

of **Yokogawa Europe B.V.**
Yokogawa European Standards Laboratory

This annex is valid from: **24-06-2015** to **01-07-2019**

Replaces annex dated: **NA**

Location where activities are performed under accreditation

Head Office

Euroweg 2
3825 HD
Amersfoort
The Netherlands

HCS code	Measured quantity, Range	Frequency	CMC ¹	Remarks
LF	Electricity			
LF 0 0	DC/LF Quantities			
LF 1 0	Direct Voltage			
	1 V; 1.018 V		1.5 μ V	Zener reference
	10 V		15 μ V	
	0.1 mV – 1 mV		$(1.2 \cdot 10^{-4} - 1.2 \cdot 10^{-3}) \cdot U$	Generate
	1 mV – 10 mV		$(1.8 \cdot 10^{-5} - 1.3 \cdot 10^{-4}) \cdot U$	
	10 mV – 100 mV		$(2.0 \cdot 10^{-5} - 1.6 \cdot 10^{-4}) \cdot U$	
	100 mV – 200 mV		$(1.6 \cdot 10^{-5} - 2.4 \cdot 10^{-5}) \cdot U$	
	200 mV – 2 V		$(6 \cdot 10^{-6} - 9 \cdot 10^{-6}) \cdot U$	
	2 V – 10 V		$(5 \cdot 10^{-6} - 8 \cdot 10^{-6}) \cdot U$	
	10 V – 20 V		$(5 \cdot 10^{-6} - 7 \cdot 10^{-6}) \cdot U$	
	20 V – 200 V		$(5 \cdot 10^{-6} - 6 \cdot 10^{-6}) \cdot U$	
	200 V – 1000 V		$(9 \cdot 10^{-6} - 1.1 \cdot 10^{-5}) \cdot U$	
	1 V; 1.018 V		2.5 μ V	Measure

This annex has been approved by:

Ir. J.C. van der Poel
Chief Executive

¹ Calibration and Measurement Capability (CMC): Demonstrated measurement uncertainty, with coverage probability of 95%, in a given measurement point or measurement range.
Measurement uncertainty, U , is calculated according to EA-4/02 "Expression of the Uncertainty of Measurement in Calibration".

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HCS code	Measured quantity, Range	Frequency	CMC ¹	Remarks
	10 V		25 μ V	
	0.1 mV – 1 mV		$(1.2 \cdot 10^{-4} - 1.2 \cdot 10^{-3}) \cdot U$	Measure
	1 mV – 10 mV		$(3.2 \cdot 10^{-5} - 1.7 \cdot 10^{-4}) \cdot U$	
	10 mV – 100 mV		$(1.6 \cdot 10^{-5} - 2.2 \cdot 10^{-4}) \cdot U$	
	100 mV – 1 V		$(6 \cdot 10^{-6} - 6 \cdot 10^{-5}) \cdot U$	
	1 V – 10 V		$(7 \cdot 10^{-6} - 1.1 \cdot 10^{-4}) \cdot U$	
	10 V – 100 V		$(8 \cdot 10^{-6} - 7 \cdot 10^{-5}) \cdot U$	
	100 V – 1100 V		$(2.4 \cdot 10^{-5} - 2.4 \cdot 10^{-5}) \cdot U$	
LF 2 1	Direct Current			
	100 μ A – 200 μ A		$(4 \cdot 10^{-5} - 5 \cdot 10^{-5}) \cdot I$	Generating
	0.2 mA – 2 mA		$(5 \cdot 10^{-5} - 2 \cdot 10^{-4}) \cdot I$	
	2 mA – 20 mA		$(4 \cdot 10^{-5} - 2.8 \cdot 10^{-4}) \cdot I$	
	20 mA – 200 mA		$(6 \cdot 10^{-5} - 2.8 \cdot 10^{-4}) \cdot I$	
	0.2 A – 2 A		$(7 \cdot 10^{-5} - 4 \cdot 10^{-4}) \cdot I$	
	2 A – 10 A		$(1.5 \cdot 10^{-5} - 4.3 \cdot 10^{-5}) \cdot I$	
	10 A – 35 A		$(4 \cdot 10^{-4} - 5 \cdot 10^{-4}) \cdot I$	
	10 μ A – 100 μ A		$(1.9 \cdot 10^{-5} - 4 \cdot 10^{-5}) \cdot I$	Measure
	100 μ A – 1 mA		$(1.8 \cdot 10^{-5} - 1 \cdot 10^{-4}) \cdot I$	
	1 mA – 10 mA		$(1.8 \cdot 10^{-5} - 1 \cdot 10^{-4}) \cdot I$	
	10 mA – 30 mA		$(2.2 \cdot 10^{-5} - 5 \cdot 10^{-5}) \cdot I$	
	30 mA – 100 mA		$(2.0 \cdot 10^{-5} - 4 \cdot 10^{-5}) \cdot I$	
	100 mA – 300 mA		$(3 \cdot 10^{-5} - 4 \cdot 10^{-5}) \cdot I$	
	300 mA – 1 A		$(6 \cdot 10^{-5} - 1.1 \cdot 10^{-4}) \cdot I$	
	3 A – 10 A		$(1.3 \cdot 10^{-4} - 1.6 \cdot 10^{-4}) \cdot I$	
	10 A – 30 A		$(4 \cdot 10^{-4} - 5 \cdot 10^{-4}) \cdot I$	

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HCS code	Measured quantity, Range	Frequency	CMC ¹	Remarks
LF 3 1	Alternating Voltage			
	8 mV – 80mV	53 Hz	$(3.0 \cdot 10^{-5} - 3.0 \cdot 10^{-4}) \cdot U$	Generate / Measure
	80 mV – 800mV	53 Hz	$(3.0 \cdot 10^{-5} - 1.1 \cdot 10^{-4}) \cdot U$	
	800 mV – 8 V	53 Hz	$(3.0 \cdot 10^{-5} - 1.3 \cdot 10^{-4}) \cdot U$	
	8 V – 80 V	53 Hz	$(3.0 \cdot 10^{-5} - 1.5 \cdot 10^{-4}) \cdot U$	
	80 V – 800 V	53 Hz	$(3.0 \cdot 10^{-5} - 1.5 \cdot 10^{-4}) \cdot U$	
				Generate
	10 mV – 100 mV	10 Hz – 40 Hz	$(1.2 \cdot 10^{-4} - 4 \cdot 10^{-3}) \cdot U$	On impedance > 50MΩ
		40 Hz – 20 kHz	$(7 \cdot 10^{-5} - 1.5 \cdot 10^{-3}) \cdot U$	On impedance > 50MΩ
		20 kHz – 100 kHz	$(7 \cdot 10^{-5} - 1.2 \cdot 10^{-3}) \cdot U$	On impedance > 50MΩ
		100 kHz – 500kHz	$(8 \cdot 10^{-5} - 7 \cdot 10^{-3}) \cdot U$	On impedance > 50MΩ
		500 kHz – 1 MHz	$(6 \cdot 10^{-4} - 1.5 \cdot 10^{-2}) \cdot U$	On impedance > 50MΩ
	100 mV – 1 V	10 Hz – 40 Hz	$(6 \cdot 10^{-5} - 9 \cdot 10^{-4}) \cdot U$	
		40 Hz – 20 kHz	$(5 \cdot 10^{-5} - 8 \cdot 10^{-4}) \cdot U$	
		20 kHz – 100 kHz	$(5 \cdot 10^{-5} - 5 \cdot 10^{-3}) \cdot U$	
		100 kHz – 500kHz	$(4 \cdot 10^{-4} - 6 \cdot 10^{-3}) \cdot U$	
		500 kHz – 1 MHz	$(5 \cdot 10^{-4} - 1.3 \cdot 10^{-2}) \cdot U$	
	1 V – 10 V	10 Hz – 40 Hz	$(5 \cdot 10^{-5} - 8 \cdot 10^{-4}) \cdot U$	
		40 Hz – 20 kHz	$(5 \cdot 10^{-5} - 8 \cdot 10^{-4}) \cdot U$	
		20 kHz – 100 kHz	$(5 \cdot 10^{-5} - 9 \cdot 10^{-4}) \cdot U$	
		100 kHz – 500kHz	$(9 \cdot 10^{-5} - 5 \cdot 10^{-3}) \cdot U$	
		500 kHz – 1 MHz	$(5 \cdot 10^{-4} - 2.5 \cdot 10^{-2}) \cdot U$	
	10 V – 100 V	10 Hz – 40 Hz	$(9 \cdot 10^{-5} - 1.0 \cdot 10^{-3}) \cdot U$	
		40 Hz – 20 kHz	$(7 \cdot 10^{-5} - 1.0 \cdot 10^{-3}) \cdot U$	
		20 kHz – 100 kHz	$(6 \cdot 10^{-5} - 2.5 \cdot 10^{-3}) \cdot U$	
	100 V – 1100 V	60 Hz – 400 Hz	$(6 \cdot 10^{-5} - 1.5 \cdot 10^{-3}) \cdot U$	
		400 Hz – 1 kHz	$(6 \cdot 10^{-5} - 1.0 \cdot 10^{-3}) \cdot U$	

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HCS code	Measured quantity, Range	Frequency	CMC ¹	Remarks
	10 mV – 100 mV	40 Hz – 100 kHz	$(1.0 \cdot 10^{-4} - 1 \cdot 10^{-2}) \cdot U$	Measure
	100 mV – 1 V	40 Hz – 100 kHz	$(1.2 \cdot 10^{-4} - 6 \cdot 10^{-3}) \cdot U$	
	1 V – 10 V	40 Hz – 100 kHz	$(9 \cdot 10^{-5} - 9 \cdot 10^{-4}) \cdot U$	
	10 V – 100 V	40 Hz – 100 kHz	$(1.4 \cdot 10^{-4} - 4 \cdot 10^{-3}) \cdot U$	
	100 V – 1000 V	40 Hz – 30 kHz	$(9 \cdot 10^{-5} - 1.6 \cdot 10^{-2}) \cdot U$	
LF 4 1	Alternating Current			
	10mA – 1 A	53 Hz	$(3 \cdot 10^{-5} - 2.4 \cdot 10^{-4}) \cdot I$	Generate / Measure
	1 A – 5 A	53 Hz	$(4 \cdot 10^{-5} - 6 \cdot 10^{-5}) \cdot I$	
	5 A – 9 A	53 Hz	$4 \cdot 10^{-5} \cdot I$	
	9 A – 24 A	53 Hz	$5 \cdot 10^{-5} \cdot I$	
	24 A – 50 A	53 Hz	$(4 \cdot 10^{-5} - 5 \cdot 10^{-5}) \cdot I$	
	50 A – 100 A	53 Hz	$5 \cdot 10^{-5} \cdot I$	
	100 A – 600 A	53 Hz	$(5 \cdot 10^{-5} - 8 \cdot 10^{-5}) \cdot I$	
	600 A – 1200 A	53 Hz	$5 \cdot 10^{-5} \cdot I$	
	10 µA – 100 µA	10 Hz – 40 Hz	$(4 \cdot 10^{-4} - 3 \cdot 10^{-3}) \cdot I$	Generate
		40 Hz – 1 kHz	$(3 \cdot 10^{-4} - 4 \cdot 10^{-3}) \cdot I$	
		1 kHz – 5 kHz	$(3 \cdot 10^{-4} - 3 \cdot 10^{-3}) \cdot I$	
		5 kHz – 10 kHz	$(3 \cdot 10^{-4} - 7 \cdot 10^{-3}) \cdot I$	
	0.1 mA – 1 mA	10 Hz – 40 Hz	$(2.6 \cdot 10^{-4} - 2.6 \cdot 10^{-3}) \cdot I$	
		40 Hz – 1 kHz	$(2.2 \cdot 10^{-4} - 2.6 \cdot 10^{-3}) \cdot I$	
		1 kHz – 5 kHz	$(2.2 \cdot 10^{-4} - 2.2 \cdot 10^{-3}) \cdot I$	
		5 kHz – 10 kHz	$(2.2 \cdot 10^{-4} - 5 \cdot 10^{-3}) \cdot I$	
	1 mA – 10 mA	10 Hz – 40 Hz	$(4 \cdot 10^{-4} - 4 \cdot 10^{-3}) \cdot I$	
		40 Hz – 1 kHz	$(2.8 \cdot 10^{-4} - 4 \cdot 10^{-3}) \cdot I$	
		1 kHz – 5 kHz	$(2.8 \cdot 10^{-4} - 3 \cdot 10^{-3}) \cdot I$	
		5 kHz – 10 kHz	$(3 \cdot 10^{-4} - 5 \cdot 10^{-3}) \cdot I$	

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	10 mA – 100 mA	10 Hz – 40 Hz	$(4 \cdot 10^{-4} - 4 \cdot 10^{-3}) \cdot I$	
		40 Hz – 1 kHz	$(4 \cdot 10^{-4} - 4 \cdot 10^{-3}) \cdot I$	
		1 kHz – 5 kHz	$(4 \cdot 10^{-4} - 3 \cdot 10^{-3}) \cdot I$	
		5 kHz – 10 kHz	$(4 \cdot 10^{-4} - 6 \cdot 10^{-3}) \cdot I$	
	0.1 A – 2 A	40 Hz – 1 kHz	$(4 \cdot 10^{-4} - 6 \cdot 10^{-3}) \cdot I$	
		1 kHz – 5 kHz	$(6 \cdot 10^{-4} - 1.2 \cdot 10^{-2}) \cdot I$	
		5 kHz – 10 kHz	$(1.4 \cdot 10^{-3} - 2.2 \cdot 10^{-2}) \cdot I$	
		40 Hz – 1 kHz	$(2.8 \cdot 10^{-4} - 4 \cdot 10^{-3}) \cdot I$	
	10 μ A – 100 μ A	300 Hz – 5 kHz	$(7 \cdot 10^{-4} - 7 \cdot 10^{-3}) \cdot I$	Measure
	100 μ A – 1 mA	300 Hz – 5 kHz	$(6 \cdot 10^{-4} - 6 \cdot 10^{-3}) \cdot I$	Direct Method
	1 mA – 10 mA	300 Hz – 5 kHz	$(5 \cdot 10^{-4} - 6 \cdot 10^{-3}) \cdot I$	
	10 mA – 100 mA	300 Hz – 5 kHz	$(5 \cdot 10^{-4} - 5 \cdot 10^{-3}) \cdot I$	
	100 mA – 1A	300 Hz – 5 kHz	$(6 \cdot 10^{-4} - 1.3 \cdot 10^{-3}) \cdot I$	
	10 μ A	40 Hz – 100 kHz	$(1.0 \cdot 10^{-3} - 9 \cdot 10^{-2}) \cdot I$	Measure
	10 μ A – 100 μ A	40 Hz – 100 kHz	$(5 \cdot 10^{-4} - 9 \cdot 10^{-3}) \cdot I$	Via Shunts
	100 μ A – 1 mA	40 Hz – 100 kHz	$(5 \cdot 10^{-4} - 6 \cdot 10^{-3}) \cdot I$	
	1 mA – 10 mA	40 Hz – 100 kHz	$(4 \cdot 10^{-4} - 7 \cdot 10^{-3}) \cdot I$	
	10 mA – 100 mA	40 Hz – 100 kHz	$(4 \cdot 10^{-4} - 7 \cdot 10^{-3}) \cdot I$	
	100 mA – 1 A	40 Hz – 100 kHz	$(4 \cdot 10^{-4} - 7 \cdot 10^{-3}) \cdot I$	
	1 A – 5 A	40 Hz – 100 kHz	$(4 \cdot 10^{-4} - 4 \cdot 10^{-3}) \cdot I$	
	5 A – 10 A	40 Hz – 100 kHz	$(6 \cdot 10^{-4} - 3 \cdot 10^{-3}) \cdot I$	
	10 A – 20 A	40 Hz – 20 kHz	$(1.1 \cdot 10^{-3} - 2 \cdot 10^{-3}) \cdot I$	

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HCS code	Measured quantity, Range	Frequency	CMC ¹	Remarks
LF 4 2	AC Current Ratio			
	Current transformer - ratio	53 Hz	$(3.7 \cdot 10^{-5} - 5 \cdot 10^{-5}) \cdot I_{in}/I_{out}$	Measure Primary: 100 A to 1200 A Secondary: 100 mA to 5 A
	Current transformer - phase	53 Hz	2.5 m°	Measure Primary: 100 A to 1200 A Secondary: 100 mA to 5 A
LF 5 1	Power			
	100 µW – 30 kW	DC	$(1.4 \cdot 10^{-5} - 4 \cdot 10^{-4}) \cdot W$	Generate / Measure 100 mV – 1 kV 1 mA – 30 A
	1 mW – 12 kW	53 Hz	$(4 \cdot 10^{-5} - 1.0 \cdot 10^{-3}) \cdot W/VA$	Generate / Measure 0.1 – 8 V 10 mA – 1200 A $\cos(\varphi) = 1$
	0.1 W – 240 kW	53 Hz	$(3 \cdot 10^{-5} - 1.0 \cdot 10^{-3}) \cdot W/VA$	10–200 V 10 mA – 1200 A $0 \leq \cos(\varphi) \leq 1$
	2 W – 960 kW	53 Hz	$(4 \cdot 10^{-5} - 1.4 \cdot 10^{-3}) \cdot W/VA$	200–800 V 10 mA – 1200 A $\cos(\varphi) = 1$
	0.1 mW – 100 mW	53 Hz	$(3 \cdot 10^{-5} - 4 \cdot 10^{-5}) \cdot W/VA$	0.1 – 8 V 1 mA – 10 mA $\cos(\varphi) = 1$
	10 mW – 2 W	53 Hz	$(4 \cdot 10^{-5} - 1.8 \cdot 10^{-4}) \cdot W/VA$	10–200 V 1 mA – 10 mA $0 \leq \cos(\varphi) \leq 1$
	0.2 W – 8 W	53 Hz	$(4 \cdot 10^{-5} - 1.3 \cdot 10^{-4}) \cdot W/VA$	200–800 V 1 mA – 10 mA $\cos(\varphi) = 1$
	5 mW – 20 kW	10 – 1 kHz	$(4 \cdot 10^{-4} - 1.8 \cdot 10^{-3}) W/VA$	(1.0 – 1000) V 5 mA – 20 A $0.940 \leq \cos(\varphi) \leq 1$
	5 mW – 20 kW	10 – 1 kHz	$(4 \cdot 10^{-4} - 5 \cdot 10^{-3}) W/VA$	(1.0 – 1000) V 5 mA – 20 A $0 \leq \cos(\varphi) \leq 0.940$
	5 mW – 1.5 kW	1 kHz – 100 kHz	$(4 \cdot 10^{-4} - 1.6 \cdot 10^{-2}) W/VA$	(1.0 – 150) V 5 mA – 10 A $0.940 \leq \cos(\varphi) \leq 1$

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	5 mW – 1.5 kW	1 kHz – 100 kHz	$(5 \cdot 10^{-4} - 5 \cdot 10^{-2}) \text{ W/VA}$	(1.0 – 150) V 5 mA – 10 A $0 \leq \cos(\varphi) \leq 0.940$
LF 6 2	DC Resistance			
	0.01 Ω		1.0 $\mu\Omega$	Generate 4 wire
	0.1 Ω		5 $\mu\Omega$	Generate 4 wire
	1 Ω		3 $\mu\Omega$	Generate 4 wire
	1.9 Ω		0.08 m Ω	Generate 4 wire
	10 Ω		0.10 m Ω	Generate 4 wire
	19 Ω		0.3 m Ω	Generate 4 wire
	100 Ω		1.0 m Ω	Generate 4 wire
	190 Ω		1.9 m Ω	Generate 4 wire
	1 k Ω		10 m Ω	Generate 4 wire
	1.9 k Ω		19 m Ω	Generate 4 wire
	10 k Ω		0.08 Ω	Generate 4 wire
	19 k Ω		0.15 Ω	Generate 4 wire
	100 k Ω		0.8 Ω	Generate 4 wire
	190 k Ω		1.5 Ω	Generate 4 wire
	1 M Ω		0.012 k Ω	Generate 4 wire
	1.9 M Ω		0.05 k Ω	Generate 4 wire
	10 M Ω		0.7 k Ω	Generate 4 wire
	19 M Ω		1.3 k Ω	Generate 4 wire
	100 M Ω		35 k Ω	Generate 2 wire
	1 Ω – 100 M Ω		$(1.5 \cdot 10^{-4} - 5 \cdot 10^{-4}) \cdot R$	Generate
	1 m Ω – 10 m Ω		$(1.4 \cdot 10^{-4} \cdot R - 1.8 \cdot 10^{-4}) \cdot R$	Measure
	10 m Ω – 100 m Ω		$(5 \cdot 10^{-5} \cdot R - 6 \cdot 10^{-5}) \cdot R$	
	100 m Ω – 1 Ω		$(1.7 \cdot 10^{-6} \cdot R - 3.0 \cdot 10^{-5}) \cdot R$	

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	1 Ω – 10 Ω		$(1.0 \cdot 10^{-5} \cdot R - 1.1 \cdot 10^{-5}) \cdot R$	
	10 Ω – 100 Ω		$(1.0 \cdot 10^{-5} \cdot R - 1.2 \cdot 10^{-5}) \cdot R$	
	100 Ω – 1 kΩ		$8 \cdot 10^{-6} \cdot R$	
	1 kΩ – 10 kΩ		$(6 \cdot 10^{-6} \cdot R - 1.7 \cdot 10^{-5}) \cdot R$	
	10 kΩ – 100 kΩ		$(1.0 \cdot 10^{-5} - 7 \cdot 10^{-5}) \cdot R$	
	100 kΩ – 1 MΩ		$(2.6 \cdot 10^{-5} - 2.3 \cdot 10^{-4}) \cdot R$	
	1 MΩ – 10 MΩ		$(6 \cdot 10^{-5} - 5 \cdot 10^{-4}) \cdot R$	
	10 MΩ – 100 MΩ		$(4 \cdot 10^{-4} - 4 \cdot 10^{-3}) \cdot R$	
	100 MΩ – 1 GΩ		$(2.9 \cdot 10^{-3} - 2.8 \cdot 10^{-2}) \cdot R$	
TF	Time and Frequency			
TF 2 1	Frequency generation	10 MHz	$2.0 \cdot 10^{-12} \cdot f$	$\tau \geq 86.4 \text{ ks}$
	Frequency measurement	0.1 Hz – 225 MHz	$2 \cdot 10^{-9} \cdot f$	$\tau = 1 \text{ s}$
			$2 \cdot 10^{-10} \cdot f$	$\tau = 10 \text{ s}$
			$4 \cdot 10^{-10} \cdot f$	$\tau = 100 \text{ s}$
			$2 \cdot 10^{-11} \cdot f$	$\tau = 1 \text{ ks}$
			$3 \cdot 10^{-12} \cdot f$	$\tau = 10 \text{ ks}$
			$2 \cdot 10^{-12} \cdot f$	$\tau = 100 \text{ ks}$

Remarks:

- The ambient temperature during calibration is nominally 23 °C.
- The measurements are carried out inside the permanent laboratory.