



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

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CALIBRATION

Valid To: February 28, 2027

Certificate Number: 4184.01

In recognition of the successful completion of the A2LA evaluation process (including an assessment of the organization's compliance with R205 – A2LA's Calibration Program Requirements), accreditation is granted to this laboratory at the location listed above as well as the satellite laboratory location listed below to perform the following calibrations¹:

I. Acoustical

Parameter/Equipment	Range	CMC ² (±)	Comments
Sound Level Meter ³ – (@ 1 kHz)	(94 & 114) dB	0.59 dB	KQT-33K3-4-2911-1, BK Cal 73

II. Chemical

Parameter/Equipment	Range	CMC ² (±)	Comments
Conductivity Meter ³	1.3 µS/cm 5 µS/cm 84 µS/cm 1413 µS/cm 12.88 mS/cm	0.018 µS/cm 0.10 µS/cm 0.38 µS/cm 7.4 µS/cm 0.041 mS/cm	KQT-CD-01 manufacturer's manual, standard solution

Parameter/Equipment	Range	CMC ^{2, 5} ($\pm$)	Comments
pH Meter ³	4 pH 7 pH 10 pH	0.006 pH 0.008 pH 0.012 pH	KQT-17-20SC-42 manufacturer's manual, standard solution
Refractometer ³	(5 to 85) % Brix Up to 10 % Salinity	0.12 % Brix 0.1 % Salinity	KQT-RE-01 manufacturer's manual, Hanna HI96801 standard solution
Turbidity Meter ³	Up to 800 NTU	0.87 %	KQT-TU-01 manufacturer's manual, Hanna HI98703 standard solution
TDS Meter ³	50 mg/L 500 mg/L 1000 mg/L	0.44 mg/L 2.0 mg/L 4.3 mg/L	KQT-TDS-01 reference conductivity standard solution
Dissolved Oxygen Meter	(0.0 to 50.0) mg/L	0.17 mg/L	KQT-DO-01 manufacturer's manual standard solution Hanna HI9147 Hanna HI2004-02
Hydrometer	(0.600 to 2.000) g/cm ³	0.002 g/cm ³	KQT-HY-01, manufacturer's manual standard hydrometers
Alcoholmeter	Up to 100 % <i>V</i>	0.1 % <i>V</i>	KQT-AL-01 manufacturer' manual standard alcoholmeter

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Gas Detectors			
H ₂ S	0.0025 % <i>V</i>	4.2 %	KQT-17-20SY-06, manufacturer's manual, standard gas
CO	0.0050 % <i>V</i>	3.7 %	
CH ₄	50 % LEL	3.7 %	
C ₄ H ₈	0.001 % <i>V</i>	2.3 %	
C ₄ H ₈	0.01 % <i>V</i>	2.3 %	
O ₂	12 % <i>V</i>	3.5 %	
O ₂	18 % <i>V</i>	3.5 %	
O ₂	0.1 % <i>V</i>	3.5 %	
O ₂	20.9 % <i>V</i>	3.5 %	
CO ₂	2 % <i>V</i>	2.3 %	
CO ₂	0.2 % <i>V</i>	2.3 %	
NH ₃	0.0025 % <i>V</i>	2.3 %	
NH ₃	0.0050 % <i>V</i>	5.8 %	
NO ₂	0.0005 % <i>V</i>	3.8 %	
C ₂ H ₄ O	0.001 % <i>V</i>	12 %	
SO ₂	0.001 % <i>V</i>	12 %	
NO	0.04 % <i>V</i>	2.0 %	
SO ₂	0.05 % <i>V</i>	2.1 %	
CO	0.03 % <i>V</i>	2.1 %	
NO ₂	0.01 % <i>V</i>	5.0 %	
SiH ₄	0.0005 % <i>V</i>	12 %	
C ₄ H ₁₀	50 % LEL	2.3 %	
Viscosity Meter	(100 to 200 000) cP	0.5 %	KQT-17-20MV-01 standard solution

III. Dimensional

Parameter/Equipment	Range	CMC ² (±)	Comments
Angle Meter/Clinometer	Up to 90°	0.01 ⁰	KQT-33K6-4-157-1, angle block set
Calipers ³	Up to 500 mm (> 500 to 2000) mm	0.0014 mm/m + 8.8 μm 0.0057 mm/m + 6.7 μm	KQT-33K6-4-552-1, gauge block grade 0 +1, caliper checker
Depth Gages ³	Up to 300 mm 300 to 1000 mm	0.0066 mm/m + 0.7 μm 0.0067 mm/m + 4.3 μm	KQT-33K6-4-17-1, gauge block grade 0 +1

Parameter/Equipment	Range	CMC ² (±)	Comments
Coordinate Measuring Machines (CMM) ³ – 3-Axis Linearity Only	X: (10 to 900) mm Y: (10 to 900) mm Z: (10 to 500) mm	0.0077 mm/m + 0.15 µm 0.0077 mm/m + 0.15 µm 0.0081 mm/m + 0.15 µm	KQT-CMM-01, manufacturer's manual, gauge block grade 0+1
Micrometers ³	Up to 25 mm (> 25 to 100) mm (> 100 to 500) mm (> 500 to 1000) mm	0.27 µm 0.0043 mm/m + 0.67 µm 0.0075 mm/m + 0.35 µm 0.0054 mm/m + 5.6 µm	KQT-33K6-4-15-1, gauge block grade 0 +1
Dial Indicator ³ /Dial Test Indicator ³	Up to 1 mm (1 to 100) mm	0.64 µm 0.0042 mm/m + 0.68 µm	KQT-IN-01, gauge block grade 0 +1, Mitutoyo UDT-3
Dial Bore Gages ³	(1 to 100) mm (> 100 to 500) mm (> 500 to 800) mm	0.0043 mm/m + 0.63 µm 0.0078 mm/m + 0.33 µm 0.0073 mm/m + 0.53 µm	KQT-IN-01, gauge block grade 0 +1
Gage Blocks ³	(1 to 25) mm (> 25 to 100) mm (> 100 to 500) mm	0.0013 mm/m + 0.19 µm 0.0032 mm/m + 0.14 µm 0.0036 mm/m + 0.10 µm	KQT-33K6-4-1-1, Pratt & Whitney B Mahr ULM-1000E
Height Gages ³	(1 to 500) mm (> 500 to 1000) mm	0.0030 mm/m + 0.18 µm 0.0020 mm/m + 6.5 µm	KQT-33K6-4-1626-1, gauge block grade 0 +1
Holtest	(6 to 75) mm	0.0014 mm/m + 1.9 µm	KQT-HT-01, setting ring
Microscope, Measuring Profile Projector/Optical Comparator ³	(0.01 to 1) mm (> 1 to 500) mm	0.091 mm/m + 0.6 µm 0.0041 mm/m + 2.4 µm	KQT-33K6-4-1268-1, manufacturer's manual, KLC source procedure, standard glass scale
Pin/Plug Gages ³	Up to 100 mm	0.0027 mm/m + 0.19 µm	KQT-33K6-4-121-1, Pratt & Whitney B Mahr ULM-1000E Mitutoyo MDH-25M
Thread Plug Gage	Up to 100 mm	0.0028 mm/m + 1.1 µm	KQT-TPG-01 KLC source procedure, Mahr ULM-1000E

Parameter/Equipment	Range	CMC ² (±)	Comments
Setting Rings	Up to 150 mm	0.0008 mm/m + 0.4 µm	KQT-33K6-4-2-1, Ring gauge standards Mahr ULM-1000E
Thread Ring Gage	Up to 125 mm	0.031 mm/m + 1.3 µm	KQT-TRG-01 KLC source procedure, Mahr ULM-1000E
Surface Plate Flatness – Repeatability Only ^{3,4}	[(12 x 12) to (48 x 96)] in	62 µin	KQT-17-20MD-14, repeat-o-zero
Feeler Gages & Thickness Films ³	Up to 25 mm	0.0045 mm/m + 0.14 µm	KQT-FG-01 Mahr ULM-1000E Mitutoyo MDH-25M
Coating Thickness Gages ⁵	Up to 3 mm	1.2 %	KQT-CTG-01, coating thickness standards
Thickness Gages ³	Up to 100 mm (100 to 500) mm	0.0072 mm/m + 0.12 µm 0.0078 mm/m + 0.2 µm	KQT-TH-01, gauge block grade 0 +1
Steel Ruler	Up to 2000 mm	0.1 mm	KQT-SR-01 DLVN 283:2015 standard glass scale Wanhao WE-100 with digital microscope
Measuring Tape	Up to 100 m	0.027 mm/m + 71 µm	KQT-MT-01 DLVN 266 standard glass scale standard weight Wanhao WE-100 with digital microscope
Distance & Length Measuring Instruments	Up to 50 m	0.002 mm	KQT-D&L-01 laser distance meter
Precision Level/Square Level/Sprit Level	0.02 mm/m 0.05 mm/m 0.1 mm/m	0.03 mm/m 0.04 mm/m 0.064 mm/m	KQT-PL-01 DLVN 120 standard precision level

Parameter/Equipment	Range	CMC ² (±)	Comments
Metal Detector ³ – Ferrous Brass Sus	(0.5 to 2.5) mm (0.5 to 2.5) mm (0.5 to 3.5) mm	0.0009 mm 0.0009 mm 0.0009 mm	KQT-ME-01, manufacturer's manual, precision balls

IV. Electrical – DC/Low Frequency

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
AC Current – Generate ³ Up to 200 µA	(20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.2 mA/A + 0.005 µA 0.2 mA/A + 0.003 µA 0.2 mA/A + 0.02 µA 1.4 mA/A + 0.1 µA	KQT-17-20AQ-101, KLC source procedure manufacturer's manual, Fluke 5720A
(0.2 to 2.2) mA	(20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.2 mA/A + 0.035 µA 0.2 mA/A + 0.035 µA 0.2 mA/A + 0.11 µA 1.5 mA/A + 0.65 µA	
(2.2 to 22) mA	(20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.2 mA/A + 0.35 µA 0.2 mA/A + 0.35 µA 0.2 mA/A + 0.55 µA 1.4 mA/A + 5 µA	
(22 to 220) mA	(20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.2 mA/A + 3.5 µA 0.2 mA/A + 2.5 µA 0.2 mA/A + 3.5 µA 1.3 mA/A + 10 µA	
220 mA to 2.2 A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.3 mA/A + 5 µA 0.5 mA/A + 80 µA 8.5 mA/A + 160 µA	
(1.5 to 11) A	(45 to 65) Hz (65 to 500) Hz (0.5 to 1) kHz	0.8 mA/A + 2 mA 1.2 mA/A + 2 mA 3.8 mA/A + 2 mA	Fluke 5500A
AC Clamp Meters (11 to 500) A Toroidal-type clamps	(45 to 65) Hz	3.1 mA/A + 0.1 A	
“Other-type” of clamps)	(45 to 65) Hz	7.4 mA/A + 0.1 A	

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
AC Current – Measure ³			
(5 to 100) μA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.6 mA/A + 0.03 μA 1.8 mA/A + 0.03 μA 0.9 mA/A + 0.03 μA 0.9 mA/A + 0.03 μA	KQT-17-20AH-06, KLC source procedure, manufacturer’s manual, HP 3458A
100 μA to 10 mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.6 mA/A + 2 μA 1.8 mA/A + 2 μA 0.9 mA/A + 2 μA 0.64 mA/A + 0.2 μA	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.6 mA/A + 20 μA 1.7 mA/A + 20 μA 0.9 mA/A + 20 μA 0.6 mA/A + 20 μA	
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.7 mA/A + 0.2 mA 1.9 mA/A + 0.2 mA 1.1 mA/A + 0.2 mA 1.3 mA/A + 0.2 mA	
(1 to 20) A	(50 to 1000) Hz	1.5 mA/A + 20 μA	
Up to 2000 A	(50 to 1000) Hz	5.8 mA/A + 0.2 A	HP 3458A & high voltage divider & Kyoritsu 2009R, Advantest R6581
AC Voltage – Generate ³			
(Up to 220) mV	40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.11 mV/V + 7 μV 0.26 mV/V + 7 μV 0.59 mV/V + 17 μV 1.1 mV/V + 20 μV 3.4 mV/V + 45 μV	KQT-17-20AQ-101, KLC source procedure, manufacturer’s manual, Fluke 5720A & 5500A
220 mV to 2.2 V	40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.06 mV/V + 8 μV 0.10 mV/V + 10 μV 0.14 mV/V + 30 μV 0.52 mV/V + 80 μV 2.1 mV/V + 0.3 mV	
(2.2 to 22) V	40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.06 mV/V + 0.05 mV 0.10 mV/V + 0.1 mV 0.13 mV/V + 0.2 mV 0.35 mV/V + 0.6 mV 1.9 mV/V + 3.2 mV	
(22 to 220) V	40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.07 mV/V + 0.6 mV 0.10 mV/V + 1 mV 0.14 mV/V + 2.5 mV	
220 V to 1.1 kV	50 Hz to 1 kHz	0.09 mV/V + 3.5 mV	

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
AC Voltage – Measure ³			
(0 to 10) mV	40 Hz to 1 kHz 1 kHz to 20 kHz 50 kHz to 100 kHz	0.2 mV/V + 1.1 μV 0.4 mV/V + 1.1 μV 6 mV/V + 1.1 μV	KQT-17-20AH-06, KLC source procedure, manufacturer's manual HP 3458A
(10 to 100) mV	40 Hz to 1 kHz 1 kHz to 20 kHz 50 kHz to 100 kHz	0.1 mV/V + 2 μV 0.2 mV/V + 2 μV 0.9 mV/V + 2 μV	
100 mV to 1 V	40 Hz to 1 kHz 1 kHz to 20 kHz 50 kHz to 100 kHz	0.1 mV/V + 20 μV 0.2 mV/V + 20 μV 0.9 mV/V + 20 μV	
(1 to 10) V	40 Hz to 1 kHz 1 kHz to 20 kHz 50 kHz to 100 kHz	0.1 mV/V + 0.2 mV 0.2 mV/V + 0.2 mV 0.9 mV/V + 0.2 mV	
(10 to 100) V	40 Hz to 1 kHz 1 kHz to 20 kHz 50 kHz to 100 kHz	0.2 mV/V + 2 mV 0.2 mV/V + 2 mV 1.4 mV/V + 2 mV	
100 V to 1 kV	40 Hz to 1 kHz 1 kHz to 20 kHz 50 kHz to 100 kHz	0.5 mV/V + 20 mV 0.7 mV/V + 20 mV 3.5 mV/V + 20 mV	
AC Power Analyzer/Meter ³			
Up to 5 kW Up to 10 kW (10 to 500) kW	(45 to 65) Hz (45 to 65) Hz (45 to 65) Hz	0.19 % 0.2 % 0.3 %	KQT-33K1-4-1683-1, KLC source procedure, manufacturer's manual, Fluke 5500A

Parameter/Equipment	Range	CMC ^{2,6} ($\pm$)	Comments
Capacitance – Generate ³ (@ 1 kHz)	(0.5 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F (0.33 to 1) mF	1.4 mF/F + 10 pF 1.2 mF/F + 10 pF 1.9 mF/F + 10 pF 3.1 mF/F + 100 pF 3.3 mF/F + 100 pF 3.3 mF/F + 300 pF 3.8 mF/F + 1 nF 4.2 mF/F + 3 nF 4.5 mF/F + 10 nF 4.8 mF/F + 30 nF 6.4 mF/F + 0.1 μ F 8.2 mF/F + 0.3 μ F 5.2 mF/F + 1 μ F	KQT-17-20AQ-101, KLC source procedure, manufacturer's manual, Fluke 5500A
	50 pF to 1.1 μ F	0.58 % + 5 pF	GR 1412BC

Parameter/Equipment	Range	CMC ^{2, 5, 6} ($\pm$)	Comments
DC Current – Generate ³	(0 to 220) μ A (0.22 to 2.2) mA	59 μ A/A + 6 nA 48 μ A/A + 7 nA	KQT-17-20AQ-101, KLC source procedure, manufacturer's manual, Fluke 5720A
	220 μ A to 22 mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A	50 μ A/A + 40 nA 58 μ A/A + 0.7 μ A 100 μ A/A + 12 μ A 54 μ A/A + 330 μ A	Fluke 5500A
	(11 to 500) A	2 mA/A + 17 mA	Fluke 5500A w/ 550/coil
DC Current – Measure ³	(0 to 100) μ A 100 μ A to 1 mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	25 μ A/A + 0.8 nA 25 μ A/A + 5 nA 25 μ A/A + 5 nA 45 μ A/A + 0.5 μ A 120 μ A/A + 10 μ A	KQT-17-20AH-06, KLC source procedure, manufacturer's manual HP 3458A, Fluke 8845A,
	(1 to 10) A (1 to 20) A (20 to 100) A (10 to 2000) A (100 to 2000) A	0.58 mA/A + 0.5 mA 0.5 mA/A + 20 μ A 3.4 mA/A + 20 μ A 6 mA/A + 10 mA 5.8 mA/A + 20 mA	HP 3458A & shunt Kyoritsu 2009R, Advantest R6581
DC Voltage – Generate ³	(0 to 220) mV	17 μ V/V + 0.6 μ V	KQT-17-20AQ-101, KLC source procedure, manufacturer's manual, Fluke 5720A & 5500A
	220 mV to 2.2 V	9.2 μ V/V + 1.3 μ V	
	(2.2 to 11) V	7.2 μ V/V + 4.5 μ V	
	(11 to 22) V	7.3 μ V/V + 8 μ V	
	(22 to 220) V	12 μ V/V + 0.1 mV	
	(220 to 1100) V	13 μ V/V + 0.7 mV	

Parameter/Equipment	Range	CMC ^{2, 5, 6} (±)	Comments
DC Voltage – Measure ³	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1000) V (0.5 to 10) kV	12 $\mu\text{V/V} + 0.35 \mu\text{V}$ 9.3 $\mu\text{V/V} + 0.4 \mu\text{V}$ 9.3 $\mu\text{V/V} + 1 \mu\text{V}$ 12 $\mu\text{V/V} + 40 \mu\text{V}$ 12 $\mu\text{V/V} + 0.15 \text{ mV}$ 1.7 %	KQT-17-20AH-06, KLC source procedure, manufacturer's manual, Fluke 8845A, HP 3458A 149-10A HV DMM
DC Power Analyzer/Meter ³	Up to 5 kW Up to 10 kW (10 to 500) kW	0.13 % 0.2 % 0.3 %	KQT-33K1-4-1683-1, KLC source procedure, manufacturer's manual, Fluke 5500A
Resistance – Generate ³	(0.001 to 1) Ω (1 to 100) Ω (0.13 to 10) k Ω 10 k Ω to 1 M Ω (1 to 100) M Ω (0.1 to 1) G Ω (1 to 10) G Ω (10 to 100) G Ω	0.64 m $\Omega/\Omega + 2 \text{ m}\Omega$ 0.12 m $\Omega/\Omega + 2 \text{ m}\Omega$ 0.12 m $\Omega/\Omega + 2 \text{ m}\Omega$ 0.19 m $\Omega/\Omega + 2 \text{ m}\Omega$ 1.2 m Ω/Ω 2.4 m Ω/Ω 6.2 m Ω/Ω 13 m Ω/Ω	KQT-17-20AQ-101, KLC source procedure, manufacturer's manual, standard resistance HARS-X- 9-0.001, HRRS-9-5- 10-5kV, HRRS decade resistance
Resistance – Measure ³	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω (0.1 to 1) M Ω (1 to 10) M Ω (10 to 100) M Ω (0.1 to 1) G Ω	0.03 m $\Omega/\Omega + 0.05 \text{ m}\Omega$ 0.03 m $\Omega/\Omega + 0.5 \text{ m}\Omega$ 0.015 m $\Omega/\Omega + 0.5 \text{ m}\Omega$ 0.023 m $\Omega/\Omega + 5 \text{ m}\Omega$ 5.5 m $\Omega/\Omega + 50 \text{ m}\Omega$ 0.1 m $\Omega/\Omega + 2 \Omega$ 0.2 m $\Omega/\Omega + 100 \Omega$ 3.7 m $\Omega/\Omega + 1.1 \text{ k}\Omega$ 6.9 m $\Omega/\Omega + 20 \text{ k}\Omega$	KQT-17-20AH-06, KLC source procedure, manufacturer's manual, HP 3458A, Advantest R6581

Parameter/Equipment	Range	CMC ^{2, 5, 6} (±)	Comments
Oscilloscopes ³ –			
DC Gain (Into 1MΩ)	(1.8 to 200) mV 200 mV to 33 V	3.1 mV/V + 0.1 mV 2.9 mV/V + 0.1 mV	KQT-CG-7, KLC source procedure, manufacturer's manual, Fluke 5500A-SC300
DC Gain (Into 50 Ω)	(1.8 to 200) mV 200 mV to 2 V	3.1 mV/V + 0.1 mV 4.1 mV/V + 0.1 mV	
Leveled Sine Wave (Into 50 Ω)	50 kHz to 10 MHz (10 to 300) MHz	0.006 mHz/Hz 0.17 mHz/Hz	
Time Base Sweep Rate – (Into 50 Ω)	5 s to 100 μs (50 to 2) μs 1 μs to 20 ns (10 to 2) ns	2 m/s 17 ms/s 0.04 m/s 0.03 ms/s	
Electrical Calibration of Thermocouple Type K with Indicators	(-200 to < 0) °C (0 to 1200) °C	0.26 % 0.05 %	KQT-33K5-4-42-1 Fluke 5500A
Magnetic Flux – Gauss Meters ³	3 mT 50 mT 300 mT	2.5 % 1.6 % 3.6 %	KQT-33K1-4-1658-1 manufacturer's manual, magnetic tool
Hipot/Withstanding Testers ³	(0.5 to 10) kV (AC) (0.5 to 10) kV (DC) (10 to 20) kV (AC/DC) (0.5 to 100) mA	13 mV/V + 5 V 7.6 mV/V + 3 V 3.5 % 1.4 %	KQT-33K1-4-181-1, KLC source procedure, manufacturer's manual, Kikusui 149-10A & TOS 1200 & Tektronix P6015A
Insulation Testers ³	Up to 100 MΩ (0.1 to 10) GΩ (10 to 100) GΩ	0.2 % 1.6 % 1.3 %	KQT-33K2-4-33-1, KLC source procedure, manufacturer's manual, HRRS decade resistance
LCR Meters ³			KQT-33K1-4-1260-1, KLC source procedure, manufacturer's manual, LCR standard
Resistance	Up to 50 MΩ	0.01 %	
Inductance	1 μH to 999 mH	2.3 % + 0.5 μH	
Capacitance (Fixed Points)	1 pF 10 pF 100 pF 1000 pF	0.19 % 0.12 % 0.12 % 0.12 %	

V. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
RF Power – Measure ³ (-40 to 15) dBm (-40 to 5) dBm	10 MHz to 5 GHz 5 GHz to 26.5 GHz	0.20 dBm 0.19 dBm	KQT-33K4-4-715-1, KQT-33K4-4-105-1 KLC source procedure, manufacturer's manual, HP 8340B monitored w/ Agilent N1911A w/ E4412A & N8482A
RF Power –Measuring Equipment ³ (-30 to 20) dBm (-30 to 20) dBm	100 kHz to 10 MHz 10 MHz to 6 GHz	0.34 dBm 0.37 dBm	KQT-33K4-4-715-1, KQT-33K4-4-105-1 KLC source procedure, Agilent N1911A w/ E4412A & N8482A

VI. Fluid Quantities

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Air Speed/Velocity Meters	Up to 30 m/s	2.1 %	KQT-33K6-4-1769-1, velocity standard
Air/Mass Flow Meters ³	(0.1 to 1) lpm (> 1 to 30) lpm (> 30 to 2500) lpm	1.5 % 1.3 % 2.9 %	KQT-33K6-4-1769- 1A, mini-AP buck flow calibrator M30B
Flow Meter for Liquid	Up to 1000 lpm (1000 to 3300) lpm	(0.0084%) lpm + 0.17 lpm 2 %	KQT-33K6-4-1769- 1B, flow rate rig, magnetic flowmeter, ultrasonic flowmeter
Burets	(100 to 1000) µL (1 to 10) mL (10 to 500) mL	1.1 mL/L 0.2 mL/L 0.1 mL/L	KQT-VO-01, standard weight E2 & balance
Pipettes	(1 to 10) µL (10 to 100) µL (100 to 1000) µL (1 to 10) mL (10 to 500) mL	14 mL/L 5.2 mL/L 1.1 mL/L 0.2 mL/L 0.1 mL/L	KQT-VO-01, standard weight E2, E1 & standard scale

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Volumetric Flasks	Up to 1000 mL (1000 to 5000) mL	0.17 mL/L 0.14 mL/L	KQT-VO-01, standard weight E2 & standard scale

VII. Mechanical

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Balances & Scales ³			
Class I & II	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1000 g 2000 g 5000 g 10 000 g 20 000 g 30 000 g	0.0017 mg 0.0017 mg 0.0017 mg 0.0017 mg 0.0017 mg 0.0019 mg 0.0022 mg 0.0024 mg 0.0030 mg 0.0036 mg 0.0042 mg 0.0055 mg 0.0068 mg 0.0084 mg 0.014 mg 0.021 mg 0.08 mg 0.12 mg 0.79 mg 1.2 mg 3 mg 19 mg 140 mg 150 mg	KQT-BA-01, OIML R76-1 standard weights E1, E2 & F1
Class II, III, & IV	(1 to 30) kg (30 to 60) kg (60 to 200) kg (200 to 500) kg (500 to 2000) kg	0.7 mg/kg + 69 g 0.24 g/kg – 7.3 g 0.039 g/kg + 5.1 g 0.057 g/kg + 1.7 g 0.07 g/kg – 6.7 g	KQT-BA-01, OIML R76-1 standard weights, F2 M1 & M2
Durometer – Spring Force			
Type A – B – O – F	Up to 4.5 kg	0.5 %	KQT-33K6-4-1362-1, ASTM D2240 partial calibration, standard weight E2 & standard scale
Type C – D – DO	Up to 4.5 kg	0.1 %	

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Force Tester ³	Up to 50 kgf (50 to 500) kgf (500 to 5000) kgf (5000 to 10 000) kgf	0.02 % 0.1 % 0.46 % 0.4 %	KQT-17-20MF-04, DLVN 109 KLC source procedure, standard weight E2, M1 & load cell LYLC-50and loadcell VLC-10, loadcell 500-BE
Hardness Testers ³ – Indirect Verification of Rockwell Hardness Testers	HRBW: Medium High HRC: Low Medium High	0.93 HRBW 0.92 HRBW 0.5 HRC 0.5 HRC 0.5 HRC	KQT-HAR-01 DLVN 63, manufacturer's manual
Hardness Testers ³ – Indirect Verification of Vickers Hardness Testers	HV: 300 HV 501 HV 703 HV HVM: 501 HV	1.9 HV 9.1 HV 13 HV 9.8 HV	KQT-HAR-01 DLVN 63, manufacturer's manual
Mass/Weights Class E2, F1, F2, M1, M2 & M3	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g	0.0023 mg 0.0024 mg 0.0024 mg 0.0024 mg 0.0024 mg 0.0026 mg 0.003 mg 0.003 mg 0.004 mg 0.005 mg 0.006 mg 0.008 mg 0.010 mg 0.012 mg 0.019 mg 0.028 mg 0.11 mg 0.15 mg	KQT-SW-01, OIML R111-1, weight standard with OIML class E1
Class F1, F2, M1, M2 & M3	1000 g 2000 g 5000 g 10 000 g	1.2 mg 1.7 mg 4 mg 20 mg	Weight standard with OIML class E2
Class F2, M1, M2 & M3	20 000 g	0.2 g	Weight standard with OIML class F1

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Particle Counter ³ /Dust Monitor	(0.3 to 10) µm (0.001 to 10.000) mg/m ³	5.4 % 3.2 %	KQT-LCP-2800, particle counter digital dust monitor
Pressure – Measuring Equipment ³ Gauges/Pressure Switch/Safety Valve Pressure Transmitter Barometer/Manometer	 Down to-12 psi Up to 300 psi Up to 10 000 psi (4 to 20) mA Up to 1100 hPa	 0.06 % 0.06 % 0.025 % 0.7 % 0.06 %	 DLVN 76, KQT-17-20MP-06, KLC source procedure, Fluke 718 Seri & module & Fluke 1G & Additel ADT681
Surface Roughness Specimens	(0.4 to 3) µm (0.3 to 6) µm	0.14 µm	KQT-SRS-01, manufacturer's manual, Mitutoyo SJ-210 & federal reference standard
Surface Roughness & Surface Roughness Testers ³	0.48 µm 2.97 µm	0.2 µm 0.2 µm	KQT-33K6-4-2021-1, manufacturer's manual, Mitutoyo 178-602 & federal reference standard
Crockmeter – Force on the Finger Rubbing Distance Test Circular Friction Head	Up to 50 N Up to 200 mm	0.12 N 0.03 mm	KQT-CM-01 digimatic caliper, force gauge
Torque Drivers & Wrenches ³	(0.10 to 300) N.m (300 to 2000) N.m	0.8 % 1.3 %	KQT-33K6-4-2930-1, KLC source procedure, mount LTT-2100, Insize IST-2200 N.m
Torque Analyzers	Up to 500 N.m	0.1 %	KQT-TA-01 DLVN 110:2002, KLC source procedure torque wheel with E2+M1+F1 weights

VIII. Optical Quantities

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Light Meters Illumination ³ – Measure & Measuring Equipment	(20 to 100) lux (100 to 1000) lux (1000 to 20 000) lux	3.0 % + 0.1 lux 3.0 % + 1 lux 3.0 % + 10 lux	KQT-33K4-4-475-1, Konica CL-70F
Luminance	100 to 1000 cd/m ²	3.0 %	TES-137
Color Temperature	(2500 to 6500) K	4.1 % + 1 K	Konica CL 200A
Colorimeter & Spectrophotometry – Diffuse Reflectance Color data: CIELAB			
L* Illuminants C	2° Observer 64.80, 94.41, 72.64 & 72.27	0.05	Chroma meter MFR manual KQT-CH-01 certified calibration plates
	10° Observer 66.15, 94.42, 71.94 & 71.17	0.05	
L* Illuminants D65	2° Observer 65.04, 94.42, 72.86 & 72.11	0.05	
	10° Observer 66.44, 94.41, 72.19 & 71.08	0.05	
a* Illuminants C	2° Observer -29.16, - 0.16, -24.29 & 18.27	0.05	
	10° Observer -27.26, - 0.26, -19.97 & 20.17	0.05	
a* Illuminants D65	2° Observer -29.51, - 0.31, -24.45 & 19.88	0.05	
	10° Observer -27.72, - 0.62, -20.16 & 21.40	0.05	
b* Illuminants C	2° Observer 8.84, 2.35, 25.55 & 32.47	0.05	
	10° Observer 9.64, 2.31, 25.37 & 30.83	0.05	
b* Illuminants D65	2° Observer 8.92, 2.22, 25.63 & 32.14	0.05	
	10° Observer 9.92, 2.26, 25.59 & 30.63	0.05	

Parameter/Equipment	Range	CMC ² (±)	Comments
Colorimeter & Spectrophotometry – Diffuse Reflectance Color data: CIELAB (cont)			
X Illuminants C	2° Observer 0.2772, 0.3152, 0.3237 & 0.4174	0.016	Chroma meter MFR manual KQT-CH-01 certified calibration plates
	10° Observer 0.2832, 0.3155, 0.3312 & 0.4182	0.016	
X Illuminants D65	2° Observer 0.2781, 0.3178, 0.3238 & 0.4194	0.016	
	10° Observer 0.2849, 0.3180, 0.3324 & 0.4208	0.016	
Y Illuminants C	2° Observer 0.3652, 0.3219, 0.4019 & 0.3698	0.016	
	10° Observer 0.3692, 0.3221, 0.4004 & 0.3647	0.016	
Y Illuminants D65	2° Observer 0.3813, 0.3346, 0.4152 & 0.3786	0.016	
	10° Observer 0.3833, 0.3348, 0.4128 & 0.3758	0.016	
UV/Vis Spectrometer Light Absorbed Measure at Wavelength (254 to 875) nm	(254 to 875) nm	0.2 nm	
	Up to 0.3 Abs	0.0031 Abs	
	(0.3 to 0.5) Abs	0.0032 Abs	
	(0.5 to 2) Abs	0.0047 Abs	
	(0 to 100) % T	0.2 %	KQT-SP-01, DLVN 91:2001, ASTM E - 925 type 666-S000/F7 certified reference standard

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Radiometry – Measure, Mass Fraction As, Arsenic Br, Bromine Cd, Cadmium Cr, Chromium Hg, Mercury Pb, Lead S, Sulfur Sb, Antimony Sn, Tin Zn, Zinc	4.7 mg/kg 181 mg/kg 20.8 mg/kg 9.6 mg/kg 2.56 mg/kg 11.3 mg/kg 86 mg/kg 9.6 mg/kg 20.7 mg/kg 194 mg/kg	0.4 mg/kg 9 mg/kg 0.9 mg/kg 0.5 mg/kg 0.16 mg/kg 0.4 mg/kg 9 mg/kg 0.7 mg/kg 1.6 mg/kg 12 mg/kg	X-Ray analyzer, manufacturer's manual KQT-XRF-01 low-density polyethylene CRM
XRF – Measure Coating Thickness Ni, Nickel Cu, Copper Au, Gold	9.6 µm 9.2 µm 0.26 µm	0.6 µm 0.6 µm 0.06 µm	Manufacturer's manual KQT-XRF-01 Calmetrics foil standards
Measuring Irradiance	(Up to 150) mW/cm ² (150 to 480) mW/cm ²	4.7 % 10 %	KQT-33K4-4-576-1, OmniCure R2000 UV radiometer MFR manual, Ling shang LS120, Extech SDL470
Specular Gloss ³ – Gloss Meters High Gloss Semi Gloss Low Gloss	7.6 GU @ 20° 37.4 GU @ 60° 77.5 GU @ 85° 96.8 GU @ 60°	0.6 GU 0.8 GU 0.8 GU 0.9 GU	KQT-GL-01, standard gloss surface standard, manufacturer's manual
Specular Gloss ³ – Gloss Standards High Gloss Semi Gloss Low Gloss	7.6 GU @ 20° 37.5 GU @ 60° 77.5 GU @ 85° 96.8 GU @ 60°	0.6 GU 0.8 GU 0.8 GU 0.9 GU	KQT-GL-01, transfer using standard gloss surface standard & manufacturer's manual

VIII. Thermodynamics

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Relative Humidity – Measuring Relative Humidity Meters	(20 to 90) % RH	2.4 % RH	KQT-33K5-4-84-1, Vaisala HMP75 with JIEO tech TH-ME 65
Temperature Measuring Meters	(-40 to 150) °C	0.5 °C	KQT-33K5-4-84-1, Testo 735-1 with JIEO tech TH-KE 065 media chamber
Temperature – Measuring Equipment ³ Dry block, Heater, Furnace	(-80 to -40) °C (-40 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 600) °C (600 to 1200) °C	0.36 °C 0.13 °C 0.07 °C 0.08 % + 0.05 °C 0.1 % 0.45 %	KQT-CG-13, manufacturer's manual, Testo 735-1 Fluke 725 with TC sensors
Temperature – Measuring Equipment Probe Thermometers ³	(-40 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 650) °C	0.22 °C 0.10 °C 0.27 °C 0.17 % + 0.1 °C	KQT-33K5-4-42-1, DLVN 137 & 138: 2004, KLC source procedure, E Testo 735-1 Pt 100, HS 5609 PRT with LK LAB & Fluke dry/oil bath, Presys T-45NIR
Infrared Temperature – Measuring Instruments ³	(-45 to 0) °C (0 to 50) °C (50 to 100) °C (100 to 200) °C (200 to 400) °C (400 to 600) °C (600 to 800) °C (800 to 930) °C	1.3 °C 0.3 °C 0.7 °C 2.1 °C 3.4 °C 5.0 °C 6.8 °C 8.0 °C	KQT-33K4-4-615-1, DLVN 124:2003, Omega BB701 + BB-4A + Presys T-45NIR
Chamber/Dry Oven ³ – Humidity Temperature	(> 0 to 40) % RH (40 to 97) % RH (-80 to -50) °C (-50 to 200) °C (200 to 400) °C	1.3 % RH 1.6 % RH 0.4 °C 0.6 °C 1.2 °C	KQT-CHDO-2015 ASTM D 5374 -1999 Vaisala MI 70 + Dickson DSB, Keysight 34970A data acquisition with data loggers

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Washing Machine, Tumble Dry	(30 to 70) °C (50 to 2000) rpm Up to 10 800 s Up to 100 L	0.15 °C 1.7 rpm 2.2 s 0.7 L	KQT-WM-01 Testo 735, stopwatch, tachometer RPM10 flow meter
Moisture Content – Measure			KQT-WO-01
Moisture Meter	(10 to 20) %	0.7 %	Orion 910
Moisture Grain meter	(3 to 10) %	0.3 %	Ohaus MB25
Steam Sterilizer & Autoclave, Low Pressure Ovens	(100 to 140) °C (0 to 5) bar	0.2 °C 0.06 bar	KQT-AC-01 autoclave temperature & pressure data logger
Liquid Bath ³	(-50 to 200) °C (200 to 400) °C	0.6 °C 1.2 °C	KQT-CHDO-2015 ASTM D 5374 -1999 Dickson DSB, Keysight 34970A data acquisition with data loggers

IX. Time & Frequency

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Frequency —Measure ³	Up to 1MHz (1 to 100) MHz (100 to 500) MHz (0.5 to 1) GHz (1 to 3) GHz (3 to 5) GHz (5 to 8) GHz (8 to 12.4) GHz	0.23 Hz 1.0 Hz 0.3 Hz 1 Hz 3 Hz 5 Hz 8 Hz 12 Hz	KQT-33K3-4-3340-1 KLC source procedure, manufacturer's manual: Agilent 53132A
Frequency —Measurement Equipment ³	Up to 50 MHz (0.05 to 1) GHz (1 to 26.5) GHz	0.042 Hz 0.42 Hz 5 Hz	KQT-33K3-4-3028-1 KLC source procedure, manufacturer's manual: Agilent 33250A, Agilent 8340B

Parameter/Equipment	Range	CMC ^{2, 5, 7} ($\pm$)	Comments
Stopwatch & Timer	Up to 10 800 s	0.04 s	KQT-ST&T -01 universal frequency counter
Rotational Speed (Contact) Tachometers (CW)	Up to 5000 rpm	1.5 rpm	KQT-17-20MA-03, Ideal 1790
Rotational Speed (Non-Contact) Tachometers	Up to 600 rpm (600 to 96 000) rpm	0.1 rpm 1 rpm	KQT-17-20MA-03, Led + Agilent 33250A
Rotational Speed RPM Measurement	(10 to 90 000) rpm	0.06 % + 0.8 rpm	KQT-CF-01 Extech 461995
Vibration Meter ³ – Acceleration Velocity Displacement Frequency	10 m/s ² 10 mm/s 10 μ m 159.2 Hz	0.37 m/s ² 0.48 mm/s 0.64 μ m 0.28 Hz	KQT-33K1-4-19-1, vibration calibrator

SATELLITE LABORATORY

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CALIBRATION

I. Acoustical

Parameter/Equipment	Range	CMC ² (±)	Comments
Sound Level Meter – (@ 1 kHz) ³	(94 & 114) dB	0.59 dB	KQT-33K3-4-2911-1, BK Cal 73

II. Chemical

Parameter/Equipment	Range	CMC ² (±)	Comments
Conductivity Meter ³	1.3 µS/cm 5 µS/cm 84 µS/cm 1413 µS/cm 12.88 mS/cm	0.018 µS/cm 0.10 µS/cm 0.38 µS/cm 7.4 µS/cm 0.041 mS/cm	KQT-CD-01 manufacturer's manual, standard solution
pH Meter ³	4 pH 7 pH 10-pH	0.006 pH 0.008 pH 0.012 pH	KQT-17-20SC-42 manufacturer's manual, standard solution
Refractometer ³	(5 to 85) % Brix Up to 10 % Salinity	0.12 % Brix 0.1 % Salinity	KQT-RE-01, manufacturer's manual, Hanna HI96801
Turbidity Meter ³	(0 to 800) NTU	0.87 %	KQT-TU-01, manufacturer's manual, Hanna HI98703 standard solution

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
TDS Meter ³	50 mg/L 500 mg/L 1000 mg/L	0.44 mg/L 2.0 mg/L 4.3 mg/L	KQT-TDS-01 reference conductivity standard solution
Dissolved Oxygen Meter	(0.0 to 50.0) mg/L	0.17 mg/L	KQT-DO-01 manufacturer's manual standard solution Hanna HI9147 Hanna HI2004-02
Hydrometer	(0.600 to 2.000) g/cm ³	0.002 g/cm ³	KQT-HY-01, manufacturer's manual, standard hydrometers
Alcoholmeter	Up to 100 % <i>V</i>	0.1 % <i>V</i>	KQT-AL-01 manufacturer's manual standard alcoholmeter
Gas Detectors H ₂ S CO CH ₄ C ₄ H ₈ C ₄ H ₈ O ₂ O ₂ O ₂ O ₂ CO ₂ CO ₂ NH ₃ NH ₃ NO ₂ C ₂ H ₄ O SO ₂ NO SO ₂ CO NO ₂ SiH ₄ C ₄ H ₁₀	 0.0025 % 0.0050 % 50 % LEL 0.001 % 0.01 % 12 % 18 % 0.1 % <i>V</i> 20.9 % 2 % 0.2 % 0.0025 % 0.0050 % 0.0005 % 0.001 % 0.001 % 0.04 % 0.05 % 0.03 % 0.01 % 0.0005 % 50 % LEL	 4.2 % 3.7 % 3.7 % 2.3 % 2.3 % 3.5 % 3.5 % 2.3 % 3.5 % 2.3 % 2.3 % 2.3 % 5.8 % 3.8 % 12 % 12 % 2.0 % 2.1 % 2.1 % 5.0 % 12 % 2.3 %	 KQT-17-20SY-06, manufacturer's manual, standard gas
Viscosity Meter	(100 to 200 000) cP	0.5 %	KQT-17-20MV-01 standard solution

III. Dimensional

Parameter/Equipment	Range	CMC ² (±)	Comments
Angle Meter/Clinometer	Up to 90°	0.01 ⁰	KQT-33K6-4-157-1, angle block set
Calipers ³	Up to 500 mm (> 500 to 2000) mm	0.0014 mm/m + 8.8 µm 0.0057 mm/m + 6.7 µm	KQT-33K6-4-552-1, gauge block grade 0 +1, caliper checker
Coordinate Measuring Machines (CMM) ³ – 3-Axis Linearity Only	X: (10 to 900) mm Y: (10 to 900) mm Z: (10 to 500) mm	0.0077 mm/m + 0.15 µm 0.0077 mm/m + 0.15 µm 0.0081 mm/m + 0.15 µm	Manufacturer's manual, gauge block grade 0 + 1
Depth Gages ³	Up to 300 mm 300 to 1000 mm	0.0066 mm/m + 0.7 µm 0.0067 mm/m + 4.3 µm	KQT-33K6-4-17-1, gauge block grade 0 +1
Dial Indicator ³ /Dial Test Indicator ³	Up to 1 mm (1 to 100) mm	0.64 µm 0.0042 mm/m + 0.68 µm	KQT-IN-01, gauge block grade 0 +1, Mitutoyo UDT-3
Dial Bore Gages ³	(1 to 100) mm (> 100 to 500) mm (> 500 to 800) mm	0.0043 mm/m + 0.63 µm 0.0078 mm/m + 0.33 µm 0.0073 mm/m + 0.53 µm	KQT-IN-01, gauge block grade 0 +1
Height Gages ³	(1 to 500) mm (> 500 to 1000) mm	0.0030 mm/m + 0.18 µm 0.0020 mm/m + 6.5 µm	KQT-33K6-4-1626-1, gauge block grade 0 +1
Micrometers ³	Up to 25 mm (> 25 to 100) mm (> 100 to 500) mm (> 500 to 1000) mm	0.27 µm 0.0043 mm/m + 0.67 µm 0.0075 mm/m + 0.35 µm 0.0054 mm/m + 5.6 µm	KQT-33K6-4-15-1, gauge block grade 0 +1

Parameter/Equipment	Range	CMC ^{2, 7} (±)	Comments
Microscope, Measuring ³ Profile Projector/Optical Comparator ³	(0.01 to 1) mm (> 1 to 500) mm	0.091 mm/m + 0.6 µm 0.0041 mm/m + 2.4 µm	KQT-33K6-4-1268-1, manufacturer's manual, KLC source procedure, standard glass scale
Pin/Plug Gages ³	Up to 100 mm	0.0027 mm/m + 0.19 µm	KQT-33K6-4-121-1, Pratt & Whitney B
Surface Plate Flatness – Repeatability Only ^{3, 4}	[(12 x 12) to (48 x 96)] in	62 µin	KQT-17-20MD-14, repeat-o-zero
Feeler Gages & Thickness Films ³	Up to 25 mm	0.0045 mm/m + 0.14 µm	KQT-FG-01 Mahr ULM-1000E Mitutoyo MDH-25M
Coating Thickness Gages ³	Up to 3 mm	1.2 %	KQT-CTG-01 coating thickness standards
Thickness Gages ³	Up to 100 mm (100 to 500) mm	0.0072 mm/m + 0.12 µm 0.0078 mm/m + 0.2 µm	KQT-TH-01, gauge block grade 0 +1
Holtest	(6 to 75) mm	0.0014 mm/m + 1.9 µm	KQT-HT-01 setting ring
Distance & Length Measuring Instruments	Up to 50 m	0.002 mm	KQT-D&L-01 laser distance meter
Radius Gauge	(0.1 to 50) mm	0.032 mm/m + 3 µm	KQT-RAG-01 video measuring system VMS-3020G
Sieve	(0.05 to 50) mm (> 50 to 200) mm	0.032 mm/m + 3 µm 0.027 mm	KQT-SI-01 digimatic caliper, video measuring system VMS-3020G, Caliper CD-6"CSX

Parameter/Equipment	Range	CMC ^{2,7} (±)	Comments
Metal Detector ³ – Ferrous Brass Sus	 (0.5 to 2.5) mm (0.5 to 2.5) mm (0.5 to 3.5) mm	 0.0009 mm 0.0009 mm 0.0009 mm	 KQT-ME-01, manufacturer's manual, precision balls

IV. Electrical – DC/Low Frequency

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
AC Current – Generate ³ Up to 200 µA	 (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	 0.2 mA/A + 0.005 µA 0.2 mA/A + 0.003 µA 0.2 mA/A + 0.02 µA 1.4 mA/A + 0.1 µA	KQT-17-20AQ-101, KLC source procedure manufacturer's manual, Fluke 5720A
(0.2 to 2.2) mA	(20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.2 mA/A + 0.035 µA 0.2 mA/A + 0.035 µA 0.2 mA/A + 0.11 µA 1.5 mA/A + 0.65 µA	
(2.2 to 22) mA	(20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.2 mA/A + 0.35 µA 0.2 mA/A + 0.35 µA 0.2 mA/A + 0.55 µA 1.4 mA/A + 5 µA	
(22 to 220) mA	(20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.2 mA/A + 3.5 µA 0.2 mA/A + 2.5 µA 0.2 mA/A + 3.5 µA 1.3 mA/A + 10 µA	
220 mA to 2.2 A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.3 mA/A + 5 µA 0.5 mA/A + 80 µA 8.5 mA/A + 160 µA	
(1.5 to 11) A	(45 to 65) Hz (65 to 500) Hz (0.5 to 1) kHz	0.8 mA/A + 2 mA 1.2 mA/A + 2 mA 3.8 mA/A + 2 mA	Fluke 5500A
AC Clamp Meters (11 to 500) A Toroidal-type clamps	(45 to 65) Hz	3.1 mA/A + 0.1 A	Fluke 5500A w/ 5500/coil
“Other-type” of clamps	(45 to 65) Hz	7.4 mA/A + 0.1 A	

Parameter/Range	Frequency	CMC ^{2, 6} ($\pm$)	Comments
AC Current – Measure ³			
(5 to 100) μ A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.6 mA/A + 0.03 μ A 1.8 mA/A + 0.03 μ A 0.9 mA/A + 0.03 μ A 0.9 mA/A + 0.03 μ A	KQT-17-20AH-06, KLC source procedure, manufacturer's manual, HP 3458A
100 μ A to 10 mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.6 mA/A + 2 μ A 1.8 mA/A + 2 μ A 0.9 mA/A + 2 μ A 0.64 mA/A + 0.2 μ A	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.6 mA/A + 20 μ A 1.7 mA/A + 20 μ A 0.9 mA/A + 20 μ A 0.6 mA/A + 20 μ A	
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.7 mA/A + 0.2 mA 1.9 mA/A + 0.2 mA 1.1 mA/A + 0.2 mA 1.3 mA/A + 0.2 mA	
(1 to 20) A	(50 to 1000) Hz	1.5 mA/A + 20 μ A	
Up to 2000A	(50 to 1000) Hz	5.8 mA/A + 0.2 A	HP 3458A & high voltage divider, Kyoritsu 2009R
AC Voltage – Generate ³			
Up to 220 mV	40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.11 mV/V + 7 μ V 0.26 mV/V + 7 μ V 0.59 mV/V + 17 μ V 1.1 mV/V + 20 μ V 3.4 mV/V + 45 μ V	KQT-17-20AQ-101, KLC source procedure, manufacturer's manual, Fluke 5720A & 5500A
220 mV to 2.2 V	40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.06 mV/V + 8 μ V 0.10 mV/V + 10 μ V 0.14 mV/V + 30 μ V 0.52 mV/V + 80 μ V 2.1 mV/V + 0.3 mV	
(2.2 to 22) V	40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.06 mV/V + 0.05 mV 0.10 mV/V + 0.1 mV 0.13 mV/V + 0.2 mV 0.35 mV/V + 0.6 mV 1.9 mV/V + 3.2 mV	
(22 to 220) V	40 Hz to 20 kHz	0.07 mV/V + 0.6 mV	

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
AC Voltage – Generate ³ (cont) (22 to 220) V 220 V to 1.1 kV	 (20 to 50) kHz (50 to 100) kHz 50 Hz to 1 kHz	 0.10 mV/V + 1 mV 0.14 mV/V + 2.5 mV 0.09 mV/V + 3.5 mV	 KQT-17-20AQ-101, KLC source procedure, manufacturer's manual, Fluke 5720A & 5500A
AC Voltage – Measure ³ (0 to 10) mV (10 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	 1 kHz to 20 kHz 40 Hz to 1 kHz 40 Hz to 1 kHz (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (50 to 100) kHz 10 Hz to 20 kHz 40 Hz to 1 kHz	 0.4 mV/V + 1.1 µV 0.2 mV/V + 2 µV 0.2 mV/V + 20 µV 0.8 mV/V + 0.4 mV 0.1 mV/V + 0.2 mV 0.2 mV/V + 0.2 mV 1.0 mV/V + 0.2 mV 0.2 mV/V + 2 mV 0.7 mV/V + 20 mV	 KQT-17-20AH-06, KLC source procedure, manufacturer's manual HP 3458A
Power Analyzer/Meter ³ Up to 5 kW Up to 10 kW (10 to 500) kW Up to 5 kW Up to 10 kW (10 to 500) kW	 DC DC DC (45 to 65) Hz (45 to 65) Hz (45 to 65) Hz	 0.13 % 0.2 % 0.3 % 0.19 % 0.2 % 0.3 %	 KQT-33K1-4-1683-1, KLC source procedure, manufacturer's manual, Fluke 5500A
Capacitance – Generate ³ (@ 1 kHz)	(0.5 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 µF (1.1 to 3.3) µF (3.3 to 11) µF (11 to 33) µF (33 to 110) µF (110 to 330) µF (0.33 to 1) mF	1.4 mF/F + 10 pF 1.2 mF/F + 10 pF 1.9 mF/F + 10 pF 3.1 mF/F + 100 pF 3.3 mF/F + 100 pF 3.3 mF/F + 300 pF 3.8 mF/F + 1 nF 4.2 mF/F + 3 nF 4.5 mF/F + 10 nF 4.8 mF/F + 30 nF 6.4 mF/F + 0.1 µF 8.2 mF/F + 0.3 µF 5.2 mF/F + 1 µF	KQT-17-20AQ-101, KLC source procedure, manufacturer's manual, Fluke 5500A

Parameter/Equipment	Range	CMC ^{2, 5, 6} ($\pm$)	Comments
DC Current – Generate ³	(0 to 220) μ A (0.22 to 2.2) mA	59 μ A/A + 6 nA 48 μ A/A + 7 nA	KQT-17-20AQ-101, KLC source procedure, manufacturer's manual, Fluke 5720A
	220 μ A to 22 mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A	50 μ A/A + 40 nA 58 μ A/A + 0.7 μ A 100 μ A/A + 12 μ A 850 μ A/A + 330 μ A	Fluke 5500A
	(11 to 500) A	2 mA/A + 17 mA	Fluke 5500A w/ 550/coil
DC Current – Measure ³	(0 to 100) μ A 100 μ A to 1 mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	25 μ A/A + 0.8 nA 25 μ A/A + 5 nA 25 μ A/A + 5 nA 45 μ A/A + 0.5 μ A 120 μ A/A + 10 μ A	KQT-17-20AH-06, KLC source procedure, manufacturer's manual HP 3458A, Fluke 8845A,
	(1 to 10) A (1 to 20) A (20 to 100) A (10 to 2000) A (100 to 2000) A	0.58 mA/A + 0.5 mA 0.5 mA/A + 20 μ A 3.4 mA/A + 20 μ A 6 mA/A + 10 mA 5.8 mA/A + 20 mA	HP 3458A & shunt Kyoritsu 2009R, Advantest R6581
DC Voltage – Generate ³	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	17 μ V/V + 0.6 μ V 9.2 μ V/V + 1.3 μ V 7.2 μ V/V + 4.5 μ V 7.3 μ V/V + 8 μ V 12 μ V/V + 0.1 mV 13 μ V/V + 0.7 mV	KQT-17-20AQ-101, KLC source procedure, manufacturer's manual, Fluke 5720A & 5500A
DC Voltage – Measure ³	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1000) V	12 μ V/V + 0.35 μ V 9.3 μ V/V + 0.4 μ V 9.3 μ V/V + 1 μ V 12 μ V/V + 40 μ V 12 μ V/V + 0.15 mV	KQT-17-20AH-06, KLC source procedure, manufacturer's manual, Fluke 8845A, HP 3458A
	(0.5 to 10) kV	1.7 %	149-10A HV DMM
Power Analyzer/Meter ³	Up to 5 kW Up to 10 kW (10 to 500) kW	0.13 % 0.2 % 0.3 %	KQT-33K1-4-1683-1, KLC source procedure, manufacturer's manual, Fluke 5500A
Resistance – Generate ³	(0.13 to 1) Ω (1 to 100) Ω (0.13 to 10) k Ω 10 k Ω to 1 M Ω (1 to 100) M Ω	0.64 m Ω / Ω + 2 m Ω 0.12 m Ω / Ω + 2 m Ω 0.12 m Ω / Ω + 2 m Ω 0.19 m Ω / Ω + 2 m Ω 1.2 m Ω / Ω	KQT-17-20AQ-101, KLC source procedure, manufacturer's manual, standard resistance HARS-X-9- 0.001

Parameter/Equipment	Range	CMC ^{2, 5, 6} ($\pm$)	Comments
Resistance – Measure ³	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω (0.1 to 1) M Ω (1 to 10) M Ω (10 to 100) M Ω (0.1 to 1) G Ω	0.03 m Ω/Ω + 0.05 m Ω 0.03 m Ω/Ω + 0.5 m Ω 0.015 m Ω/Ω + 0.5 m Ω 0.023 m Ω/Ω + 5 m Ω 5.5 m Ω/Ω + 50 m Ω 0.1 m Ω/Ω + 2 Ω 0.2 m Ω/Ω + 100 Ω 3.7 m Ω/Ω + 1.1 k Ω 6.9 m Ω/Ω + 20 k Ω	KQT-17-20AH-06, KLC source procedure, manufacturer's manual, HP 3458A, Advantest R6581
Oscilloscopes ³ – DC Gain (Into 1 M Ω) DC Gain (Into 50 Ω) Leveled Sine Wave (Into 50 Ω) Time Base Sweep Rate – (Into 50 Ω)	(1.8 to 200) mV 200 mV to 33 V (1.8 to 200) mV 200 mV to 2 V 50 kHz to 10 MHz (10 to 300) MHz 5 s to 100 μ s (50 to 2) μ s 1 μ s to 20 ns (10 to 2) ns	3.1 mV/V + 0.1 mV 2.9 mV/V + 0.1 mV 3.1 mV/V + 0.1 mV 4.1 mV/V + 0.1 mV 0.006 mHz/Hz 0.17 mHz/Hz 2 m/s 17 ms/s 0.04 m/s 0.03 ms/s	KQT-CG-7, KLC source procedure, manufacturer's manual, Fluke 5500A-SC300
Electrical Calibration of Thermocouple Type K with Indicators	(-200 to < 0) $^{\circ}$ C (0 to 1200) $^{\circ}$ C	0.26 % 0.05 %	KQT-33K5-4-42-1 Fluke 5500A
Magnetic Flux – Gauss Meters ³	3 mT 50 mT 300 mT	2.5 % 1.6 % 3.6 %	KQT-33K1-4-1658-1 manufacturer's manual magnetic tool
Hipot/Withstanding Testers ³	(0.5 to 10) kV(AC) (0.5 to 10) kV(DC) (10 to 20) kV (AC/DC) (0.5 to 100) mA	13 mV/V + 5 V 7.6 mV/V + 3 V 3.5 % 1.4 %	KQT-33K1-4-181-1, KLC source procedure, manufacturer's manual, Kikusui 149-10A & TOS 1200 & Tektronix P6015A

Parameter/Equipment	Range	CMC ^{2, 5, 6} ($\pm$)	Comments
Insulation Testers ³	Up to 100 M Ω (0.1 to 10) G Ω (10 to 100) G Ω	0.2 % 1.6 % 1.3 %	KQT-33K2-4-33-1, KLC source procedure, manufacturer's manual, HRRS decade resistance
LCR Meters ³ Resistance	Up to 50 M Ω	0.01 %	KQT-33K1-4-1260-1, KLC source procedure, manufacturer's manual, LCR standard
Inductance	1 μ H to 999 mH	2.3 % + 0.5 μ H	
Capacitance (Fixed Points)	1 pF	0.19 %	
	10 pF	0.12 %	
	100 pF	0.12 %	
	1000 pF	0.12 %	

V. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2, 6} ($\pm$)	Comments
RF Power – Measure ³ (-40 to 15) dBm (-40 to 5) dBm	10 MHz to 5 GHz 5 GHz to 26.5 GHz	0.20 dBm 0.19 dBm	KQT-33K4-4-715-1, KQT-33K4-4-105-1 KLC source procedure, manufacturer's manual, HP 8340B monitored w/ Agilent N1911A w/ E4412A & N8482A
RF Power –Measuring Equipment ³ (-30 to 20) dBm (-30 to 20) dBm	100 kHz to 10 MHz 10 MHz to 6 GHz	0.34 dBm 0.37 dBm	KQT-33K4-4-715-1, KQT-33K4-4-105-1 KLC source procedure, Agilent N1911A w/ E4412A & N8482A

VI. Fluid Quantities

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Air Speed/Velocity – Measuring Equipment	Up to 30 m/s	2.1 %	KQT-33K6-4 1769-1, velocity standard
Air/Mass Flow Meters ³	(0.1 to 1) lpm (> 1 to 30) lpm (> 30 to 2500) lpm	1.5 % 1.3 % 2.9 %	KQT-33K6-4-1769-1A, mini-AP Buck Flow Calibrator M30B flow rate standard meter magnetic flowmeter
Flow Meter for Liquid	Up to 1000 lpm (1000 to 3300) lpm	(0.0028V) lpm + 0.33 lpm 2 %	KQT-33K6-4-1769-1B, flow rate rig, magnetic flowmeter, ultrasonic flowmeter
Burets	(100 to 1000) µL (1 to 10) mL (10 to 500) mL	1.1 mL/L 0.2 mL/L 0.1 mL/L	KQT-VO-01, standard weight E2 & balance
Pipettes	(10 to 100) µL (100 to 1000) µL (1 to 10) mL (10 to 500) mL	5.2 mL/L 1.1 mL/L 0.2 mL/L 0.1 mL/L	KQT-VO-01, standard weight E2 & standard scale
Volumetric Flasks	Up to 1000 mL (1000 to 5000) mL	0.17 mL/L 0.14 mL/L	KQT-VO-01, standard weight E2 & standard scale

VII. Mechanical

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Durometer – Spring Force			
Type A – B – O – F	Up to 4.5 kg	0.5 %	KQT-33K6-4-1362-1, ASTM D2240 partial calibration, standard weight E2 & standard scale
Type C – D – DO	Up to 4.5 kg	0.1 %	

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Balances & Scales ³			
Class I & II	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1000 g 2000 g 5000 g 10 000 g 20 000 g 30 000 g	0.0017 mg 0.0017 mg 0.0017 mg 0.0017 mg 0.0017 mg 0.0019 mg 0.0022 mg 0.0024 mg 0.0030 mg 0.0036 mg 0.0042 mg 0.0055 mg 0.0068 mg 0.0084 mg 0.014 mg 0.021 mg 0.08 mg 0.12 mg 0.79 mg 1.2 mg 3 mg 19 mg 140 mg 150 mg	KQT-BA-01, OIML R76-1 standard weights E1, E2 & F1
Class II, III, & IV	(1 to 30) kg (30 to 60) kg (60 to 200) kg (200 to 500) kg (500 to 2000) kg	0.7 mg/kg + 69 g 0.24 g/kg – 7.3 g 0.039 g/kg + 5.1 g 0.057 g/kg + 1.7 g 0.07 g/kg – 6.7 g	KQT-BA-01, OIML R76-1 standard weights, F2 M1 & M2
Force Tester ³	Up to 50 kgf (50 to 500) kgf (500 to 5000) kgf (5000 to 10 000) kgf	0.02 % 0.1 % 0.46 % 0.4 %	KQT-17-20MF-04, DLVN 109 KLC source procedure, standard weight E2 & load cell
Hardness Testers ³ –			
Indirect Verification of Rockwell Hardness Testers	HRBW: Medium High HRC: Low Medium High	0.93 HRBW 0.92 HRBW 0.5 HRC 0.5 HRC 0.5 HRC	DLVN 63, manufacturer's manual

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Hardness Testers ³ – Indirect Verification of Vickers Hardness Testers	HV: 300 HV 501 HV 703 HV HMV: 501 HV	1.9 HV 9.1 HV 13 HV 9.8 HV	DLVN 63, manufacturer's manual
Mass/Weights Class E2, F1, F2, M1, M2 & M3	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g	0.0023 mg 0.0024 mg 0.0024 mg 0.0024 mg 0.0024 mg 0.0026 mg 0.003 mg 0.003 mg 0.004 mg 0.005 mg 0.006 mg 0.008 mg 0.010 mg 0.012 mg 0.019 mg 0.028 mg 0.11 mg 0.15 mg	KQT-SW-01, OIML R111-1, weight standard with OIML class E1
Class F1, F2, M1, M2 & M3	1000 g 2000 g 5000 g 10 000 g	1.2 mg 1.7 mg 4 mg 20 mg	weight standard with OIML class E2
Class F2, M1, M2 & M3	20 000 g	0.2 g	weight standard with OIML class F1
Particle Counter ³ /Dust Monitor	(0.3 to 10) µm (0.001 to 10.000) mg/m ³	5.4 % 3.2 %	KQT-LCP-2800, particle counter digital dust monitor

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Pressure ³ – Gauges/Pressure Switch/Safety Valve Pressure Transmitter Barometer/ Manometer	Down to -12 psi Up to 300 psi Up to 10 000 psi (4 to 20) mA Up to 1100 hPa	0.06 % 0.06 % 0.025 % 0.7 % 0.06 %	DLVN 76 KQT-17-20MP-06, KLC source procedure, Fluke 718 Seri & module & Fluke 1G
Surface Roughness Specimens	(0.4 to 3) µm (0.3 to 6) µm	0.14 µm	KQT-SRS-01, manufacturer's manual, Mitutoyo SJ-210 & federal reference standard
Surface Roughness & Surface Roughness Testers ³	0.48 µm 2.97 µm	0.2 µm 0.2 µm	KQT-33K6-4-2021-1, manufacturer's manual, Mitutoyo 178-602 & federal reference standard
Crockmeter – Force on the Finger Rubbing Distance Test Circular Friction Head	Up to 50 N Up to 200 mm	0.05 N 0.04 mm	KQT-CM-01 digimatic caliper, force gauge
Torque Drivers & Wrenches ³	(0.001 to 10) N·m (10 to 300) N·m (300 to 2000) N·m	0.5 % 0.8 % 1.3 %	KQT-33K6-4-2930-1, KLC source procedure, mount LTT-2100, insize IST- 2200 N·m
Torque Analyzers	Up to 500 N·m	0.13 %	KQT-TA-01 DLVN 110KLC source procedure torque wheel with E2+M1+F1 weights

VIII. Optical Quantities

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Light Meters Illumination ³ – Measure & Measuring Equipment	(20 to 100) lux (100 to 1000) lux (1000 to 20 000) lux	3.0 % + 0.1 lux 3.0 % + 1 lux 3.0 % + 10 lux	KQT-33K4-4-475-1, Konica CL-70F
Luminance	100 to 1000 cd/m ²	3.0 %	TES-137
Color Temperature	(2500 to 6500) K	4.1 % + 1 K	Konica CL 200A

Parameter/Equipment	Range	CMC ² (±)	Comments
Colorimeter & Spectrophotometry – Diffuse Reflectance Color data: CIELAB			
L* Illuminants C	2° Observer 64.80, 94.41, 72.64 & 72.27	0.05	Chroma meter MFR manual KQT-CH-01 certified calibration plates
	10° Observer 66.15, 94.42, 71.94 & 71.17	0.05	
L* Illuminants D65	2° Observer 65.04, 94.42, 72.86 & 72.11	0.05	
	10° Observer 66.44, 94.41, 72.19 & 71.08	0.05	
a* Illuminants C	2° Observer -29.16, - 0.16, -24.29 & 18.27	0.05	
	10° Observer -27.26, - 0.26, -19.97 & 20.17	0.05	
a* Illuminants D65	2° Observer -29.51, - 0.31, -24.45 & 19.88	0.05	
	10° Observer -27.72, - 0.62, -20.16 & 21.40	0.05	
b* Illuminants C	2° Observer 8.84, 2.35, 25.55 & 32.47	0.05	
	10° Observer 9.64, 2.31, 25.37 & 30.83	0.05	
b* Illuminants D65	2° Observer 8.92, 2.22, 25.63 & 32.14	0.05	
	10° Observer 9.92, 2.26, 25.59 & 30.63	0.05	
X Illuminants C	2° Observer 0.2772, 0.3152, 0.3237 & 0.4174	0.016	
	10° Observer 0.2832, 0.3155, 0.3312 & 0.4182	0.016	

Parameter/Equipment	Range	CMC ^{2,7} (±)	Comments
Colorimeter & Spectrophotometry – Diffuse Reflectance Color data: CIELAB (cont)			
X Illuminants D65	2° Observer 0.2781, 0.3178, 0.3238 & 0.4194	0.016	Chroma meter MFR manual, KQT-CH-01, certified calibration plates
	10° Observer 0.2849, 0.3180, 0.3324 & 0.4208	0.016	
Y Illuminants C	2° Observer 0.3652, 0.3219, 0.4019 & 0.3698	0.016	
	10° Observer 0.3692, 0.3221, 0.4004 & 0.3647	0.016	
Y Illuminants D65	2° Observer 0.3813, 0.3346, 0.4152 & 0.3786	0.016	
	10° Observer 0.3833, 0.3348, 0.4128 & 0.3758	0.016	
UV/Vis Spectrometer Light Absorbed Measure at Wavelength (254 to 875) nm	(254 to 875) nm Up to 0.3 Abs (0.3 to 0.5) Abs (0.5 to 2) Abs (0 to 100) % T	0.2 nm 0.0031 Abs 0.0032 Abs 0.0047 Abs 0.2 %	KQT-SP-01, DLVN 91:2001, ASTM E - 925 type 666-S000/F7 certified reference standard
XRF – Measure Coating Thickness			
Ni, Nickel Cu, Copper Au, Gold	9.6 µm 9.2 µm 0.26 µm	0.6 µm 0.6 µm 0.06 µm	Manufacturer's manual KQT-XRF-01 Calmetrics foil standards

Parameter/Equipment	Range	CMC ^{2, 5, 7} ($\pm$)	Comments
Specular Gloss ³ – Gloss Meters			
High Gloss	7.6 GU @ 20°	0.6 GU	KQT-GL-01, standard gloss surface standard, manufacturer's manual
Semi Gloss	37.6 GU @ 60°	0.8 GU	
Low Gloss	77.5 GU @ 85°	0.8 GU	
	96.8 GU @ 60°	0.9 GU	
Specular Gloss ³ – Gloss Standards			
High Gloss	7.6 GU @ 20°	0.6 GU	KQT-GL-01, transfer using standard gloss surface standard & manufacturer's manual
Semi Gloss	37.7 GU @ 60°	0.8 GU	
Low Gloss	77.5 GU @ 85°	0.8 GU	
	96.8 GU @ 60°	0.9 GU	

IX. Thermodynamics

Parameter/Equipment	Range	CMC ^{2, 5, 7} ($\pm$)	Comments
Relative Humidity – Measuring Relative Humidity Meters	(20 to 90) % RH	2.4 % RH	KQT-33K5-4-84-1, Vaisala HMP75 with JIEO tech TH-ME 65
Temperature – Measuring Meters	(-40 to 150) °C	0.5 °C	KQT-33K5-4-84-1, Testo 735-1 with JIEO tech TH-KE 065 media chamber
Temperature – Measuring Equipment ³ Dry block, Heater, Furnace	(-80 to -40) °C (-40 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 600) °C (600 to 1200) °C	0.36 °C 0.13 °C 0.07 °C 0.08 % + 0.05 °C 0.1 % 0.45 %	KQT-CG-13, manufacturer's manual, Testo 735-1 Fluke 725 with TC sensors

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Temperature – Measuring Equipment, Probe Thermometers ³	(-40 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 650) °C	0.22 °C 0.10 °C 0.27 °C 0.17 % + 0.1 °C	KQT-33K5-4-42-1, DLVN 137 & 138: 2004, KLC source procedure, E Testo 735-1 Pt 100, HS 5609 PRT with LK LAB & Fluke dry/oil bath
Infrared Temperature – Measuring Instruments ³	(-45 to 0) °C (0 to 50) °C (50 to 100) °C (100 to 200) °C (200 to 400) °C (400 to 600) °C (600 to 800) °C (800 to 930) °C	1.3 °C 0.3 °C 0.7 °C 2.1 °C 3.4 °C 5.0 °C 6.8 °C 8.0 °C	KQT-33K4-4-615-1, DLVN 124:2003, Omega BB701 + BB-4A + CEM BXC-15
Chamber/Dry Oven ³ – Humidity Temperature	(> 0 to 40) % RH (40 to 97) % RH (-80 to -50) °C (-50 to 200) °C (200 to 400) °C	1.3 % RH 1.6 % RH 0.4 °C 0.6 °C 1.2 °C	KQT-CHDO-2015 ASTM D 5374 -1999 Vaisala MI 70 & Dickson DSB, Keysight 34970A data acquisition with data loggers
Washing Machine, Tumble Dry	(30 to 70) °C (50 to 2000) rpm Up to 10 800 s Up to 100 L	0.15 °C 1.7 rpm 2.2 s 0.7 L	KQT-WM-01 Testo 735, stopwatch, Tachometer RPM10 flow meter
Moisture Content – Measure Moisture Meter Moisture Grain Meter	(10 to 20) % (3 to 10) %	0.7 % 0.3 %	KQT-WO-01 Orion 910 Ohaus MB25
Steam Sterilizer & Autoclave, Low Pressure Ovens	(100 to 140) °C (0 to 5) bar	0.2 °C 0.06 bar	KQT-AC-01, autoclave temperature & pressure data logger
Liquid Bath ³	(-50 to 200) °C (200 to 400) °C	0.6 °C 1.2 °C	KQT-CHDO-2015 ASTM D 5374 -1999 Dickson DSB, Keysight 34970A data acquisition with data loggers

X. Time & Frequency

Parameter/Equipment	Range	CMC ^{2, 5, 7} ($\pm$)	Comments
Frequency –Measure Instruments ³	Up to 1MHz (1 to 100) MHz (100 to 500) MHz (0.5 to 1) GHz (1 to 3) GHz (3 to 5) GHz (5 to 8) GHz (8 to 12.4) GHz	0.23 Hz 1.0 Hz 0.3 Hz 1 Hz 3 Hz 5 Hz 8 Hz 12 Hz	KQT-33K3-4-3340-1 KLC source procedure, manufacturer's manual: Agilent 53132A
Frequency –Generate Instruments ³	Up to 50 MHz (0.05 to 1) GHz (1 to 26.5) GHz	0.042 Hz 0.42 Hz 5 Hz	KQT-33K3-4-3028-1 KLC source procedure, manufacturer's manual: Agilent 33250A, Agilent 8340B
Stopwatch & Timer	Up to 10 800 s	0.04 s	KQT-ST&T -01 universal frequency counter
Rotational Speed (Contact) Tachometers (CW)	Up to 5000 rpm	1.5 rpm	KQT-17-20MA-03, Ideal 1790,
Rotational Speed (Non-Contact) Tachometers	Up to 600 rpm (600 to 96 000) rpm	0.1 rpm 1 rpm	KQT-17-20MA-03, Led + Agilent 33250A
Rotational Speed RPM Measurement	(10 to 90 000) rpm	0.06 % + 0.8 rpm	KQT-CF-01 Extech 461995
Vibration Meter ³ – Acceleration Velocity Displacement Frequency	10 m/s ² 10 mm/s 10 μ m 159.2 Hz	0.37 m/s ² 0.48 mm/s 0.64 μ m 0.28 Hz	KQT-33K1-4-19-1, vibration calibrator

SATELLITE LABORATORY

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CALIBRATION

I. Acoustical

Parameter/Equipment	Range	CMC ² (±)	Comments
Sound Level Meter – (@ 1 kHz) ³	(94 & 114) dB	0.59 dB	KQT-33K3-4-2911-1, BK Cal 73

II. Chemical

Parameter/Equipment	Range	CMC ² (±)	Comments
Conductivity Meter ³	1.3 µS/cm 5 µS/cm 84 µS/cm 1413 µS/cm 12.88 mS/cm	0.018 µS/cm 0.10 µS/cm 0.38 µS/cm 7.4 µS/cm 0.041 mS/cm	KQT-CD-01 manufacturer's manual, standard solution
pH Meter ³	4 pH 7 pH 10 pH	0.006 pH 0.008 pH 0.012 pH	KQT-17-20SC-42 manufacturer's manual, standard solution
Hydrometer	(0.600 to 2.000) g/cm ³	0.002 g/cm ³	KQT-HY-01 manufacturer's manual, standard hydrometers
Refractometer ³	(5 to 85) % Brix Up to 10 % Salinity	0.12 % Brix 0.1 % Salinity	KQT-RE-01 manufacturer's manual, Hanna HI96801 standard solution

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
TDS Meter ³	50 mg/L 500 mg/L 1000 mg/L	0.44 mg/L 2.0 mg/L 4.3 mg/L	KQT-TDS-01 reference conductivity standard solution
Dissolved Oxygen Meter	(0.0 to 50.0) mg/L	0.17 mg/L	KQT-DO-01 manufacturer's manual standard solution Hanna HI9147 Hanna HI2004-02
Alcoholmeter	Up to 100 % <i>V</i>	0.1 % <i>V</i>	KQT-AL-01 manufacturer's manual standard alcoholmeter
Viscosity Meter	(100 to 200 000) cP	0.5 %	KQT-17-20MV-01 standard solution
Gas Detectors			
H ₂ S	0.0025 % <i>V</i>	4.2 %	KQT-17-20SY-06, manufacturer's manual, standard gas
CO	0.0050 % <i>V</i>	3.7 %	
CH ₄	50 % LEL	3.7 %	
C ₄ H ₈	0.001 % <i>V</i>	2.3 %	
C ₄ H ₈	0.01 % <i>V</i>	2.3 %	
O ₂	12 % <i>V</i>	3.5 %	
O ₂	18 % <i>V</i>	3.5 %	
O ₂	0.1 % <i>V</i>	3.5 %	
O ₂	20.9 % <i>V</i>	3.5 %	
CO ₂	2 % <i>V</i>	2.3 %	
CO ₂	0.2 % <i>V</i>	2.3 %	
NH ₃	0.0025 % <i>V</i>	2.3 %	
NH ₃	0.0050 % <i>V</i>	5.8 %	
NO ₂	0.0005 % <i>V</i>	3.8 %	
C ₂ H ₄ O	0.001 % <i>V</i>	12 %	
SO ₂	0.001 % <i>V</i>	12 %	
NO	0.04 % <i>V</i>	2.0 %	
SO ₂	0.05 % <i>V</i>	2.1 %	
CO	0.03 % <i>V</i>	2.1 %	
NO ₂	0.01 % <i>V</i>	5.0 %	
SiH ₄	0.0005 % <i>V</i>	12 %	
C ₄ H ₁₀	50 % LEL	2.3 %	

III. Dimensional

Parameter/Equipment	Range	CMC ² (±)	Comments
Angle Meter/Clinometer	Up to 90°	0.01 ⁰	KQT-33K6-4-157-1, angle block set
Calipers ³	Up to 500 mm (> 500 to 2000) mm	0.0014 mm/m + 8.8 µm 0.0057 mm/m + 6.7 µm	KQT-33K6-4-552-1, gauge block grade 0 & 1, caliper checker
Depth Gages ³	Up to 300 mm 300 to 1000 mm	0.0066 mm/m + 0.7 µm 0.0067 mm/m + 4.3 µm	KQT-33K6-4-17-1, gauge block grade 0 & 1
Dial Indicator ³ / Dial Test Indicator ³	Up to 1 mm (1 to 100) mm	0.64 µm 0.0042 mm/m + 0.68 µm	KQT-IN-01, gauge block grade 0 & 1, Mitutoyo UDT-3
Distance & Length Measuring Instruments	Up to 50 m	0.003 m	KQT-D&L-01 laser distance meter
Holtest	(6 to 75) mm	0.0014 mm/m + 1.9 µm	KQT-HT-01 setting ring
Height Gages ³	(1 to 500) mm (> 500 to 1000) mm	0.0030 mm/m + 0.18 µm 0.0020 mm/m + 6.5 µm	KQT-33K6-4-1626-1, gauge block grade 0 +1
Micrometers ³	Up to 25 mm (> 25 to 100) mm (> 100 to 500) mm (> 500 to 1000) mm	0.27 µm 0.0043 mm/m + 0.67 µm 0.0075 mm/m + 0.35 µm 0.0054 mm/m + 5.6 µm	KQT-33K6-4-15-1, gauge block grade 0 +1
Surface Plate Flatness – Repeatability Only ^{3, 4}	[(12 x 12) to (48 x 96)] in	62 µin	KQT-17-20MD-14, repeat-o-zero

Parameter/Equipment	Range	CMC ² (±)	Comments
Feeler Gages & Thickness Films ³	Up to 25 mm	0.0045 mm/m + 0.14 µm	KQT-FG-01 Mahr ULM-1000E Mitutoyo MDH-25M
Coating Thickness Gages ³	Up to 3 mm	1.2 %	KQT-CTG-01 coating thickness standards
Thickness Gages ³	Up to 100 mm (100 to 500) mm	0.0072 mm/m + 0.12 µm 0.0078 mm/m + 0.2 µm	KQT-TH-01, gauge block grade 0 +1
Microscope, Measuring ³ Profile Projector/Optical Comparator ³	(0.01 to 1) mm (> 1 to 500) mm	0.091 mm/m + 0.6 µm 0.0041 mm/m + 2.4 µm	KQT-33K6-4-1268-1, manufacturer's manual, KLC source procedure, standard glass scale
Metal Detector ³ – Ferrous Brass Sus	(0.5 to 2.5) mm (0.5 to 2.5) mm (0.5 to 3.5) mm	0.0009 mm 0.0009 mm 0.0009 mm	KQT-ME-01, manufacturer's manual, precision balls

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
DC Current – Generate ³	(0 to 220) µA 220 µA to 22 mA (22 to 220) mA 220 mA to 1 A	110 µA/A + 6 nA 52 µA/A + 40 nA 70 µA/A + 0.7 µA 110 µA/A + 12 µA	KQT-17-20AQ-101, KLC source procedure, manufacturer's manual, Keithley 2450
DC Current – Measure ³	(0 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA (0.1 to 3) A (3 to 100) A	110 µA/A + 0.8 nA 50 µA/A + 5 nA 47 µA/A + 50 nA 67 µA/A + 0.5 µA 150 µA/A + 10 µA 7.2 mA/A	KQT-17-20AH-06, KLC source procedure, manufacturer's manual HP 34401A HP 34401A w/ L&N 4361 shunt

Parameter/Equipment	Range	CMC ^{2, 6} ($\pm$)	Comments
DC Voltage – Generate ³	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 200) V	14 μ V/V + 0.7 μ V 8.1 μ V/V + 1.4 μ V 5.6 μ V/V + 5 μ V 5.6 μ V/V + 9 μ V 8.1 μ V/V + 90 μ V	KQT-17-20AQ-101, KLC source procedure, manufacturer's manual, Keithley 2450
DC Voltage – Measure ³	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1000) V	12 μ V/V + 0.35 μ V 9.3 μ V/V + 0.4 μ V 9.3 μ V/V + 1 μ V 12 μ V/V + 40 μ V 12 μ V/V + 0.15 mV	KQT-17-20AH-06, KLC source procedure, manufacturer's manual HP 34401A
Capacitance – Generate ³ (@ 1 kHz)	(0.5 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F (0.33 to 1) mF	1.4 mF/F + 10 pF 1.2 mF/F + 10 pF 1.9 mF/F + 10 pF 3.1 mF/F + 100 pF 3.3 mF/F + 100 pF 3.3 mF/F + 300 pF 3.8 mF/F + 1 nF 4.2 mF/F + 3 nF 4.5 mF/F + 10 nF 4.8 mF/F + 30 nF 6.4 mF/F + 0.1 μ F 8.2 mF/F + 0.3 μ F 5.2 mF/F + 1 μ F	KQT-17-20AQ-101, KLC source procedure, manufacturer's manual, decade capacitor AEMC-BC05
Resistance – Generate ³	(0.001 to 1) Ω (1 to 100) Ω (0.13 to 10) k Ω 10 k Ω to 1 M Ω (1 to 100) M Ω (0.1 to 1) G Ω (1 to 10) G Ω (10 to 100) G Ω	0.64 m Ω / Ω + 2 m Ω 0.12 m Ω / Ω + 2 m Ω 0.12 m Ω / Ω + 2 m Ω 0.19 m Ω / Ω + 2 m Ω 1.2 m Ω / Ω 2.4 m Ω / Ω 6.2 m Ω / Ω 13 m Ω / Ω	KQT-17-20AQ-101, KLC source procedure, manufacturer's manual, standard resistance HARS-X-9-0.001, HRRS-9-5-10-5kV, HRRS decade resistance
Resistance – Measure ³	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω (0.1 to 1) M Ω (1 to 10) M Ω	0.03 m Ω / Ω + 0.05 m Ω 0.03 m Ω / Ω + 0.5 m Ω 0.015 m Ω / Ω + 0.5 m Ω 0.023 m Ω / Ω + 5 m Ω 5.5 m Ω / Ω + 50 m Ω 0.1 m Ω / Ω + 2 Ω 0.2 m Ω / Ω + 100 Ω	KQT-17-20AH-06, KLC source procedure, manufacturer's manual, HP 34401A

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
LCR Meters ³			KQT-33K1-4-1260-1, KLC source procedure, manufacturer's manual, LCR standard
Resistance	Up to 50 MΩ	0.01 %	
Inductance	1 μH to 999 mH	2.3 % + 0.5 μH	
Capacitance (Fixed Points)	1 pF 10 pF 100 pF 1000 pF	0.19 % 0.12 % 0.12 % 0.12 %	
Power Analyzer/Meter ³			KQT-33K1-4-1683-1, KLC source procedure, manufacturer's manual, Fluke 5500A
Up to 5 kW	DC	0.13 %	
Up to 10 kW	DC	0.2 %	
(10 to 500) kW	DC	0.3 %	
Up to 5 kW	(45 to 65) Hz	0.19 %	
Up to 10 kW	(45 to 65) Hz	0.2 %	
(10 to 500) kW	(45 to 65) Hz	0.3 %	
Hipot/Withstanding Testers ³	(0.5 to 10) kV (AC) (0.5 to 10) kV (DC) (10 to 20) kV (AC/DC) (0.5 to 100) mA	13 mV/V + 5 V 7.6 mV/V + 3 V 3.5 % 1.4 %	KQT-33K1-4-181-1, KLC source procedure, manufacturer's manual, Kikusui 149-10A & TOS 1200 & Tektronix P6015A
Insulation Testers ³	Up to 100 MΩ (0.1 to 10) GΩ (10 to 100) GΩ	0.2 % 1.6 % 1.3 %	KQT-33K2-4-33-1, KLC source procedure, manufacturer's manual, HRRS decade resistance

V. Fluid Quantities

Parameter/Equipment	Range	CMC ² (±)	Comments
Air Speed/Velocity Meter	Up to 30 m/s	2.1 %	KQT-33K6-4-1769-1, velocity standard
Burets	(100 to 1000) μL (1 to 10) mL (10 to 400) mL	1.1 mL/L 0.2 mL/L 0.1 mL/L	KQT-VO-01, standard weight F1 & balance

Parameter/Equipment	Range	CMC ² (±)	Comments
Pipettes	(100 to 1000) µL (1 to 10) mL (10 to 400) mL	1.1 mL/L 0.2 mL/L 0.1 mL/L	KQT-VO-01, standard weight F1 & balance
Volumetric Flasks	Up to 1000 mL (1000 to 4000) mL	0.17 mL/L 0.14 mL/L	KQT-VO-01, standard weight F1 & standard scale

VI. Mechanical

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Balances & Scales ³			
Class I & II	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1000 g 2000 g 5000 g 10 000 g 20 000 g 30 000 g	0.0017 mg 0.0017 mg 0.0017 mg 0.0017 mg 0.0017 mg 0.0019 mg 0.0022 mg 0.0024 mg 0.0030 mg 0.0036 mg 0.0042 mg 0.0055 mg 0.0068 mg 0.0084 mg 0.014 mg 0.021 mg 0.08 mg 0.12 mg 0.79 mg 1.2 mg 3 mg 19 mg 140 mg 150 mg	KQT-BA-01, OIML R76-1 standard weights E1, E2 & F1
Class II, III, & IV	(1 to 30) kg (30 to 60) kg (60 to 200) kg (200 to 500) kg (500 to 2000) kg	0.7 mg/kg + 69 g 0.24 g/kg – 7.3 g 0.039 g/kg + 5.1 g 0.057 g/kg + 1.7 g 0.07 g/kg – 6.7 g	KQT-BA-01, OIML R76-1 standard weights, F2 M1 & M2

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Durometer – Spring Force			
Type A – B – O – F	Up to 4.5 kg	0.5 %	KQT-33K6-4-1362-1, ASTM D2240 partial calibration, standard weight F1 & standard scale
Type C – D – DO	Up to 4.5 kg	0.1 %	
Force Tester ³	Up to 50 kgf (50 to 500) kgf (500 to 5000) kgf (5000 to 10 000) kgf	0.02 % 0.1 % 0.46 % 0.4 %	KQT-17-20MF-04, DLVN 109, KLC source procedure, standard weight E2 & load cell
Mass/Weights			
Class E2, F1, F2, M1, M2 & M3	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g	0.0023 mg 0.0024 mg 0.0024 mg 0.0024 mg 0.0024 mg 0.0026 mg 0.003 mg 0.003 mg 0.004 mg 0.005 mg 0.006 mg 0.008 mg 0.010 mg 0.012 mg 0.019 mg 0.028 mg 0.11 mg 0.15 mg	KQT-SW-01, OIML R111-1, weight standard with OIML class E1
Class F1, F2, M1, M2 & M3	1000 g 2000 g 5000 g 10 000 g	1.2 mg 1.7 mg 4 mg 20 mg	Weight standard with OIML class E2
Class F2, M1, M2 & M3	20 000 g	0.2 g	Weight standard with OIML class F1
Pressure ³ –			
Gauges/Pressure Switch/Safety Valve	Down to -12 psi Up to 300) psi Up to 10 000 psi	0.06 % 0.06 % 0.025 %	DLVN 76; KQT-17-20MP-06, KLC source procedure, Fluke 718 Seri & module & Fluke 1G
Pressure Transmitter Barometer/Manometer	(4 to 20) mA Up to 1100 hPa	0.7 % 0.06 %	

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Torque Drivers & Wrenches ³	(0.001 to 10) N·m (10 to 300) N·m (300 to 2000) N·m	0.5 % 0.8 % 1.3 %	KQT-33K6-4-2930-1, KLC source procedure, mount LTT-2100, Insize IST-2200 N·m
Torque Analyzers	Up to 10 N·m	0.13 %	KQT-TA-01 DLVN 110 KLC source procedure torque wheel with E2+M1+F1 weights

VIII. Optical Quantities

Parameter/Equipment	Range	CMC ² (±)	Comments
Colorimeter & Spectrophotometry – Diffuse Reflectance Color Data: CIELAB			
L* Illuminants C	2° Observer 64.80, 94.41, 72.64 & 72.27	0.05	Chroma meter MFR manual KQT-CH-01 certified calibration plates
	10° Observer 66.15, 94.42, 71.94 & 71.17	0.05	
L* Illuminants D65	2° Observer 65.04, 94.42, 72.86 & 72.11	0.05	
	10° Observer 66.44, 94.41, 72.19 & 71.08	0.05	
a* Illuminants C	2° Observer -29.16, -0.16, -24.29 & 18.27	0.05	
	10° Observer -27.26, -0.26, -19.97 & 20.17	0.05	
a* Illuminants D65	2° Observer -29.51, -0.31, -24.45 & 19.88	0.05	
	10° Observer -27.72, -0.62, -20.16 & 21.40	0.05	
b* Illuminants C	2° Observer 8.84, 2.35, 25.55 & 32.47	0.05	
	10° Observer 9.64, 2.31, 25.37 & 30.83	0.05	

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Colorimeter & Spectrophotometry – Diffuse Reflectance Color Data: CIELAB (cont)			
b* Illuminants D65	2° Observer 8.92, 2.22, 25.63 & 32.14	0.05	Chroma meter MFR manual KQT-CH-01 certified calibration plates
	10° Observer 9.92, 2.26, 25.59 & 30.63	0.05	
X Illuminants C	2° Observer 0.2772, 0.3152, 0.3237 & 0.4174	0.016	
	10° Observer 0.2832, 0.3155, 0.3312 & 0.4182	0.016	
X Illuminants D65	2° Observer 0.2781, 0.3178, 0.3238 & 0.4194	0.016	
	10° Observer 0.2849, 0.3180, 0.3324 & 0.4208	0.016	
Y Illuminants C	2° Observer 0.3652, 0.3219, 0.4019 & 0.3698	0.016	
	10° Observer 0.3692, 0.3221, 0.4004 & 0.3647	0.016	
Y Illuminants D65	2° Observer 0.3813, 0.3346, 0.4152 & 0.3786	0.016	
	10° Observer 0.3833, 0.3348, 0.4128 & 0.3758	0.016	
Light Meters Illumination ³ – Measure & Measuring Equipment	(20 to 100) lux (100 to 1000) lux (1000 to 20 000) lux	3.0 % + 0.1 lux 3.0 % + 1 lux 3.0 % + 10 lux	KQT-33K4-4-475-1, Konica CL-70F
Luminance	100 to 1000 cd/m ²	3.0 %	TES-137
Color Temperature	(2500 to 6500) K	4.1 % + 1 K	Konica CL-70F

Parameter/Equipment	Range	CMC ^{2, 7} (±)	Comments
UV/Vis Spectrometer Light Absorbed Measure at Wavelength (254 to 875) nm	(254 to 875) nm Up to 0.3 Abs (0.3 to 0.5) Abs (0.5 to 2) Abs (0 to 100) % T	0.2 nm 0.0031 Abs 0.0032 Abs 0.0047 Abs 0.2 %	KQT-SP-01, DLVN 91:2001, ASTM E - 925 type 666-S000/F7 certified reference standard
Radiometry – Measure Mass Fraction As, Arsenic Br, Bromine Cd, Cadmium Cr, Chromium Hg, Mercury Pb, Lead S, Sulfur Sb, Antimony Sn, Tin Zn, Zinc	 4.7 mg/kg 181 mg/kg 20.8 mg/kg 9.6 mg/kg 2.56 mg/kg 11.3 mg/kg 86 mg/kg 9.6 mg/kg 20.7 mg/kg 194 mg/kg	 0.4 mg/kg 9 mg/kg 0.9 mg/kg 0.5 mg/kg 0.16 mg/kg 0.4 mg/kg 9 mg/kg 0.7 mg/kg 1.6 mg/kg 12 mg/kg	X-Ray analyzer manufacturer's manual KQT-XRF-01 low-density polyethylene CRM
XRF – Measure Coating Thickness Ni, Nickel Cu, Copper Au, Gold	 9.6 µm 9.2 µm 0.26 µm	 0.6 µm 0.6 µm 0.06 µm	Manufacturer's manual KQT-XRF-01 Calmetrics foil standards

VIII. Thermodynamics

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Relative Humidity – Measuring Relative Humidity Meters	(20 to 90) % RH	2.4 % RH	KQT-33K5-4-84-1, Vaisala HMP75 with JIEO tech TH-ME 65
Temperature – Measuring Meters	(-40 to 150) °C	0.5 °C	KQT-33K5-4-84-1, Testo 735-1 with JIEO tech TH-KE 065 media chamber

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Temperature Measuring Equipment ³ – Dry block, Heater, Furnace	(-80 to -40) °C (-40 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 600) °C (600 to 1200) °C	0.36 °C 0.13 °C 0.07 °C 0.08 % + 0.05 °C 0.1 % 0.45 %	KQT-CG-13, manufacturer's manual, Testo 735-1 Fluke 725 with TC sensors
Temperature – Measuring Equipment Probe Thermometers ³	(-40 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 650) °C	0.22 °C 0.10 °C 0.27 °C 0.17 % + 0.1 °C	KQT-33K5-4-42-1, DLVN 137 & 138: 2004, KLC source procedure, E Testo 735-1 Pt 100, HS 5609 PRT with LK LAB & Fluke dry/oil bath
Infrared Temperature – Measuring Instruments ³	(-45 to 0) °C (0 to 50) °C (50 to 100) °C (100 to 200) °C (200 to 400) °C (400 to 600) °C (600 to 800) °C (800 to 930) °C	1.3 °C 0.3 °C 0.7 °C 2.1 °C 3.4 °C 5.0 °C 6.8 °C 8.0 °C	KQT-33K4-4-615-1, DLVN 124:2003, Omega BB701 + BB-4A + CEM BXC-15
Chamber/Dry Oven ³ – Humidity Temperature	Up to 40 % RH (40 to 97) % RH (-80 to -50) °C (-50 to 200) °C (200 to 400) °C	1.3 % RH 1.6 % RH 0.4 °C 0.6 °C 1.2 °C	KQT-CHDO-2015 ASTM D 5374 -1999 Vaisala MI 70 & Dickson DSB, Keysight 34970A data acquisition with data loggers
Washing Machine, Tumble Dry	(30 to 70) °C (50 to 2000) rpm Up to 10 800 s Up to 100 L	0.15 °C 1.7 rpm 2.2 s 0.7 L	KQT-WM-01 Testo 735, stopwatch, tachometer RPM10 flow meter
Steam Sterilizer & Autoclave, Low Pressure Ovens	(-40 to 140) °C (0 to 5) bar	0.2 °C 0.06 bar	KQT-AC-01, autoclave temperature & pressure data logger

Parameter/Equipment	Range	CMC ² (±)	Comments
Liquid Bath ³	(-50 to 200) °C (200 to 400) °C	0.6 °C 1.2 °C	KQT-CHDO-2015 ASTM D 5374 -1999 Dickson DSB, Keysight 34970A data acquisition with data loggers

¹ This laboratory offers commercial calibration service and field calibration service.

² Calibration and Measurement Capability Uncertainty (CMC) is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards or nearly ideal measuring equipment. CMCs represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of $k = 2$. The actual measurement uncertainty of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer's device and to influences from the circumstances of the specific calibration.

³ Field calibration service is available for this calibration. Please note the actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the CMC found on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the actual uncertainty introduced by the item being calibrated, (e.g., resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC.

⁴ Surface plate calibrations are only offered as a partial calibration that is limited to repeat readings that reflect local variations in flatness, as agreed upon by the customer as documented during the contract negotiation process in compliance with ISO/IEC 17025:2017, section 7.1.

⁵ In the statement of the CMC, percentages are percent of reading, unless otherwise indicated. In the statement of the CMC, V is defined as volume measured.

⁶ The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a percentage or fraction of the reading plus a fixed floor specification.

⁷ The type of instrument or material being calibrated is defined by the parameter. This indicates the laboratory is capable of calibrating instruments that measure or generate the values in the ranges indicated for the listed measurement parameter.



Accredited Laboratory

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Ho Chi Minh City, VIETNAM

for technical competence in the field of

Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets R205 – Specific Requirements: Calibration Laboratory Accreditation Program. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).



Presented this 20th day of May 2025

A blue ink signature of Mr. Trace McInturff.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 4184.01
Valid to February 28, 2027

For the calibrations to which this accreditation applies, please refer to the laboratory's Calibration Scope of Accreditation.