

CERTIFICATE OF CALIBRATION

Preliminary

Customer: CARLETON UNIVERSITY
1125 COLONEL BY DRIVE
OTTAWA, ON K1S 5B6

PO Number: CC



Certificate/SO Number: 5-Q1Z9L-20-1 Revision 0

Manufacturer: Advantest
Model Number: R6581T
Description: Digital Multimeter, 8.5 digit
Serial Number: 562300337
ID: NONE

As-Found: Out Of Tolerance
As-Left: Out Of Tolerance

Issue Date:
Printed On: Aug 23, 2021
Due Date: Jul 02, 2021

Calibrated To: Manufacturer Specification
Calibration Procedure: 1-AC104587-0

Transcat Calibration Laboratories have been audited and found in compliance with ISO/IEC 17025:2017. Accredited calibrations performed within the Lab Scope of Accreditation are indicated by the presence of the Accrediting Body Logo and Certificate Number. Any measurements on an accredited calibration not covered by the Lab Scope of Accreditation are listed in the notes section of the certificate. SCC, NRC, CLAS or ANAB do not guarantee the accuracy of an individual calibration by accredited laboratories.

Transcat calibrations, as applicable, are performed in compliance with the requirements of the Transcat Quality Manual QAC-P01-000, the customer Purchase Order and/or Quality Agreement requirements, ISO 9001:2015, ANSI/NCSL Z540.1-1994 (R2002), and ISO 10012:2003, as applicable. When specified contractually, the requirements of ISO TS16949:2009, 10CFR21, 10CFR50 App. B, ASME NQA-1:2012, and ANSI/NCSL Z540.3-2006 (R2013) are also covered.

Complete records of work performed are maintained by Transcat and are available for inspection. Laboratory standards used in the performance of this calibration are listed on this certificate.

Transcat documents the traceability of measurements to the SI units through the National Institute of Standards and Technology (NIST), or the National Research Council of Canada (NRC), or other national measurement institutes (NMI) that are signatories to the CIPM Mutual Recognition Arrangement, or accepted fundamental and/or natural physical constants, or by the use of specified methods, consensus standards or ratio type measurements. Documentation supporting traceability information is available for review upon written request at a Transcat facility. The measured quantity and the measurement uncertainty are required for further dissemination of traceability.

Uncertainties are reported with a coverage factor $k=2$, providing a level of confidence of approximately 95%. All calibrations have been performed using processes having a TUR of 4:1 or better (3:1 for mass calibrations), unless otherwise noted. The Test Uncertainty Ratio (TUR) is calculated in accordance with NCSL International RP-18. For mass calibrations: Conventional mass referenced to 8.0 g/cm³.

The results in this report relate only to the item calibrated or tested. Recorded calibration data is valid at the time of calibration within the stated uncertainties at the environmental conditions noted. The determination of compliance to the specification is specific to the model/serial no./ID no. referenced above based on the tolerances shown; these tolerances are either the original equipment manufacturers (OEM's) warranted specifications or the client's requested specifications. Any number of factors can cause a unit to drift out of tolerance at any time following its calibration. Limitations on the uses of this instrument are detailed in the OEM's operating instructions. This certificate may not be reproduced except in full, without the written approval of Transcat. Additional information, if applicable may be included on separate report(s).

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As Found Data

Description	Setpoints	Accuracy	Low Limit	High Limit	As Found	O O T	Cal Process Uncertainty (k=2; ±)	Measurement Uncertainty (k=2; ±)	Units	TUR
DC Volts Measure										
100 mV Range	0.00000mV	±(0.001% FS + 0.0007% Rdg)	-0.00120	0.00120	-0.00034 mV					
100 mV Range	100.00000mV	±(0.001% FS + 0.0007% Rdg)	99.99810	100.00190	100.00018 mV		2.6e-004	2.6e-004	mV	7.3 : 1
100 mV Range	-100.00000mV	±(0.001% FS + 0.0007% Rdg)	-100.00190	-99.99810	-100.00087 mV		2.6e-004	2.6e-004	mV	7.3 : 1
1000 mV Range	0.00000mV	±(0.0001% FS + 0.0006% Rdg)	-0.00120	0.00120	-0.00006 mV					
1000 mV Range	1000.00000mV	±(0.0001% FS + 0.0006% Rdg)	999.99280	1000.00720	999.99729 mV		1.8e-003	1.8e-003	mV	4.0 : 1
1000 mV Range	-1000.00000mV	±(0.0001% FS + 0.0006% Rdg)	-1000.00720	-999.99280	-999.99634 mV		1.8e-003	1.8e-003	mV	4.0 : 1
10 V Range	0.0000000V	±(0.00002% FS + 0.0005% Rdg)	-0.0000024	0.0000024	0.0000002 V					
10 V Range	10.0000000V	±(0.00002% FS + 0.0005% Rdg)	9.9999476	10.0000524	9.9999617 V		1.8e-005	1.8e-005	V	2.9 : 1
10 V Range	1.0000000V	±(0.00002% FS + 0.0005% Rdg)	0.9999926	1.0000074	0.9999981 V		1.8e-006	1.8e-006	V	4.1 : 1
10 V Range	-1.0000000V	±(0.00002% FS + 0.0005% Rdg)	-1.0000074	-0.9999926	-0.9999887 V	*	1.8e-006	1.8e-006	V	4.1 : 1
10 V Range	-10.0000000V	±(0.00002% FS + 0.0005% Rdg)	-10.0000524	-9.9999476	-9.9999615 V		1.8e-005	1.8e-005	V	2.9 : 1
100 V Range	100.000000V	±(0.0001% FS + 0.0007% Rdg)	99.999180	100.000820	99.999506 V		3.0e-004	3.0e-004	V	2.7 : 1
100 V Range	-100.000000V	±(0.0001% FS + 0.0007% Rdg)	-100.000820	-99.999180	-99.999518 V		3.0e-004	3.0e-004	V	2.7 : 1
1000 V Range	1000.00000V	±(0.00002% FS + 0.0007% Rdg)	999.99278	1000.00722	999.99217 V	*	3.2e-003	3.2e-003	V	2.3 : 1
1000 V Range	-1000.00000V	±(0.00002% FS + 0.0007% Rdg)	-1000.00722	-999.99278	-999.99254 V	*	3.2e-003	3.2e-003	V	2.3 : 1

Date Received: July 02, 2021
Service Level : P9

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Customer Number: 9-323302-000

OPS-F20-014R9 08/05/21 FP001R9 4/9/2021

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As Found Data

Description	Setpoints	Accuracy	Low Limit	High Limit	As Found	O O T	Cal Process Uncertainty (k=2; ±)	Measurement Uncertainty (k=2; ±)	Units	TUR
DC Current Measure										
100 nA Range	100.0000µA	±(0.002% FS + 0.002% Rdg)	99.9956	100.0044	100.0016 µA		2.8e-004	3.0e-004	µA	15.7 : 1
100 nA Range	-100.0000µA	±(0.002% FS + 0.002% Rdg)	-100.0044	-99.9956	-100.0012 µA		2.8e-004	3.0e-004	µA	15.7 : 1
1000 nA Range	1000.0000nA	±(0.004% FS + 0.002% Rdg)	999.9320	1000.0680	1000.0208 nA		7.2e-003	7.2e-003	nA	9.4 : 1
1000 nA Range	-1000.0000nA	±(0.004% FS + 0.002% Rdg)	-1000.0680	-999.9320	-1000.0214 nA		7.2e-003	7.2e-003	nA	9.4 : 1
10 µA Range	10.000000µA	±(0.002% FS + 0.002% Rdg)	9.999560	10.000440	9.999841 µA		6.5e-005	6.5e-005	µA	6.8 : 1
10 µA Range	-10.000000µA	±(0.002% FS + 0.002% Rdg)	-10.000440	-9.999560	-9.999915 µA		6.5e-005	6.5e-005	µA	6.8 : 1
100 µA Range	100.00000µA	±(0.002% FS + 0.002% Rdg)	99.99560	100.00440	100.00016 µA		2.8e-004	2.8e-004	µA	15.7 : 1
100 µA Range	-100.00000µA	±(0.002% FS + 0.002% Rdg)	-100.00440	-99.99560	-100.00077 µA		2.8e-004	2.8e-004	µA	15.7 : 1
1000 µA Range	1000.0000µA	±(0.002% FS + 0.002% Rdg)	999.9560	1000.0440	1000.0043 µA		2.8e-003	2.8e-003	µA	15.7 : 1
1000 µA Range	-1000.0000µA	±(0.002% FS + 0.002% Rdg)	-1000.0440	-999.9560	-1000.0054 µA		2.8e-003	2.8e-003	µA	15.7 : 1
10 mA Range	10.000000mA	±(0.002% FS + 0.002% Rdg)	9.999560	10.000440	10.000039 mA		2.0e-005	2.0e-005	mA	22.0 : 1
10 mA Range	-10.000000mA	±(0.002% FS + 0.002% Rdg)	-10.000440	-9.999560	-10.000047 mA		2.0e-005	2.0e-005	mA	22.0 : 1
100 mA Range	100.00000mA	±(0.002% FS + 0.003% Rdg)	99.99460	100.00540	100.00059 mA		2.4e-004	2.4e-004	mA	22.5 : 1
100 mA Range	-100.00000mA	±(0.002% FS + 0.003% Rdg)	-100.00540	-99.99460	-100.00238 mA		2.4e-004	2.4e-004	mA	22.5 : 1
1000 mA Range	1000.0000mA	±(0.002% FS + 0.011% Rdg)	999.8660	1000.1340	1000.0702 mA		2.4e-003	2.4e-003	mA	55.8 : 1
1000 mA Range	-1000.0000mA	±(0.002% FS + 0.011% Rdg)	-1000.1340	-999.8660	-1000.0780 mA		2.4e-003	2.4e-003	mA	55.8 : 1

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Resistance 4 Wire Comp Measure										
	1.000053Ohm	±(0.002% FS + 0.0014% Rdg)	0.999799	1.000307	0.999915 Ohm		4.1e-007	1.3e-006	Ohm	100.0 : 1
	9.999989Ohm	±(0.002% FS + 0.0014% Rdg)	9.999609	10.000369	10.000068 Ohm		6.7e-006	6.8e-006	Ohm	56.7 : 1
	100.001550Ohm	±(0.0005% FS + 0.0012% Rdg)	99.999750	100.003350	100.002762 Ohm		8.2e-005	8.2e-005	Ohm	22.0 : 1
	1000.03060Ohm	±(0.0005% FS + 0.001% Rdg)	1000.01460	1000.04660	1000.03956 Ohm		8.2e-004	8.2e-004	Ohm	19.5 : 1
	10.0003490kOhm	±(0.00005% FS + 0.0008% Rdg)	10.0002630	10.0004350	10.0004018 kOhm		2.9e-006	2.9e-006	kOhm	29.7 : 1
	100.001370kOhm	±(0.0001% FS + 0.0014% Rdg)	99.999850	100.002890	100.001660 kOhm		2.9e-005	2.9e-005	kOhm	52.4 : 1
	1000.01150kOhm	±(0.001% FS + 0.0014% Rdg)	999.98550	1000.03750	999.97030 kOhm	*	1.4e-003	1.4e-003	kOhm	18.6 : 1
	10.000048MOhm	±(0.0005% FS + 0.005% Rdg)	9.999488	10.000608	9.995709 MOhm	*	1.9e-004	1.9e-004	MOhm	2.9 : 1
	100.00677MOhm	±(0.001% FS + 0.05% Rdg)	99.95557	100.05797	99.49874 MOhm	*	3.0e-003	3.0e-003	MOhm	17.1 : 1
	1000.0890MOhm	±(0.001% FS + 0.5% Rdg)	995.0766	1005.1014	952.9165 MOhm	*	5.3e-002	5.3e-002	MOhm	94.6 : 1

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Description	Setpoints	Accuracy	Low Limit	High Limit	As Left	O O T	Cal Process Uncertainty (k=2; ±)	Measurement Uncertainty (k=2; ±)	Units	TUR
DC Volts Measure										
100 mV Range	0.00000mV	±(0.001% FS + 0.0007% Rdg)	-0.00120	0.00120	-0.00013 mV					
100 mV Range	100.00000mV	±(0.001% FS + 0.0007% Rdg)	99.99810	100.00190	99.99968 mV		2.6e-004	2.6e-004	mV	7.3 : 1
100 mV Range	-100.00000mV	±(0.001% FS + 0.0007% Rdg)	-100.00190	-99.99810	-100.00052 mV		2.6e-004	2.6e-004	mV	7.3 : 1
1000 mV Range	0.00000mV	±(0.0001% FS + 0.0006% Rdg)	-0.00120	0.00120	-0.00012 mV					
1000 mV Range	1000.00000mV	±(0.0001% FS + 0.0006% Rdg)	999.99280	1000.00720	999.99810 mV		1.8e-003	1.8e-003	mV	4.0 : 1
1000 mV Range	-1000.00000mV	±(0.0001% FS + 0.0006% Rdg)	-1000.00720	-999.99280	-1000.00459 mV		1.8e-003	1.8e-003	mV	4.0 : 1
10 V Range	0.0000000V	±(0.00002% FS + 0.0005% Rdg)	-0.0000024	0.0000024	-0.0000006 V					
10 V Range	10.0000000V	±(0.00002% FS + 0.0005% Rdg)	9.9999476	10.0000524	10.0000087 V		1.8e-005	1.8e-005	V	2.9 : 1
10 V Range	1.0000000V	±(0.00002% FS + 0.0005% Rdg)	0.9999926	1.0000074	1.0000013 V		1.8e-006	1.8e-006	V	4.1 : 1
10 V Range	-1.0000000V	±(0.00002% FS + 0.0005% Rdg)	-1.0000074	-0.9999926	-0.9999971 V		1.8e-006	1.8e-006	V	4.1 : 1
10 V Range	-10.0000000V	±(0.00002% FS + 0.0005% Rdg)	-10.0000524	-9.9999476	-10.0000215 V		1.8e-005	1.8e-005	V	2.9 : 1
100 V Range	100.000000V	±(0.0001% FS + 0.0007% Rdg)	99.999180	100.000820	99.999963 V		3.0e-004	3.0e-004	V	2.7 : 1
100 V Range	-100.000000V	±(0.0001% FS + 0.0007% Rdg)	-100.000820	-99.999180	-100.000238 V		3.0e-004	3.0e-004	V	2.7 : 1
1000 V Range	1000.00000V	±(0.00002% FS + 0.0007% Rdg)	999.99278	1000.00722	1000.00254 V		3.2e-003	3.2e-003	V	2.3 : 1
1000 V Range	-1000.00000V	±(0.00002% FS + 0.0007% Rdg)	-1000.00722	-999.99278	-1000.00367 V		3.2e-003	3.2e-003	V	2.3 : 1

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Description	Setpoints	Accuracy	Low Limit	High Limit	As Left	O O T	Cal Process Uncertainty (k=2; ±)	Measurement Uncertainty (k=2; ±)	Units	TUR
DC Current Measure										
100 nA Range	100.0000µA	±(0.002% FS + 0.002% Rdg)	99.9956	100.0044	100.0012 µA		2.8e-004	3.0e-004	µA	15.7 : 1
100 nA Range	-100.0000µA	±(0.002% FS + 0.002% Rdg)	-100.0044	-99.9956	-100.0010 µA		2.8e-004	3.0e-004	µA	15.7 : 1
1000 nA Range	1000.0000nA	±(0.004% FS + 0.002% Rdg)	999.9320	1000.0680	999.9812 nA		7.2e-003	7.2e-003	nA	9.4 : 1
1000 nA Range	-1000.0000nA	±(0.004% FS + 0.002% Rdg)	-1000.0680	-999.9320	-999.9896 nA		7.2e-003	7.2e-003	nA	9.4 : 1
10 µA Range	10.000000µA	±(0.002% FS + 0.002% Rdg)	9.999560	10.000440	9.999855 µA		6.5e-005	6.5e-005	µA	6.8 : 1
10 µA Range	-10.000000µA	±(0.002% FS + 0.002% Rdg)	-10.000440	-9.999560	-9.999948 µA		6.5e-005	6.5e-005	µA	6.8 : 1
100 µA Range	100.00000µA	±(0.002% FS + 0.002% Rdg)	99.99560	100.00440	99.99988 µA		2.8e-004	2.8e-004	µA	15.7 : 1
100 µA Range	-100.00000µA	±(0.002% FS + 0.002% Rdg)	-100.00440	-99.99560	-100.00035 µA		2.8e-004	2.8e-004	µA	15.7 : 1
1000 µA Range	1000.0000µA	±(0.002% FS + 0.002% Rdg)	999.9560	1000.0440	1000.0051 µA		2.8e-003	2.8e-003	µA	15.7 : 1
1000 µA Range	-1000.0000µA	±(0.002% FS + 0.002% Rdg)	-1000.0440	-999.9560	-1000.0028 µA		2.8e-003	2.8e-003	µA	15.7 : 1
10 mA Range	10.000000mA	±(0.002% FS + 0.002% Rdg)	9.999560	10.000440	10.000033 mA		2.0e-005	2.0e-005	mA	22.0 : 1
10 mA Range	-10.000000mA	±(0.002% FS + 0.002% Rdg)	-10.000440	-9.999560	-9.999968 mA		2.0e-005	2.0e-005	mA	22.0 : 1
100 mA Range	100.00000mA	±(0.002% FS + 0.003% Rdg)	99.99460	100.00540	99.99901 mA		2.4e-004	2.4e-004	mA	22.5 : 1
100 mA Range	-100.00000mA	±(0.002% FS + 0.003% Rdg)	-100.00540	-99.99460	-99.99864 mA		2.4e-004	2.4e-004	mA	22.5 : 1
1000 mA Range	1000.0000mA	±(0.002% FS + 0.011% Rdg)	999.8660	1000.1340	1000.0862 mA		2.4e-003	2.4e-003	mA	55.8 : 1
1000 mA Range	-1000.0000mA	±(0.002% FS + 0.011% Rdg)	-1000.1340	-999.8660	-1000.0827 mA		2.4e-003	2.4e-003	mA	55.8 : 1

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Description	Setpoints	Accuracy	Low Limit	High Limit	As Left	O O T	Cal Process Uncertainty (k=2; ±)	Measurement Uncertainty (k=2; ±)	Units	TUR
Resistance 4 Wire Comp Measure										
	1.000053Ohm	±(0.002% FS + 0.0014% Rdg)	0.999799	1.000307	1.000021 Ohm		4.1e-007	1.3e-006	Ohm	100.0 : 1
	9.999989Ohm	±(0.002% FS + 0.0014% Rdg)	9.999609	10.000369	9.999976 Ohm		6.7e-006	6.8e-006	Ohm	56.7 : 1
	100.001550Ohm	±(0.0005% FS + 0.0012% Rdg)	99.999750	100.003350	100.001324 Ohm		8.2e-005	8.2e-005	Ohm	22.0 : 1
	1000.03060Ohm	±(0.0005% FS + 0.001% Rdg)	1000.01460	1000.04660	1000.02942 Ohm		8.2e-004	8.2e-004	Ohm	19.5 : 1
	10.0003490kOhm	±(0.00005% FS + 0.0008% Rdg)	10.0002630	10.0004350	10.0003219 kOhm		2.9e-006	2.9e-006	kOhm	29.7 : 1
	100.001370kOhm	±(0.0001% FS + 0.0014% Rdg)	99.999850	100.002890	100.001422 kOhm		2.9e-005	2.9e-005	kOhm	52.4 : 1
	1000.01150kOhm	±(0.001% FS + 0.0014% Rdg)	999.98550	1000.03750	1000.00162 kOhm		1.4e-003	1.4e-003	kOhm	18.6 : 1
	10.000048MOhm	±(0.0005% FS + 0.005% Rdg)	9.999488	10.000608	9.998563 MOhm	*	1.9e-004	1.9e-004	MOhm	2.9 : 1
	100.00677MOhm	±(0.001% FS + 0.05% Rdg)	99.95557	100.05797	99.86580 MOhm	*	3.0e-003	3.0e-003	MOhm	17.1 : 1
	1000.0890MOhm	±(0.001% FS + 0.5% Rdg)	995.0766	1005.1014	984.1064 MOhm	*	5.3e-002	5.3e-002	MOhm	94.6 : 1

Field not applicable.

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Traceable Standards

Asset	Manufacturer	Model Number	Description	Cal Date	Due Date	Traceability Number	Use
131200	Guildline Instruments Inc.	9230A-30-0.1	Precision Current Shunt	29-Oct-20	31-Oct-21	5-&131200-14-1	AF/AL
131300	Guildline Instruments Inc.	9334A-100M	Precision Resistor	13-May-21	31-May-22	5-&131300-11-1	AF/AL
131400	Guildline Instruments Inc.	9334A-1G	Precision Resistor	1-Mar-21	31-Mar-22	5-&131400-11-1	AF/AL
556000	Fluke Corporation	742A-10K	Resistance Standard	28-Dec-20	31-Dec-21	5-&556000-9-1	AF/AL
557000	Fluke Corporation	742A-100k	Resistance Standard	20-Nov-20	30-Nov-21	5-&557000-9-1	AF/AL
558000	Fluke Corporation	742A-10M	Resistance Standard	12-May-21	31-May-22	5-&558000-10-1	AF/AL
561000	Fluke Corporation	742A-1k	Resistance Standard	23-Sep-20	30-Sep-21	5-&561000-11-1	AF/AL
562000	Fluke Corporation	742A-1	Resistance Standard	3-Feb-21	28-Feb-22	5-&562000-13-1	AF/AL
563000	Fluke Corporation	742A-10	Resistance Standard	21-Sep-20	30-Sep-21	5-&563000-12-1	AF/AL
564000	Fluke Corporation	742A-1M	Resistance Standard	10-May-21	31-May-22	5-&564000-9-1	AF/AL
565000	Fluke Corporation	742A-100	Resistance Standard	22-Sep-20	30-Sep-21	5-&565000-12-1	AF/AL
5974	Fluke Corporation	8508A	Reference Multimeter	9-Jun-21	9-Sep-21	5-&5974-21-1	AF/AL
HP050114	Fluke Corporation	5700A-EP-03	Multifunction Calibrator	12-Aug-21	12-Nov-21	5-&HP050114-23-1	AF/AL

The use of the standard is defined as: AF - used for as-found readings, AL - used for as-left readings.

Environmental Data

	Temperature	Relative Humidity	Temp / RH Asset
As Found:	74.25°F /23.47°C	57.60%	Dewk16
As Left:	73.64°F / 23.13°C	56.00%	Dewk16

Decision Rule

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1125 COLONEL BY DRIVE
OTTAWA, ON K1S 5B6

PO Number: CC



Certificate/SO Number: 5-Q1Z9L-20-1 Revision 0

Legend

Topic	Description
Accuracy	UUT specification that establishes expected tolerances and a time limit (calibration interval) over which the instrument is expected to hold these tolerances
As Found	Initial measurement results
As Left	Measurement results after adjustment and/or repair
Blank Data Field	Test is not applicable for the UUT
Cal Process Uncertainty (CPU)	The uncertainty of calibration process for the reported measurement result
Calibration Date	Indicates the date that the calibration was completed
Cover Factor (k)	A measure of uncertainty that defines an interval about the measurement result
Due Date	Indicates the end of the calibration cycle as requested by the customer
Issue Date	Indicates the date that the calibration has passed the Data Review Process and was signed by an authorized signatory or the date that a revision to the original certificate has been issued
Low / High Limits	Establishes UUT acceptable performance limits for the test measurement
Measurement Uncertainty	The dispersion of the values attributed to a measured quantity
OOA	Out of Acceptance (#)
OOT	Out of Tolerance (*)
Setpoints	Measurement target values
Traceability	Unbroken chain of comparisons relating an instrument's measurements to a known standard(s)
Traceability Number	Unique identifier(s) used to document traceability of calibration standards
TUR	Test Uncertainty Ratio, ratio of the tolerance or specification of the test measurement in relation to the uncertainty in measurement results
UUT	Unit Under test

CERTIFICATE OF CALIBRATION

Preliminary

Customer: CARLETON UNIVERSITY
1125 COLONEL BY DRIVE
OTTAWA, ON K1S 5B6

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Calibrated At:
16115 Park Row
Houston, TX 77084

Facility Responsible:
16115 Park Row
Houston, TX 77084
800-828-1470

Unit Barcode:



0900B406186

Date Received: July 02, 2021
Service Level : P9

Calibrated By:



Electronically Signed By:
Nancy Barker

Nancy Barker
Calibration Technician

Jul 02, 2021

Reviewed By:

Electronically Signed By:

Scott D. Caine
Lab Manager