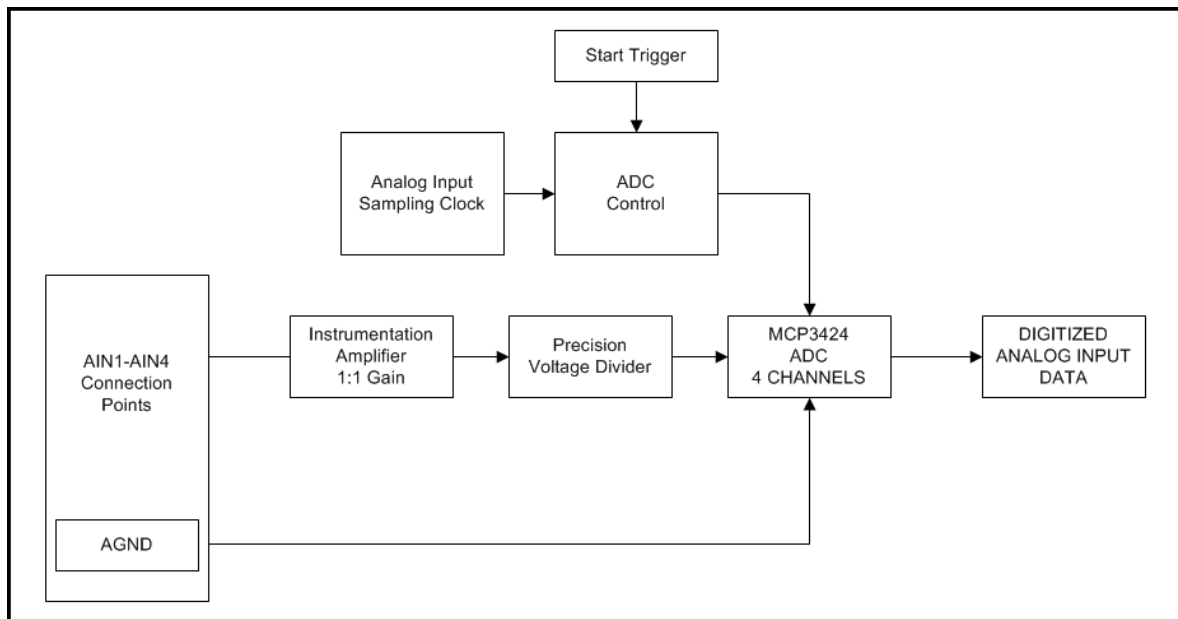
The Analog Inputs are configured for Single Ended (SE) input mode only. The input signal is referenced to analog ground (AGND) and delivered through two wires:

- Connect the wire carrying the signal to be measured (AIN1 – AIN4).
- Connect the second wire to AGND.
- The input range for single-ended mode is 0 to 10 V.

Analog Outputs

The MeasureDAQ™ board provides two (2) Analog Ouputs available from AOUT1-AOUT2 and AGND. These two outputs are capable of 0-10V at 12 bit resolution. The figure below provides the analog output circuitry. The major circuit blocks are as follows:

- Instrumentation Amplifier: The IA amplifies the analog signal to 0-10V range and ensures the driving capability for the external load
- MCP4725 Analog Output: MCP4725 is a single channel, 12-bit, voltage output Digital-to-Analog Converter with integrated EEPROM and an I2C Compatible Serial Interface. The MeasureDAQ™ unit includes two of these chips.
- AO Control: The DAC control sets the DAC data rate.

Analog output signals are referenced to AGND. Connect the loads between AOUT0 or AOUT1 and AGND as previously illustrated in the connection point diagram.
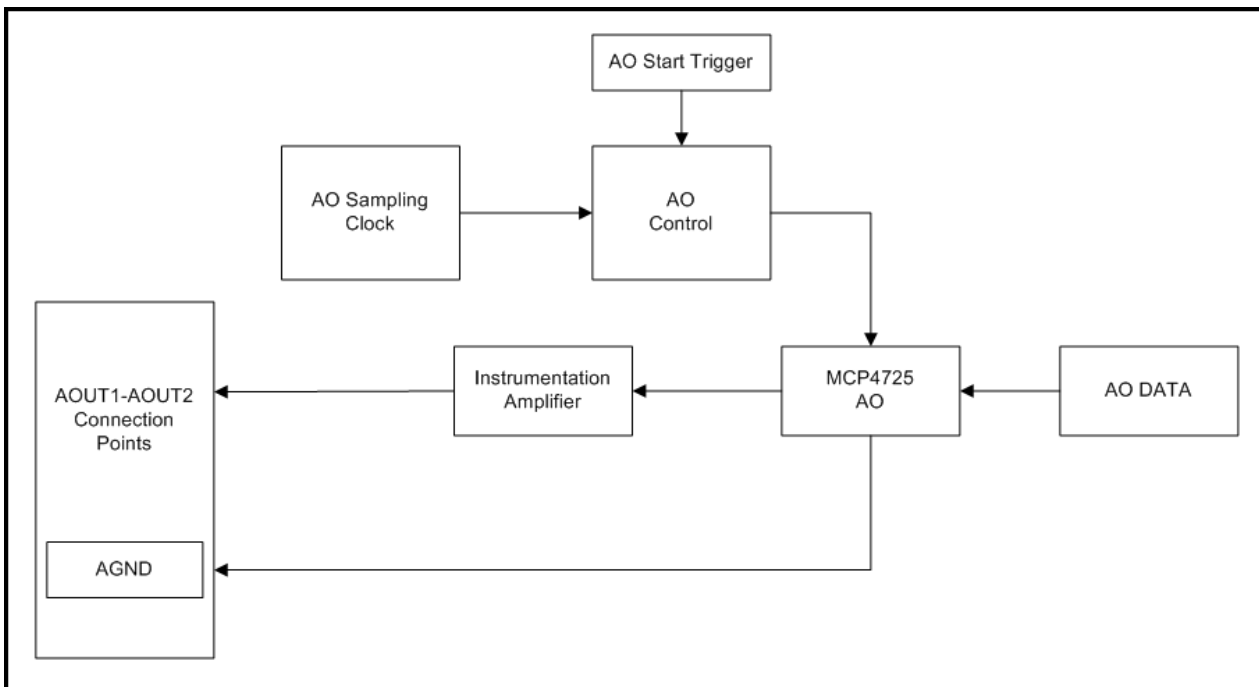
Digital Inputs and Outputs

The MeasureDAQ™ board provides two (2) Digital Inputs (DIN1 and DIN2) and two (2) Digital Outputs (DOUT1 nnd DOUT2) and a GND which is the ground reference signal for the Digital I/O.

- Each digital I/O line is predefined as an Input or Output and cannot be changed
- Digital Input voltages range from 0 V to 5V with the thresholds of 1.13V min (low) and 3.15 V max (high) – system is both 3.3V and 5V capable
- All Digital Outputs can sink/source up to 20 mA for direct drive applications
- All Digital Input lines include a weak pull-down resistor connected with a value of 47 kohms.
- All Digital I/O updates and samples are software paced at a maximum of 10 Hz
- All DIO include a 74HC2G17GV Schmitt trigger to transform slowing changing signals to sharply defined jitter-free signals.

DIO protection

To protect the DAQ device against overvoltage, undervoltage, and overcurrent conditions, as well as ESD events, avoid these fault conditions by using the following guidelines:
- The Digital Output lines should not be connected to any external signal source, ground signal, or power supply.
- Understand the current requirements of the load connected to the Digital Output lines. Do not exceed the specified current output limits of the DAQ device.
- Do not drive the Digital Inputs with voltages outside of its normal operating range. The DIO lines have a smaller operating range than the AI signals.
- Treat the DAQ device as you would treat any static-sensitive device. Always properly ground yourself and the equipment when handling the DAQ device or connecting to it.

RELAYS

The MeasureDAQ™ board includes four on-board relays, RLY1 – RLY4. The relays are Panasonic JS1-24V-F (the specifications for this part number apply to this DAQ device). The board includes a 24VDC output terminal bin that be directly wired to the Relays in a NO or NC state as required.

The relay circuit includes a 1N4148W Flyback Diode to minimize voltage spkes from arising when power is disconnected.
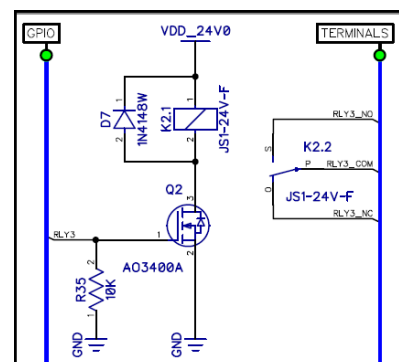
VII.   Communication Standard

The communication with the MeasureDAQ™ system is via the JSON (Javascript Object Notation) standard for representing structure data. JSON has now become a ubiquitous method of data exchange between systems.

Most modern-APIs accept JSON requests and issue JSON responses so it's useful to have a good working knowledge of the format and it features.

MeasureDAQ™ Queries

The MeasureDAQ™ system allows the User to poll the current state of DAQ outputs. The following table summarizes the API for these items (see Note at the bottom of this page)

New Query	{"DIN1": "?"}	Return status of DIN1 only -- e.g. {"DIN1": 0} or {"DIN1": 1}
	{"DIN2": "?"}	Return status of DIN2 only -- e.g. {"DIN2": 0} or {"DIN2": 1}
	{"AIN1": "?"}	Return status of AIN1 only -- e.g. {"AIN1": 62436} where the return value is in microvolts
	{"AIN2": "?"}	Return status of AIN2 only -- e.g. {"AIN2": 220566} where the return value is in microvolts
	{"AIN3": "?"}	Return status of AIN3 only -- e.g. {"AIN3": 54592} where the return value is in microvolts
	{"AIN4": "?"}	Return status of AIN4 only -- e.g. {"AIN4": 80633} where the return value is in microvolts
	{"RLY1": "?"}	Return current state of RLY1 e.g. {"RLY1": N} where N= 0 or 1
	{"RLY2": "?"}	Return current state of RLY2 e.g. {"RLY2": N} where N= 0 or 1
	{"RLY3": "?"}	Return current state of RLY3 e.g. {"RLY3": N} where N= 0 or 1
	{"RLY4":"?"}	Return current state of RLY4 e.g. {"RLY4": N} where N= 0 or 1
	{"DOUT1": "?"}	Return current state of DOUT1 e.g. {"DOUT1": N} where N= 0 or 1
	{"DOUT2": "?"}	Return current state of DOUT2 e.g. {"DOUT2": N} where N= 0 or 1
	{"AOUT1": "?"}	Return current output voltage of AOUT1 e.g. {"AOUT1": microvolt value}
	{"AOUT2": "?"}	Return current output voltage of AOUT2 e.g. {"AOUT2": microvolt value}
	{"FIRM": "?")	Provide string representing firmware installed on STM32, e.g. {"FIRM": "20230920R1.33K"}
	{"TEMP": "?")	Returns board temperature. Divide value by 100 to obtain temperature in deg C, e.g. ("TEMP": "2634") == 26.34 deg C
	{"SNUM": "?")	Returns board serial number, e.g. {"SNUM": "1031"}

MeasureDAQ™ Setpoints

The MeasureDAQ™ system allows the User to set the status of Relays 1-4, Digital Outputs 1 and 2, and Analog Outputs 1 and 2 per the following standard. See Note at the bottom of this page).

Update	{"RLY1": N} where N= 0 or 1	Update RLY1 relay state and return only updated state of RLY1 e.g. {"RLY1": N} where N= 0 or 1
	{"RLY2": N} where N= 0 or 1	Update RLY2 relay state and return only updated state of RLY2 e.g. {"RLY2": N} where N= 0 or 1
	{"RLY3": N} where N= 0 or 1	Update RLY3 relay state and return only updated state of RLY3 e.g. {"RLY3": N} where N= 0 or 1
	{"RLY4": N} where N= 0 or 1	Update RLY4 relay state and return only updated state of RLY4 e.g. {"RLY4": N} where N= 0 or 1
	{"DOUT1": N} where N= 0 or 1	Update DOUT1 state and return only updated state of DOUT1 e.g. {"DOUT1": N} where N= 0 or 1
	{"DOUT2": N} where N= 0 or 1	Update DOUT2 state and return only updated state of DOUT2 e.g. {"DOUT2": N} where N= 0 or 1
	{"AOUT1": microvolt_value}	Update AOUT1 output voltage and only return updated output voltage of AOUT1 e.g. {"AOUT1": microvolt value}
	{"AOUT2": microvolt_value}	Update AOUT2 output voltage and only return updated output voltage of AOUT2 e.g. {"AOUT2": microvolt value}

NOTE

- Each of the JSON strings sent are to be followed with a Linefeed character (TermLF = Chr$(10))
- Each of the JSON strings received from the MeasureDAQ™ board are terminated with a Linefeed

Data types and units

- All digital variables are numbers - either 0 or 1. i.e. set DOUT2 using {"DOUT2": 1}
- All voltage values are micro-volts. The DAQ board will automatically calculate proper ADC/DAC values accordingly, i.e. set AOUT1 to 2.65V using {"AOUT1": 2650000}

Communication protocol

- Reading or writing updating MeasureDAQ™ parameters is done sequentially. Your DAQ program should WRITE and then READ the response from the DAQ board.
  - Do NOT attempt to write two updates (or more) to the DAQ board sequentially before reading the response from the DAQ board.
  - You may hang the DAQ board and the only way to reset the board is to power cycle.
- Spaces and tab characters within JSON strings are ignored by the DAQ. So you can send whatever is easily readable to you, as long as the JSON ends with LF or '\n'.
- If the JSON is badly formatted or corrupt, you will get {"STATUS": "ERROR"}

JSON Reminders

- In a JSON string, numbers are not enclosed in quotes. So {"AIN1": 5600000} is valid, but {"AIN1": "5000000"} is NOT valid. The DAQ board will assume 500000 is a string and ignore the whole parameter and not throw an error either because the JSON format is still good.
- Missing brackets, odd number of quotes, etc are invalid JSON that will cause an error.

VII.   Specifications

General

Operating Temperature	0 to 45 deg C
	Designed for normal lab environment 25 deg C
Humidity	0 to 90 percent RH non-condensing
Dimensions	190 mm x 160 mm x 90 mm
USB device type	USB 2.0
USB cable type	A-B cable, UL type AWM 2725 or equivalent
USB cable length	1 meter max

Digital Inputs (Two Channels)

PINS	DIN1 and DIN2
Digital Type	TTL
Maximum Current Sink	5 mA which is enforced by the 1K resistor input
Input Low Voltage Measurement Threshold	<= 1.13V (relative to GND), 1.47V typical
Input High Voltage Measurement Threshold	>= 3.15V (relative to GND), 2.6V typical
Input Voltage Limits	-0.5V to 5.5V (relative to GND)
Over and Under Voltage Protection	NONE
Embedded Pulldown Resistor	47K ohms
Inline Current Limiter Resistor	1K ohms
Non-inverting Schmidt Trigger	74HC2G17GV
Bandwidth	10 Hz
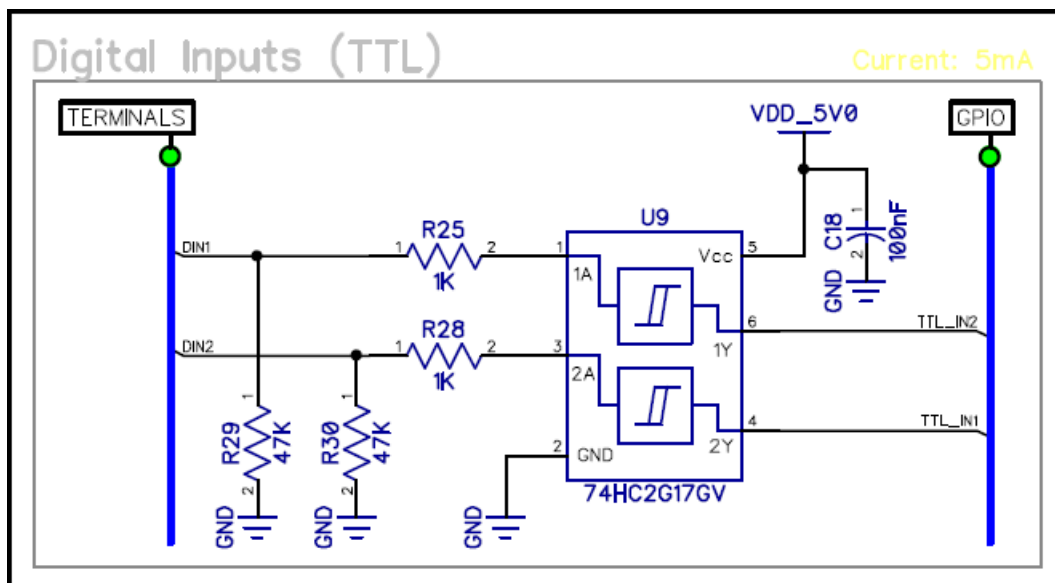
Digital Output (Two Channels)

PINS   DOUT1 and DOUT2
Digital Type   TTL
Current Output Limits   +/- 20 mA, subject to supply current limits
Low Voltage Output   0V (Digital Ground)
High Voltage Output   5V (relative to Digital Ground)
Inline Non-inverting Schmidt Trigger   74HC2G17GV
Bandwidth   10 Hz
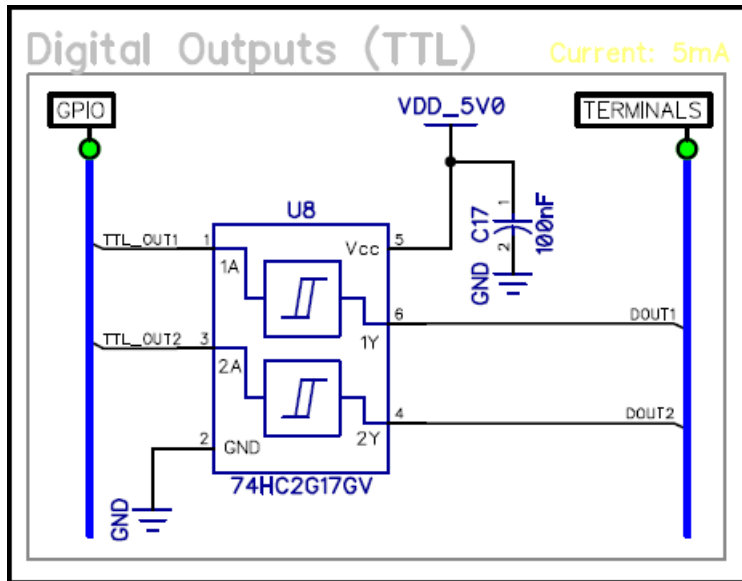
Relays

PINS   As noted on the DAQ board (see also Page 11)
Relay Model   Panasonic JS1-24V-F
Flyback Diode included   1N4148W

Power

On board Precision 5VDC Source   +/- 0.5% @ 50 mA or +/- 0.2% @ 5 mA
24VDC Integrated Power Supply   Subtract approximately 0.2A for DAQ Board
Mean Well IRM-15-24, 24VDC @ 0.6 A
Mean Well IRM-30-24, 24VDC @ 1.3 A

Temperature Sensor

On Board Temperture Sensor   10K NTC Sensor (NCU18XH103F60RB)
                                                  We may in the future compensate the AIN and
                                                  AOUT for temperature

Analog Input (4 Channels)

PINS	AIN1, AIN2, AIN3, and AIN4
Voltage Measurement Range	0V to +10V relative to GND
Maximum Measurement Frequency	10 Hz
Typical Voltage Resolution	0.005V
Meaurement Type	Single Ended (AIN to GND), 16 Bit ADC
Single Ended Input Impedance	10**12 ohms typical via TLC274 Precision Op Amp
Maximum Applied Voltage	-0.3V to +16V (relative to GND)
Recommended Warm-Up Time	15 minutes
Calibration	Each AIN input channel are individually calibrated. Our plans is to provide a program to the User that would allow them to calibrate each channel at their facility. This calibration process requires a calibrated voltage source instrument (e.g. Fluke 715). Calibration removes the large effect of the input offset voltage from the TLC274C
Gain Error Drift	15 ppm per deg C
Offset Drift vs. Temperature	50 nV per deg C
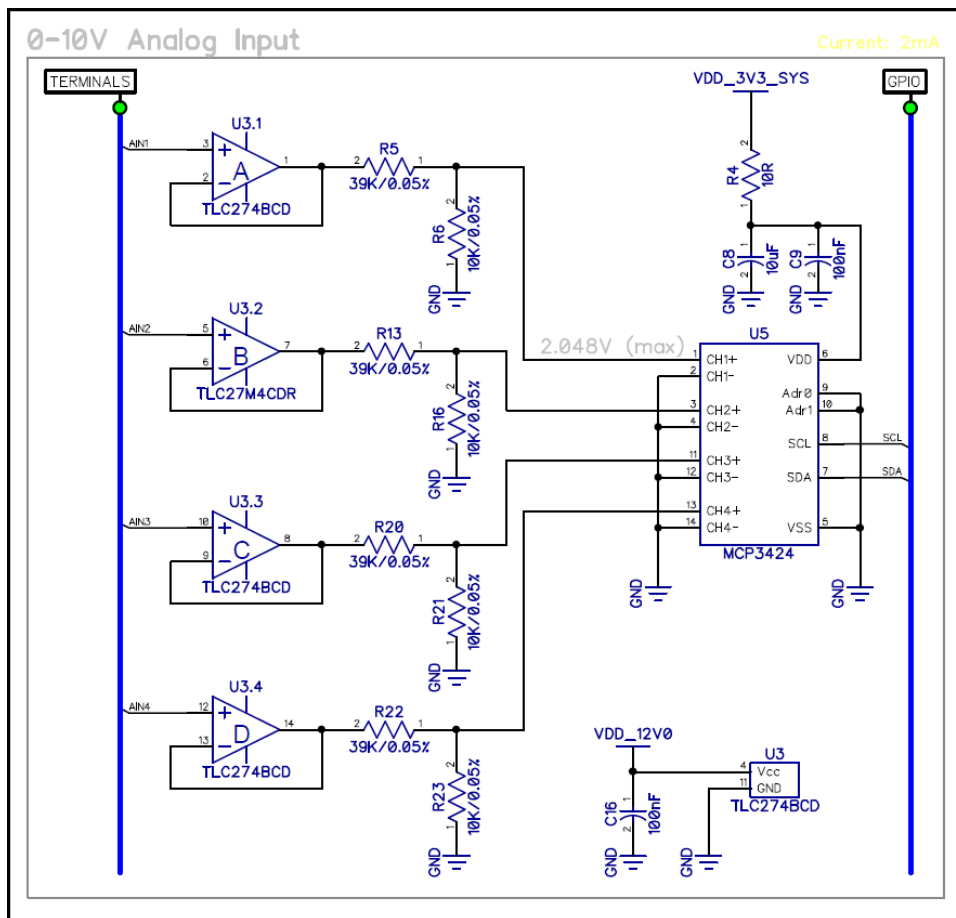
Analog Output (2 Channels)

PINS   AOUT1 and AOUT2
Voltage Output Range   0V to +10V relative to GND
DAC Resolution   12 bit ADC
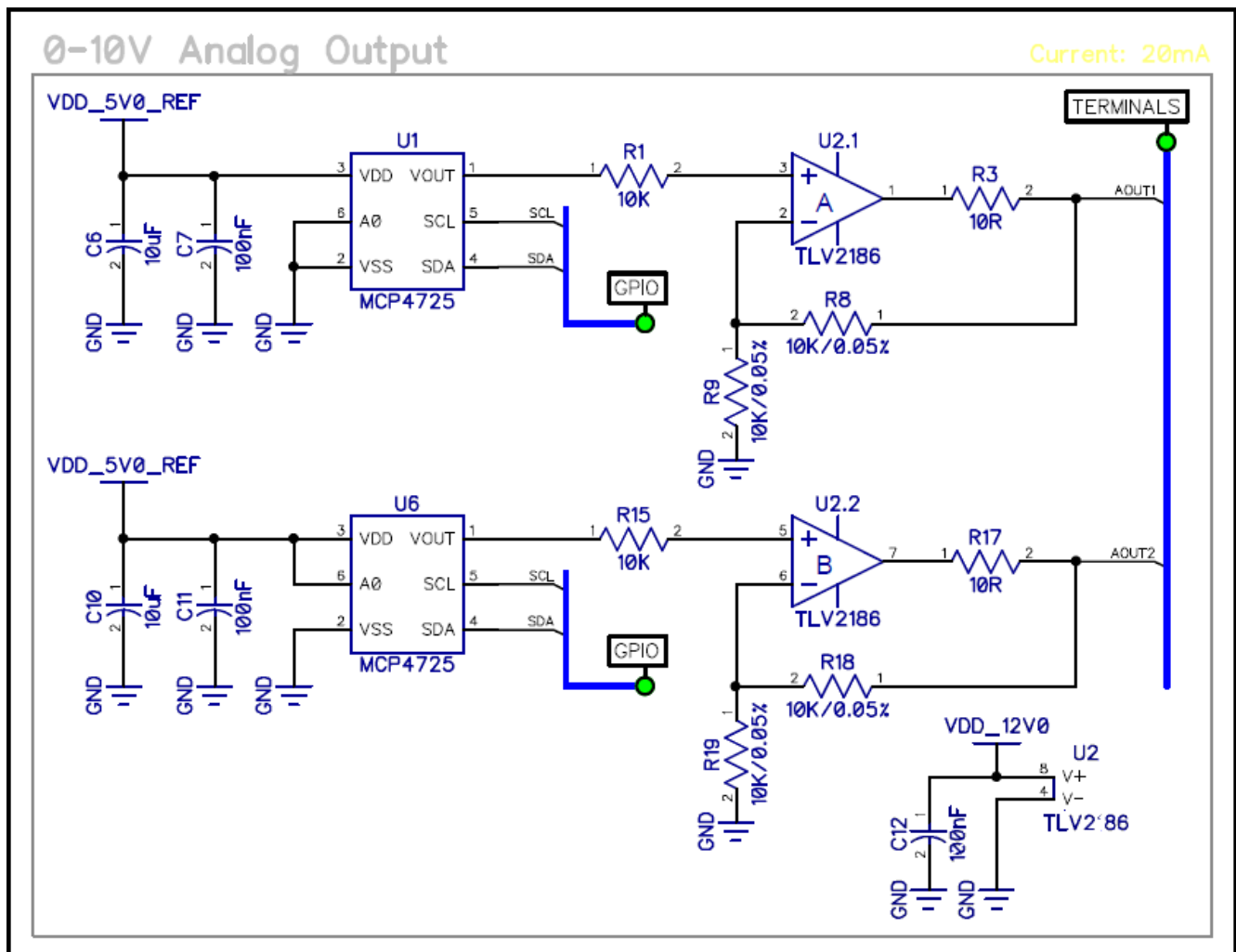Maximum Output Frequency   10 Hz
Maximum Current Output   20 mA
Calibration   Each ADC Channel is calibrated using a Fluke 715 meter. This process removes the vast majority of the offset and gain errors

IX.   FCC Certificate of Test

CERTIFICATE OF TEST

Roth Technologies, LLC

14111 Bluff Grove Drive
San Antonio, Texas 78216 USA

Product Name:	MeasureDAQ™
Model(s):	MeasureDAQ™
Report No(s).:	F2P30658A-01E

The above-listed product(s) were tested and found to comply with the following standard(s)*:

Standard: Federal Register CFR 47, Part 15, subpart B, Class A

Standard: ICES-003, Issue 7:2020 Information Technology, Class A

Ken Littell
Vice President of Operations
Issue Date: 2023-09-22

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*This Certificate is based on the evaluation of a representative sample(s) of the above-mentioned product(s) on a voluntary basis. This is to confirm that the tested sample(s) were tested to all or part of the standard(s) listed herein, as detailed in the applicable test report(s). It does not imply the assessment of the production of the product or approval of the manufacturing process or facility. The holder is authorized to use the Certificate to provide evidence of conformity as detailed above with the authority of F2 Labs.

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