

# CERTIFICATE

## TÜV Rheinland Immissionsschutz und Energiesysteme GmbH

---

**Manufacturer:** Maihak AG

**Measuring System:** S 700 - Unor 710 E / 715 E / 720 E

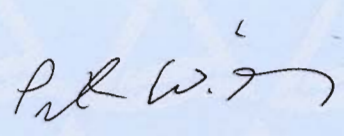
**Components:** CO, NO, SO<sub>2</sub>

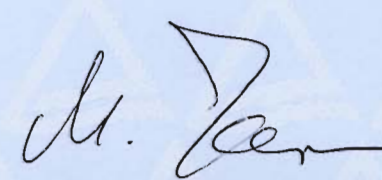
**Test Report:** RW TÜV 16/1190/94 - 203 75 784 2001-02-02

---

The measurement system fulfils  
the requirements of  
**QAL 1**  
according to EN 14181 and EN ISO 14956.

Köln, 2007-05-07

  
Dr. rer. nat. Peter Wilbring

  
Dipl.-Chem. Martin Kerpa

[www.umwelt-tuv.de](http://www.umwelt-tuv.de) / [www.eco-tuv.com](http://www.eco-tuv.com)  
tie@umwelt-tuv.de  
Tel. +49 - 221 - 806 - 2275

TÜV Rheinland Immissionsschutz und Energiesysteme GmbH  
Am Grauen Stein,  
51105 Köln

The company is accredited to DIN EN ISO/IEC 17025.



**DIN EN ISO 14956 and prEN 15267-3 calculation for QAL 1 in DIN EN 14181**
**Manufacturer data**

Manufacturer	Maihak AG
Measurement System Name	Multi Component Measuring Device
Serial Number	S 700 Unor
Measuring Principle	710 , 715 NDIR

**TÜV Data**

Approval Report	RW TÜV 16/01190/1994 - 203 75 784 - 2001-02-02
Date	2007-05-02
Editor	Dipl.Chem. M. Kerpa

<b>Measurement Component</b>	CO	100	mg/m <sup>3</sup>
------------------------------	----	-----	-------------------

**Evaluation of the cross sensitivity (CS)**

	CS	$X_{max,j}$
to 3 Vol.-% Oxygen	0,00	mg/m <sup>3</sup>
to 21 Vol.-% Oxygen	0,00	mg/m <sup>3</sup>
to 30 Vol.-% Humidity	0,00	mg/m <sup>3</sup>
to 300 mg/m <sup>3</sup> Carbon monoxide	0,00	mg/m <sup>3</sup>
to 15 Vol.-% Carbon dioxide	-1,01	mg/m <sup>3</sup>
to 50 mg/m <sup>3</sup> Methane	0,00	mg/m <sup>3</sup>
to 20 mg/m <sup>3</sup> Dinitrogen monoxide	0,27	mg/m <sup>3</sup>
to 300 mg/m <sup>3</sup> Nitrogen monoxide	0,39	mg/m <sup>3</sup>
to 30 mg/m <sup>3</sup> Nitrogen dioxide	0,00	mg/m <sup>3</sup>
to 20 mg/m <sup>3</sup> Ammonia	0,00	mg/m <sup>3</sup>
to 1000 mg/m <sup>3</sup> Sulphur dioxide	0,00	mg/m <sup>3</sup>
to 200 mg/m <sup>3</sup> Hydrogen chloride	-0,78	mg/m <sup>3</sup>

Sum of positive cross sensitivities	0,66	mg/m <sup>3</sup>
Sum of negative cross sensitivities	-1,79	mg/m <sup>3</sup>

**Calculation of the combined standard uncertainty**

Test Value		$\Delta X_{max,j}$	$u(\Delta X_{max,j}) = \frac{\Delta X}{\sqrt{3}}$	$u(\Delta X_{max,j})^2$
Lack of fit	$u_L$	0,80 mg/m <sup>3</sup>	0,46 mg/m <sup>3</sup>	0,213
Biggest interference (positiv or negativ)	$u_I$	-1,79 mg/m <sup>3</sup>	-1,04 mg/m <sup>3</sup>	1,073
Span shift in the field test	$u_{d,s}$	1,40 mg/m <sup>3</sup>	0,81 mg/m <sup>3</sup>	0,653
Zero shift in the field test	$u_{d,z}$	1,50 mg/m <sup>3</sup>	0,87 mg/m <sup>3</sup>	0,750
Sensitivity to sample volume flow	$u_v$	0,00 mg/m <sup>3</sup>	0,00 mg/m <sup>3</sup>	0,000
Sensitivity to sample pressure	$u_{sp}$	0,00 mg/m <sup>3</sup>	0,00 mg/m <sup>3</sup>	0,000
Sensitivity to sample temperature	$u_{st}$	0,00 mg/m <sup>3</sup>	0,00 mg/m <sup>3</sup>	0,000
Sensitivity to ambient temperature	$u_t$	0,40 mg/m <sup>3</sup>	0,23 mg/m <sup>3</sup>	0,053
Dependence on supply voltage	$u_{sv}$	0,00 mg/m <sup>3</sup>	0,00 mg/m <sup>3</sup>	0,000
Repeatability at span	$u_s$	0,40 mg/m <sup>3</sup>	0,23 mg/m <sup>3</sup>	0,053
Field reproducibility	$u_D$	0,50 mg/m <sup>3</sup>	0,29 mg/m <sup>3</sup>	0,083
Uncertainty of the test gas at the reference point	$u_{ig}$	3,00 mg/m <sup>3</sup>	1,73 mg/m <sup>3</sup>	3,000
Combined standard uncertainty ( $u_c$ )	$u_c$	$u_c = \sqrt{\sum(u_{max,j})^2}$		2,425
Total expanded uncertainty	$(u_c * k)$	$U_c = u_c * 1,96$		4,753
Relative total expanded uncertainty		Uc in % of the limit 50 mg/m <sup>3</sup>		9,5
Requirement		Uc in % of the limit 50 mg/m <sup>3</sup>		10,0

**Result: Requirements keep to QAL 1 of EN 14181**



**DIN EN ISO 14956 and prEN 15267-3 calculation for QAL 1 in DIN EN 14181**
**Manufacturer data**  
 Manufacturer  
 Measurement System  
 Name  
 Serial Number  
 Measuring Principle

 Maihak AG  
 Multi Component Measuring Device  
 S 700 Unor  
 710 , 715  
 NDIR

**TÜV Data**

 Approval Report  
 Date  
 Editor

 RW TÜV 16/01190/1994 - 203 75 784 - 2001-02-02  
 2007-05-02  
 Dipl.Chem. M. Kerpa

**Measurement Component**

 NO 100 mg/m<sup>3</sup>
**Evaluation of the cross sensitivity (CS)**

	CS $X_{max,j}$
to 3 Vol.-% Oxygen	0,00 mg/m <sup>3</sup>
to 21 Vol.-% Oxygen	0,00 mg/m <sup>3</sup>
to 30 Vol.-% Humidity	-0,48 mg/m <sup>3</sup>
to 300 mg/m <sup>3</sup> Carbon monoxide	-0,36 mg/m <sup>3</sup>
to 15 Vol.-% Carbon dioxide	1,52 mg/m <sup>3</sup>
to 50 mg/m <sup>3</sup> Methane	0,00 mg/m <sup>3</sup>
to 20 mg/m <sup>3</sup> Dinitrogen monoxide	0,00 mg/m <sup>3</sup>
to 300 mg/m <sup>3</sup> Nitrogen monoxide	0,00 mg/m <sup>3</sup>
to 30 mg/m <sup>3</sup> Nitrogen dioxide	0,47 mg/m <sup>3</sup>
to 20 mg/m <sup>3</sup> Ammonia	0,00 mg/m <sup>3</sup>
to 1000 mg/m <sup>3</sup> Sulphur dioxide	-0,22 mg/m <sup>3</sup>
to 200 mg/m <sup>3</sup> Hydrogen chloride	-0,59 mg/m <sup>3</sup>

Sum of positive cross sensitivities	1,99 mg/m <sup>3</sup>
Sum of negative cross sensitivities	-1,64 mg/m <sup>3</sup>

**Calculation of the combined standard uncertainty**

Test Value	$\Delta X_{max,j}$	$u(\Delta X_{max,j}) = \frac{\Delta X}{\sqrt{3}}$	$u(\Delta X_{max,j})^2$
Lack of fit	$u_L$ 0,40 mg/m <sup>3</sup>	0,23 mg/m <sup>3</sup>	0,053
Biggest interference (positiv or negativ)	$u_I$ 1,99 mg/m <sup>3</sup>	1,15 mg/m <sup>3</sup>	1,323
Span shift in the field test	$u_{d,s}$ 3,10 mg/m <sup>3</sup>	1,79 mg/m <sup>3</sup>	3,203
Zero shift in the field test	$u_{d,z}$ 2,40 mg/m <sup>3</sup>	1,39 mg/m <sup>3</sup>	1,920
Sensitivity to sample volume flow	$u_v$ 0,00 mg/m <sup>3</sup>	0,00 mg/m <sup>3</sup>	0,000
Sensitivity to sample pressure	$u_{sp}$ 0,00 mg/m <sup>3</sup>	0,00 mg/m <sup>3</sup>	0,000
Sensitivity to sample temperature	$u_{st}$ 0,00 mg/m <sup>3</sup>	0,00 mg/m <sup>3</sup>	0,000
Sensitivity to ambient temperature	$u_t$ 0,00 mg/m <sup>3</sup>	0,00 mg/m <sup>3</sup>	0,000
Dependence on supply voltage	$u_{sv}$ 0,60 mg/m <sup>3</sup>	0,35 mg/m <sup>3</sup>	0,120
Repeatability at span	$u_s$ 0,60 mg/m <sup>3</sup>	0,35 mg/m <sup>3</sup>	0,120
Field reproducibility	$u_D$ 0,65 mg/m <sup>3</sup>	0,38 mg/m <sup>3</sup>	0,143
Uncertainty of the test gas at the reference point	$u_{tg}$ 3,00 mg/m <sup>3</sup>	1,73 mg/m <sup>3</sup>	3,000
Combined standard uncertainty ( $u_c$ )	$u_c$	$u_c = \sqrt{\sum(u_{max,j})^2}$	3,144
Total expanded uncertainty ( $u_c * k$ )		$U_c = u_c * 1,96$	6,161
Relative total expanded uncertainty		$U_c$ in % of the limit 50 mg/m <sup>3</sup>	12,3
Requirement		$U_c$ in % of the limit 50 mg/m <sup>3</sup>	20,0

**Result: Requirements keep to QAL 1 of EN 14181**



**DIN EN ISO 14956 and prEN 15267-3 calculation for QAL 1 in DIN EN 14181**
**Manufacturer data**

Manufacturer	Maihak AG
Measurement System Name	Multi Component Measuring Device
Serial Number	S 700 Unor
Measuring Principle	710 , 715 NDIR

**TÜV Data**

Approval Report	RW TÜV 16/01190/1994 - 203 75 784 - 2001-02-02
Date	2007-05-02
Editor	Dipl.Chem. M. Kerpa

Measurement Component	SO2	100	mg/m <sup>3</sup>
-----------------------	-----	-----	-------------------

**Evaluation of the cross sensitivity (CS)**

	CS	$X_{max,j}$
to 3 Vol.-% Oxygen	0,00	mg/m <sup>3</sup>
to 21 Vol.-% Oxygen	0,00	mg/m <sup>3</sup>
to 30 Vol.-% Humidity	0,00	mg/m <sup>3</sup>
to 300 mg/m <sup>3</sup> Carbon monoxide	0,36	mg/m <sup>3</sup>
to 15 Vol.-% Carbon dioxide	0,00	mg/m <sup>3</sup>
to 50 mg/m <sup>3</sup> Methane	1,56	mg/m <sup>3</sup>
to 20 mg/m <sup>3</sup> Dinitrogen monoxide	0,00	mg/m <sup>3</sup>
to 300 mg/m <sup>3</sup> Nitrogen monoxide	-0,29	mg/m <sup>3</sup>
to 30 mg/m <sup>3</sup> Nitrogen dioxide	0,75	mg/m <sup>3</sup>
to 20 mg/m <sup>3</sup> Ammonia	-0,28	mg/m <sup>3</sup>
to 1000 mg/m <sup>3</sup> Sulphur dioxide	0,00	mg/m <sup>3</sup>
to 200 mg/m <sup>3</sup> Hydrogen chloride	-0,78	mg/m <sup>3</sup>

Sum of positive cross sensitivities	2,68	mg/m <sup>3</sup>
Sum of negative cross sensitivities	-1,35	mg/m <sup>3</sup>

**Calculation of the combined standard uncertainty**

Test Value		$\Delta X_{max,j}$	$u(\Delta X_{max,j}) = \frac{\Delta X}{\sqrt{3}}$	$u(\Delta X_{max,j})^2$
Lack of fit	$u_L$	0,50 mg/m <sup>3</sup>	0,29 mg/m <sup>3</sup>	0,083
Biggest interference (positiv or negativ)	$u_I$	2,68 mg/m <sup>3</sup>	1,55 mg/m <sup>3</sup>	2,393
Span shift in the field test	$u_{d,s}$	3,80 mg/m <sup>3</sup>	2,19 mg/m <sup>3</sup>	4,813
Zero shift in the field test	$u_{d,z}$	2,60 mg/m <sup>3</sup>	1,50 mg/m <sup>3</sup>	2,253
Sensitivity to sample volume flow	$u_v$	0,00 mg/m <sup>3</sup>	0,00 mg/m <sup>3</sup>	0,000
Sensitivity to sample pressure	$u_{sp}$	0,00 mg/m <sup>3</sup>	0,00 mg/m <sup>3</sup>	0,000
Sensitivity to sample temperature	$u_{st}$	0,00 mg/m <sup>3</sup>	0,00 mg/m <sup>3</sup>	0,000
Sensitivity to ambient temperature	$u_t$	0,90 mg/m <sup>3</sup>	0,52 mg/m <sup>3</sup>	0,270
Dependence on supply voltage	$u_{sv}$	0,30 mg/m <sup>3</sup>	0,17 mg/m <sup>3</sup>	0,030
Repeatability at span	$u_s$	0,80 mg/m <sup>3</sup>	0,46 mg/m <sup>3</sup>	0,213
Field reproducibility	$u_D$	0,93 mg/m <sup>3</sup>	0,54 mg/m <sup>3</sup>	0,287
Uncertainty of the test gas at the reference point	$u_{ig}$	3,00 mg/m <sup>3</sup>	1,73 mg/m <sup>3</sup>	3,000
Combined standard uncertainty ( $u_c$ )	$u_c$	$u_c = \sqrt{\sum(u_{max,j})^2}$		3,653
Total expanded uncertainty ( $u_c * k$ )	$(u_c * k)$	$U_c = u_c * 1,96$		7,159
Relative total expanded uncertainty		Uc in % of the limit 50 mg/m <sup>3</sup>		14,3
Requirement		Uc in % of the limit 50 mg/m <sup>3</sup>		20,0

**Result: Requirements keep to QAL 1 of EN 14181**