



WHITE PAPER

Opentrons Electronic GEN2 Pipettes

Technical specs, test methods, and data validation

Written by
Opentrons



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INTRODUCTION

Single-Channel and 8-Channel GEN2 Pipette

GEN2 Pipette Product Description

Opentrons GEN2 Pipettes are designed specifically for lab automation and optimized for use with the OT-2. The Opentrons Single-Channel GEN2 pipettes reliably conduct liquid transfers from 1 - 1,000 μL , while the Opentrons 8-Channel GEN2 pipettes reliably conduct liquid transfers from 1 - 300 μL . Both have tip pickup and drop $\pm 1\text{mm}$ of a successful seal when using [Opentrons tips](#).

Opentrons GEN2 pipettes feature comparable specs to pipettes 10x as expensive. They also allow researchers to complete protocols using fewer pipettes due to a newly broadened volume range and any combination of two of these pipettes.

GEN2 SINGLE-CHANNEL AVAILABLE RANGES

- P20 GEN2 (1 – 20 μL)
- P300 GEN2 (20 – 300 μL)
- P1000 GEN2 (100 – 1000 μL)

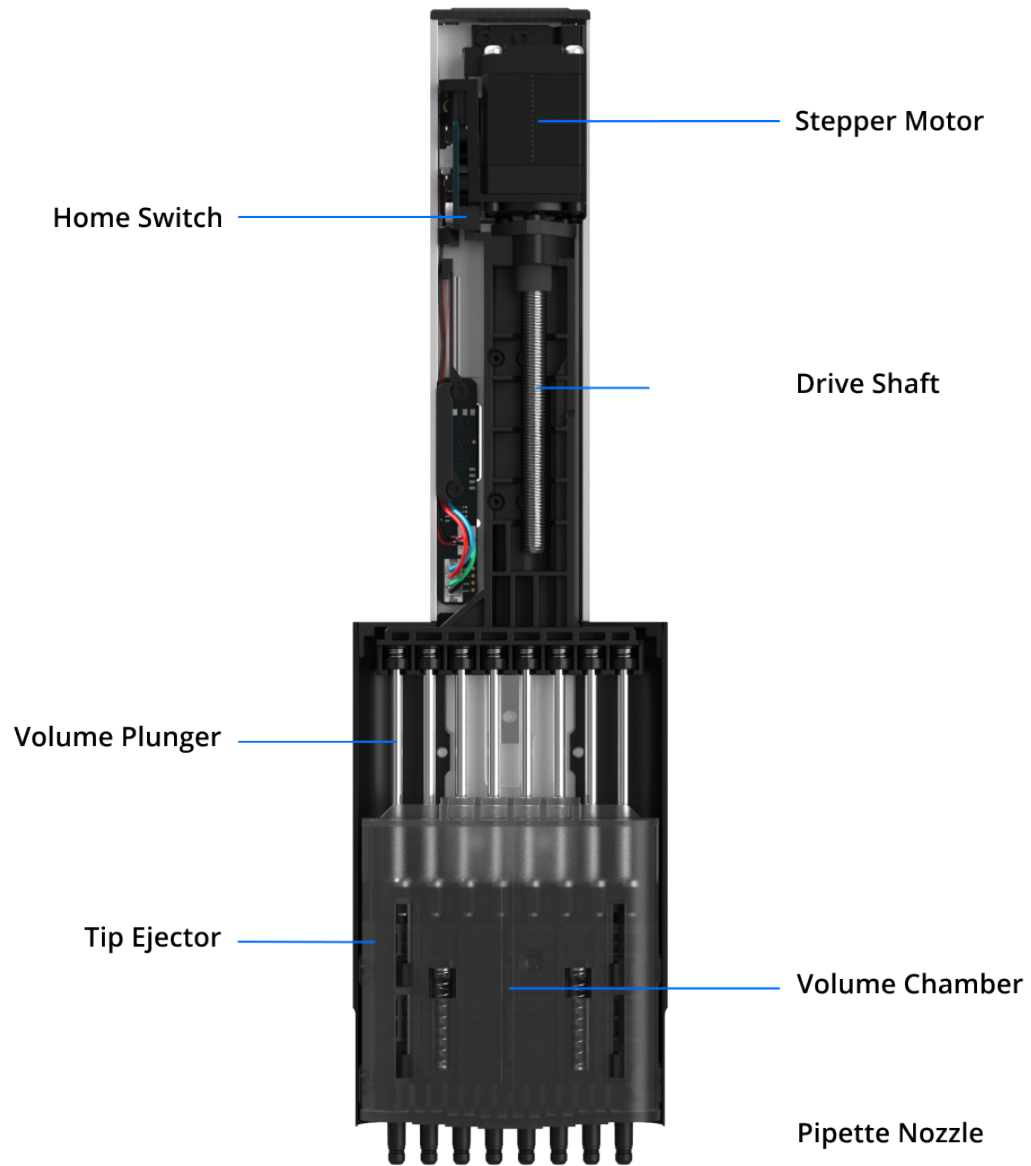
GEN2 8-CHANNEL AVAILABLE RANGES

- P20 GEN2 (1 – 20 μL)
- P300 GEN2 (20 – 300 μL)



FIGURE 1

Pipette Design Cutaway Diagram with Parts Labeled



Single-Channel GEN2 Pipette

TABLE 1

Single-Channel GEN2 Pipette Specifications

MODEL	VOLUME	ACCURACY		PRECISION	
		% D	µL	% CV	µL
P20 GEN2	1 µL	+/- 15%	0.15 µL	+/- 5 %	0.05 µL
	10 µL	+/- 2%	0.2 µL	+/- 1 %	0.1 µL
	20 µL	+/- 1.5%	0.3 µL	+/- 0.8 %	0.16 µL
P300 GEN2	20 µL	+/- 4%	0.8 µL	+/- 2.5%	0.5 µL
	150 µL	+/- 1%	1.5 µL	+/- 0.4%	0.6 µL
	300 µL	+/- 0.6%	1.8 µL	+/- 0.3%	0.9 µL
P1000 GEN2	100 µL	+/- 2%	2.0 µL	+/- 1%	1 µL
	500 µL	+/- 1%	5.0 µL	+/- 0.2%	1 µL
	1000 µL	+/- 0.7%	7.0 µL	+/- 0.15%	1.5 µL

8-Channel GEN2 Pipette

TABLE 2

8-Channel GEN2 Pipette Specifications

MODEL	VOLUME	ACCURACY		PRECISION	
		% D	μL	% CV	μL
P20 GEN2	1 μL	+/- 20%	0.2 μL	+/- 10%	0.1 μL
	10 μL	+/- 3%	0.3 μL	+/- 2%	0.2 μL
	20 μL	+/- 2.2%	0.44 μL	+/- 1.5%	0.3 μL
P300 GEN2	20 μL	+/- 10%	2.0 μL	+/- 4%	0.8 μL
	150 μL	+/- 2.5%	3.75 μL	+/- 0.8%	1.2 μL
	300 μL	+/- 1.5%	4.5 μL	+/- 0.5%	1.5 μL

TESTING METHODS

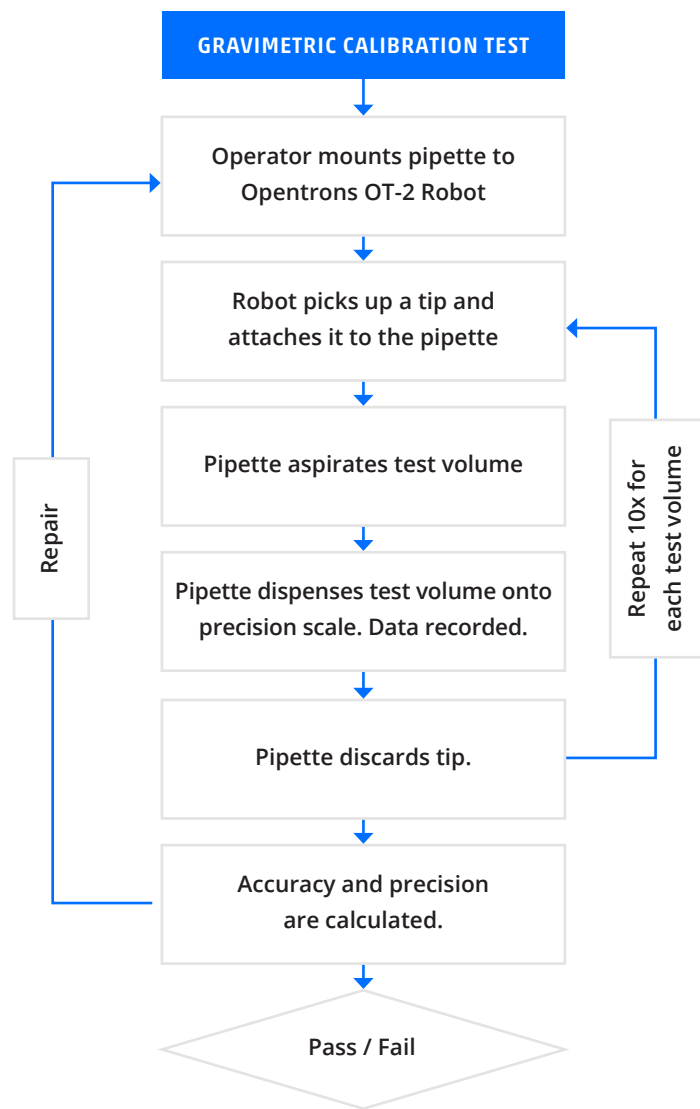
Single and 8-Channel GEN2 Pipette

Gravimetric testing for the Opentrons Pipette GEN2 is holistic in that we test the entire system rather than just the individual pipette. Specifically, the Pipette GEN2 is tested with the OT-2 Robot, Opentrons Tips, and Opentrons API exactly as a customer would use it.

Further, Opentrons adheres to a slightly stricter version of ISO8655 for pipette gravimetric testing. The key difference is that Opentrons does not include a pre-wet test for each individual aspirate of the pipette. A graphical breakdown of the process is seen in Figure 2.

FIGURE 2

Gravimetric Calibration Test Process Diagram



EXAMPLE GRAVIMETRIC TESTING OUTPUT

Single-Channel GEN2 Pipette

Example Output from Gravimetric Testing

The standard output of this process is a series of measurements taken at the pipette's minimum and maximum volumes. The data gathered is used to generate systematic and random errors for each pipette.

Pipette Serial No: P20SV202019101717			Time/Date: 10/31/2019 10:48:00		
Min Vol CV Spec:	5	Min Vol %D Spec:	15	Scale Serial No:	NB-A-552550
Mid Vol CV Spec:	1	Mid Vol %D Spec:	2	Temperature:	22.3 C
Max Vol CV Spec:	0.8	Max Vol %D Spec:	1.5	Humidity:	58% RH

TABLE 3

Pipette Calibration Testing

TEST VOLUME (µL)	TRIALS (µL)									
	1	2	3	4	5	6	7	8	9	10
1	1.052	1.0693	1.006	0.9899	0.982	1.052	0.982	1.0073	1.0599	1.00
10	9.948	10.078	10.016	9.988	10.04	10.028	10.012	10.0733	10.0866	10.0386
20	20.07	20.078	20.054	19.97	19.98	19.936	20.0473	20.092	20.068	19.976

TABLE 4

Pipette Calibration Testing

TEST VOLUME (μL)	MEAN	STANDARD DEV	%CV	%D	RESULT
1	1.0201	0.0343611	3.369	2.0067	PASS
10	10.0309	0.0429114	0.428	0.3087	PASS
20	20.0271	0.0556160	0.287	0.1357	PASS

EXAMPLE GRAVIMETRIC TESTING OUTPUT

8-Channel GEN2 Pipette

Example Output from Gravimetric Testing

The standard output of this process is a series of measurements taken at the pipette's minimum and maximum volumes. The data gathered is used to generate systematic and random errors for each pipette.

Pipette Serial No: P20MV202020033004		Time/Date: 4/30/2020 17:41:00	
Min Vol CV Spec:	10	Min Vol %D Spec:	20
Max Vol CV Spec:	0.8	Max Vol %D Spec:	2.2
		Temperature:	22 C
		Humidity:	49.79

TABLE 5

Pipette Calibration Testing

TEST VOLUME (µL)	TRIALS (µL)									
	1	2	3	4	5	6	7	8	9	10
1	1.0273	1.0420	1.0340	1.0140	1.0560	1.0280	0.9920	1.0293	1.0360	1.0267
20	20.0220	19.9733	19.9733	19.9720	20.0040	19.936	19.9980	20.0000	19.9920	19.9907

TABLE 6

Pipette Calibration Results

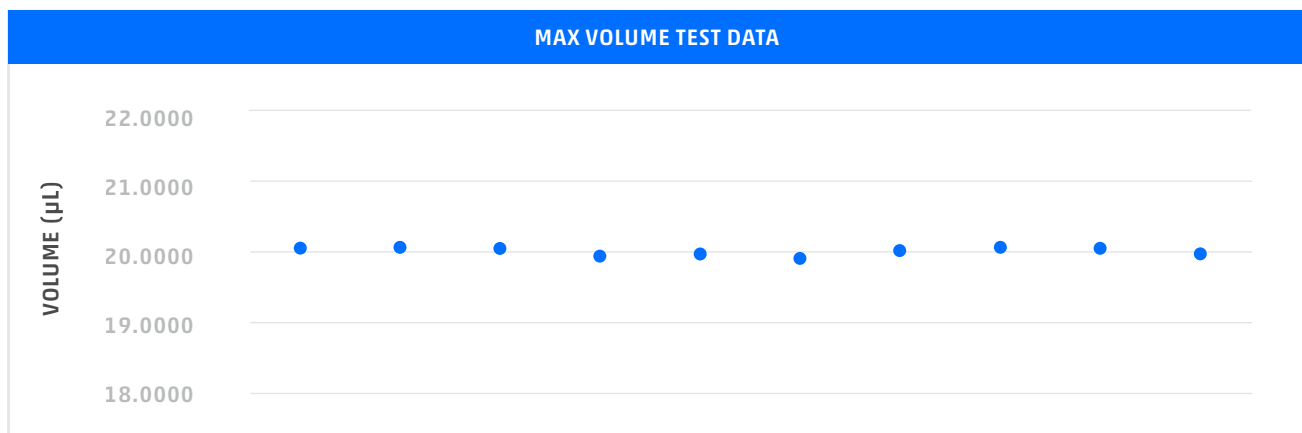
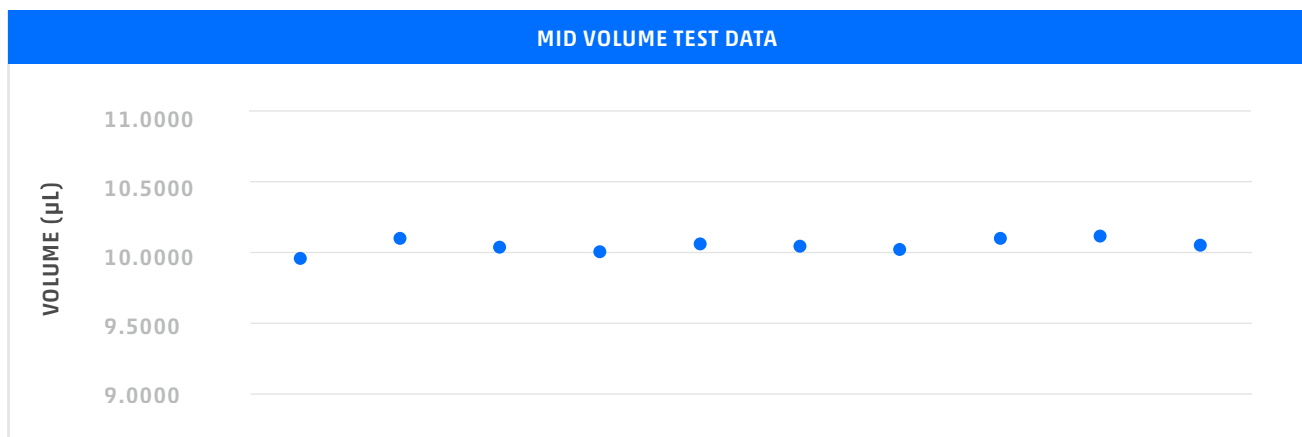
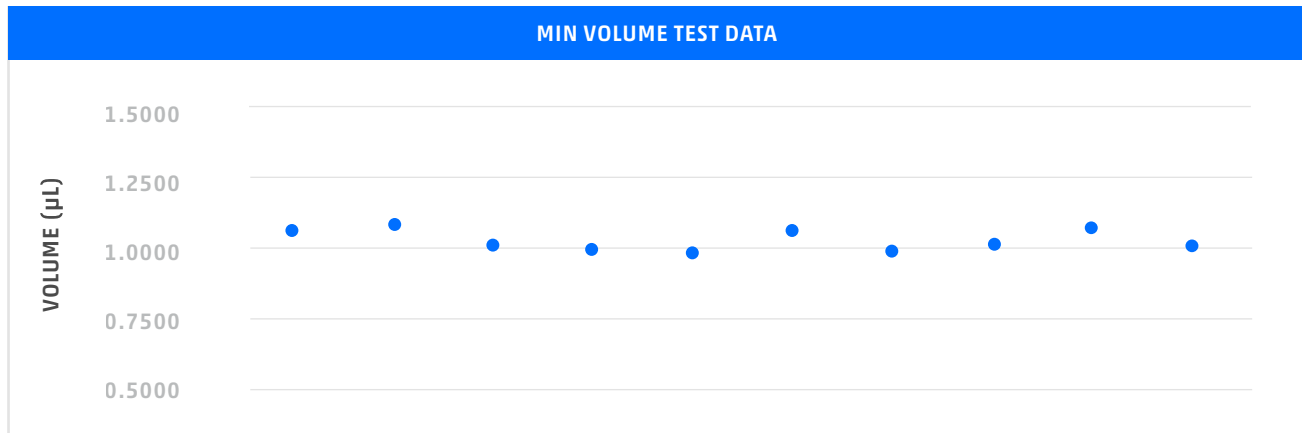
TEST VOLUME (µL)	MEAN	STANDARD DEV	%CV	%D	RESULT
1	1.0285	0.01691	1.6439	2.8530	PASS
20	19.9909	0.01579	0.0790	-0.0454	PASS

TEST DATA

Single-Channel GEN2 Pipette

TABLE 7

GEN2 Single-Channel Pipette Volumetric Test Data

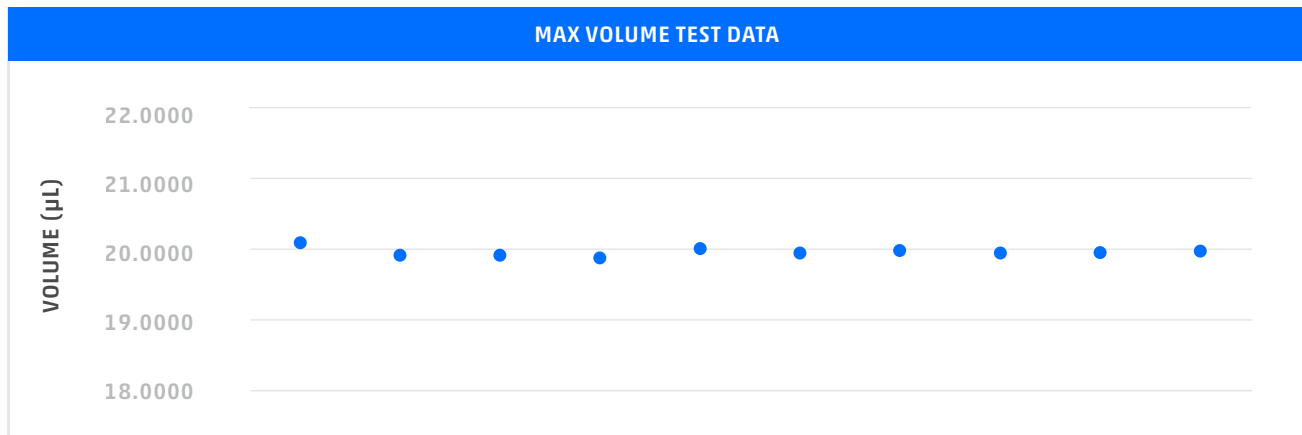
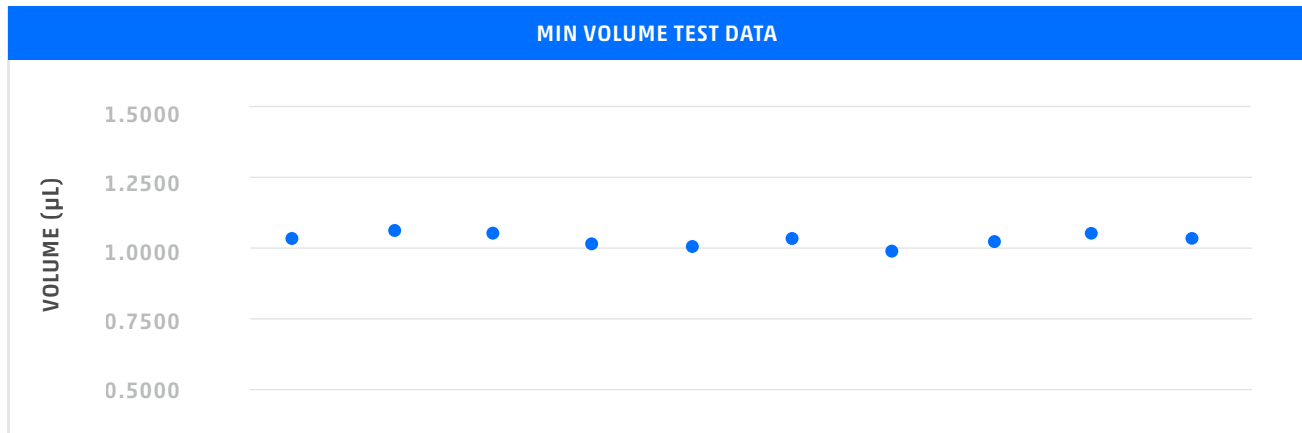


TEST DATA

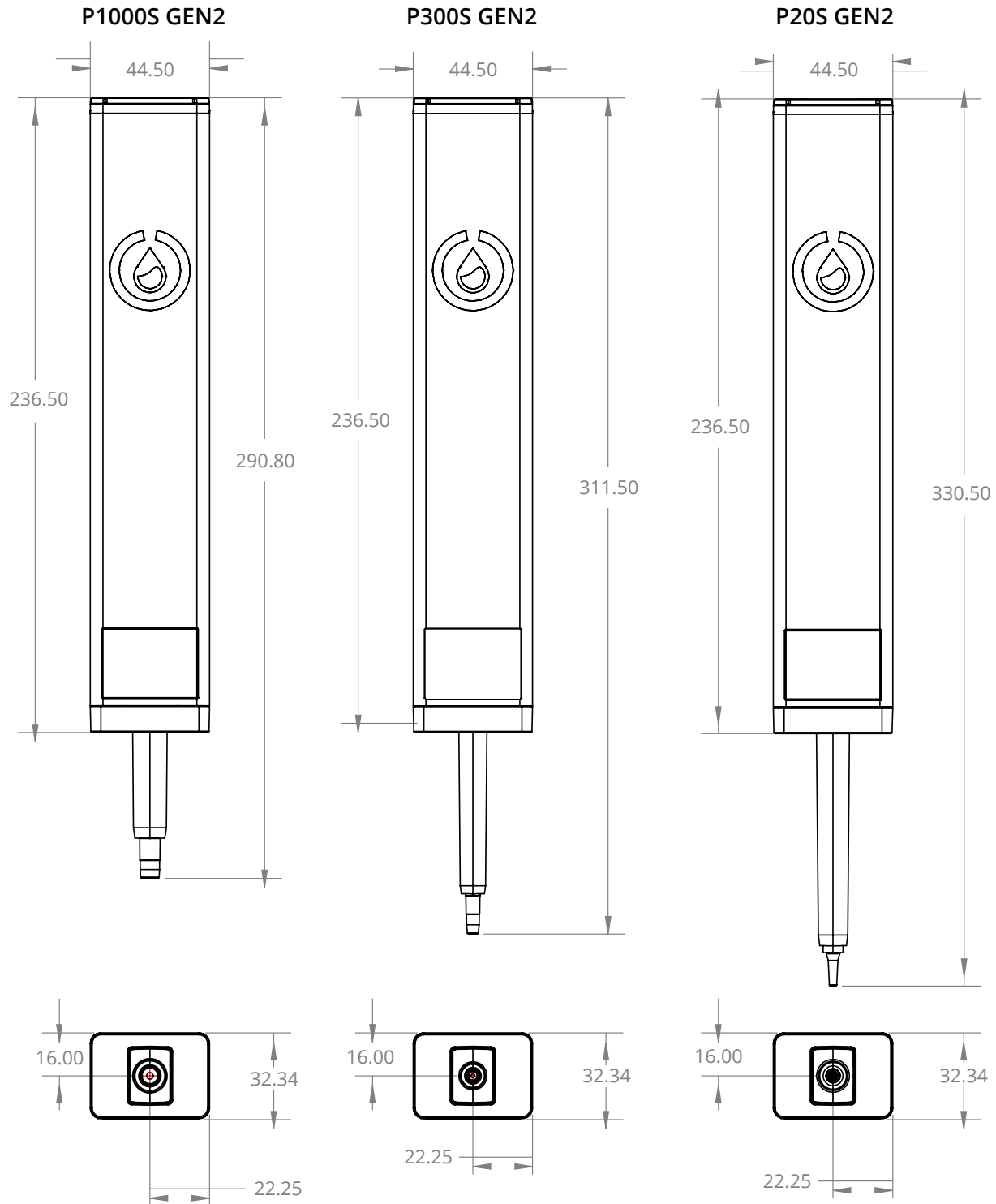
8-Channel GEN2 Pipette

TABLE 8

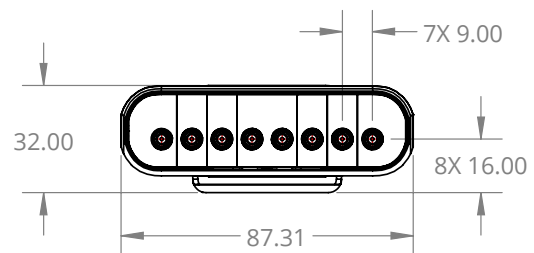
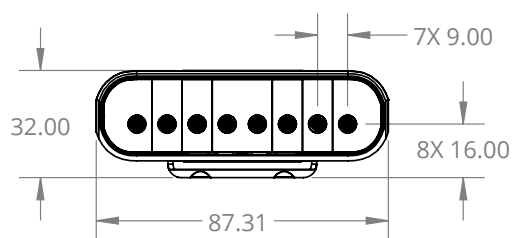
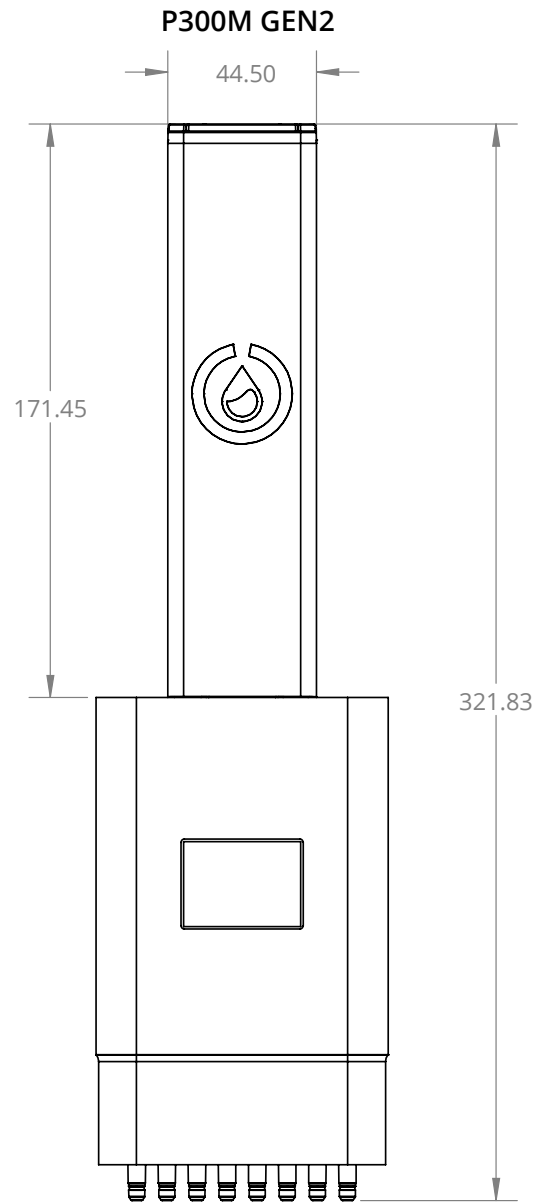
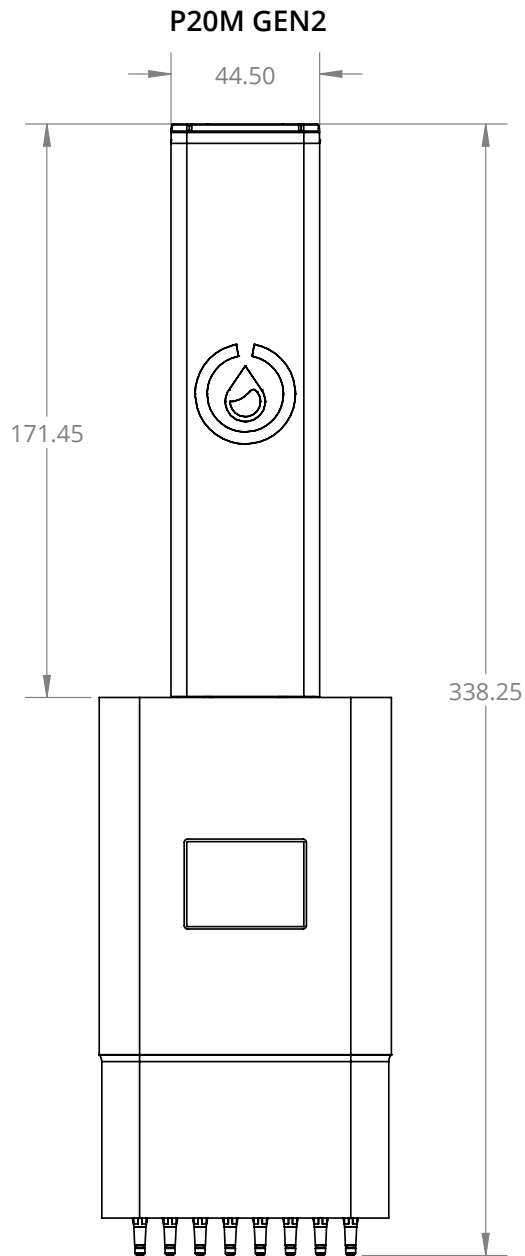
GEN2 8-Channel Pipette Volumetric Test Data



Single-Channel GEN2 Pipette



8-Channel GEN2 Pipette



LIFETIME TESTING

Single and 8-Channel GEN2 Pipette

Opentrons performs lifetime testing on each pipette model to ensure customers will have reliable results for the lifetime of their pipette. Each pipette model was tested to 1000+ hours of use: this equates to using 100,000 tips over 12 months with the robot pipetting 4 hours a day, 5 days a week.

There are two primary areas of wear Opentrons has addressed through lifetime testing. The first is the o-ring seal inside the pipette, and the second is the pipette nozzle that interacts with disposable tips. The o-ring seal was tested to 20-30 km of travel depending on the pipette model. The nozzle-to-tip interaction was tested for 100,000+ tip pickups and drops for each model. Gravitometric testing was performed at each $\frac{1}{4}$ life interval to ensure that the pipette is still in-spec.