BIROUL ROMÂN DE METROLOGIE LEGALĂ
INSTITUTUL NATIONAL DE METROLOGIE
NATIONAL INSTITUTE OF METROLOGY
INSTITUT NATIONAL DE MÉTROLOGIE

CERTIFICAT DE ETALONARE

Nr. 03.02 – 084/2015

Obiect: Instalație trifazată pentru verificarea contoarelor de energie electrică

Producător: Meter Test Equipment AG

Tip: MTE F3 22.40

Serie / număr: 65083-0.1.0

Beneficiar: 

Comanda Nr: 3937/12.08.2015

Număr de pagini: 14

Data etalonării: 11.09.2015

Ştampila INM	Data:	Şef de laborator
	14.09.2015	ing. Liliana Cîrneanu

Nota: Fără aprobarea INM, acest certificat de etalonare nu poate fi reprodus decât integral. Certificatele de etalonare fără semnături şi ştampilă originale sunt nule.

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Metoda de etalonare: Comparație directă, PS-09-3.2-INM, *Etalonarea instalațiilor de verificat contoare de energie electrică.*
Etalonul utilizat: contor static trifazat de energie electrică, tip PRS 400.3 seria 31669, fabricatie EMH, Germania, cu CE Nr. 03.02-088/2014 din data de 31.07.2014, emis de INM Bucureşti.

Locul etalonării: Laboratorul de metrologie –

Condiții de măsurare: Temperatura ambiantă: (23,2...24,0) ^{0}C ±0,5^{0}C
Umiditatea relativă: 50,0% ±2,5%

Condiții de referință: Temperatura ambiantă: (23±2) ^{0}C,
Umiditatea relativă: (50±15)%

Rezultatele etalonării: pentru funcția de măsurare a erorilor contoarelor trifazate de energie electrică activă.

Erori de măsurare în schema de conexiune cu 3 conductoare.			
$U_{aplicat}$ în V	$I_{aplicat}$ în A	cos φ	*Erori absolute* în %
			L1 – L3
3x100	10	1	-0,019
		0,5i	-0,020
		0,8c	-0,020
	6	1	-0,012
		0,5i	-0,008
		0,8c	-0,008
	5	1	-0,013
		0,5i	-0,014
		0,8c	-0,011
	1,2	1	-0,021
		0,5i	-0,031
		0,8c	-0,014
	1	1	-0,019
		0,5i	-0,023
		0,8c	-0,017
	0,5	1	-0,033
		0,5i	-0,037
		0,8c	-0,034
	0,25	1	-0,019
		0,5i	-0,025
		0,8c	-0,014
	0,2	1	-0,020
		0,5i	-0,031
		0,8c	-0,018
	0,1	1	-0,014
		0,5i	-0,034
		0,8c	-0,001
	0,05	1	-0,023
		0,5i	-0,046
		0,8c	-0,014
	0,02	1	-0,039
		0,5i	-0,074
		0,8c	0,051
	0,01	1	-0,036

Etalonarea a fost efectuată de: Dorin Flămînzeanu

Rezultatele etalonării: pentru funcția de măsurare a erorilor contoarelor trifazate de energie electrica activă.

Erori de măsurare în schema de conexiune cu 4 conductoare.						
$U_{aplicat}$ în V	$I_{aplicat}$ în A	cos φ	*Erori absolute* în %			
			L1, L2, L3	L1	L2	L3
3x57,7/100	10	1	-0,026	-0,013	-0,026	-0,032
		0,5i	-0,020	-0,006	-0,033	-0,016
		0,8c	-0,030	-	-	-
	6	1	-0,014	-0,008	-0,015	-0,017
		0,5i	-0,008	-0,004	-0,014	-0,006
		0,8c	-0,020	-	-	-
	5	1	-0,016	-0,008	-0,015	-0,020
		0,5i	-0,010	-0,002	-0,017	-0,009
		0,8c	-0,021	-	-	-
	2,5	1	-	-0,013	-0,017	-0,011
		0,5i	-	-0,009	-0,018	0,000
	1,2	1	-0,023	-0,006	-0,035	-0,026
		0,5i	-0,016	-0,016	-0,019	-0,012
		0,8c	-0,027	-	-	-
	1	1	-0,024	-0,007	-0,039	-0,020
		0,5i	-0,020	-0,014	-0,028	-0,005
		0,8c	-0,029	-	-	-
	0,5	1	-0,040	-0,022	-0,054	-0,028
		0,5i	-0,038	-0,028	-0,047	-0,016
		0,8c	-0,042	-	-	-
	0,25	1	-0,023	-0,006	-0,041	-0,022
		0,5i	-0,019	-	-	-
		0,8c	-0,026	-	-	-
	0,2	1	-0,028	-0,009	-0,044	-0,027
		0,5i	-0,028	-0,023	-0,050	-0,010
		0,8c	-0,034	-	-	-
	0,1	1	-0,010	-0,004	-0,006	-0,020
		0,5i	-0,031	-0,031	-0,038	-0,035
		0,8c	-0,003	-	-	-
	0,05	1	-0,033	-0,021	-0,034	-0,028
		0,5i	-0,062	-	-	-
		0,8c	-0,019	-	-	-
	0,02	1	-0,007	-	-	-
		0,5i	-0,106	-	-	-
		0,8c	0,027	-	-	-
	0,01	1	-0,024	-	-	-

Etalonarea a fost efectuată de: Dorin Flămînzeanu

Rezultatele etalonării: pentru funcția de măsurare a erorilor contoarelor trifazate de energie electrica activă

Erori de măsurare în schema de conexiune cu 4 conductoare.						
$U_{aplicat}$ în V	$I_{aplicat}$ în A	cos φ	*Erori absolute* în %			
			L1, L2, L3	L1	L2	L3
3x230/400	120	1	-0,011	-0,016	-0,020	-0,010
		0,5i	-0,008	-0,008	-0,015	-0,005
		0,8c	-0,017	-	-	-
	100	1	-0,011	-0,014	-0,018	-0,015
		0,5i	-0,009	-0,007	-0,018	-0,012
		0,8c	-0,017	-	-	-
	80	1	-0,019	-0,011	-0,022	-0,025
		0,5i	-0,016	-0,008	-0,026	-0,028
		0,8c	-0,023	-	-	-
	60	1	-0,021	-0,015	-0,033	-0,019
		0,5i	-0,020	-0,011	-0,036	-0,018
		0,8c	-0,025	-	-	-
	40	1	-0,021	-0,017	-0,023	-0,023
		0,5i	-0,018	-0,011	-0,028	-0,025
		0,8c	-0,021	-	-	-
	30	1	-0,027	-0,018	-0,034	-0,026
		0,5i	-0,024	-0,008	-0,037	-0,027
		0,8c	-0,029	-	-	-
	20	1	-0,021	-0,012	-0,024	-0,034
		0,5i	-0,015	-0,008	-0,025	-0,020
		0,8c	-0,023	-	-	-
	15	0,5i	-	-0,024	-0,039	-0,017

(continuă)

Etalonarea a fost efectuată de: Dorin Flămînzeanu

Rezultatele etalonării: pentru funcția de măsurare a erorilor contoarelor trifazate de energie electrica activă

(continuare)

Erori de măsurare în schema de conexiune cu 4 conductoare.						
$U_{aplicat}$ în V	$I_{aplicat}$ în A	cos φ	*Erori absolute* în %			
			L1, L2, L3	L1	L2	L3
3x230/400	10	1	-0,020	-0,014	-0,026	-0,029
		0,5i	-0,015	-0,010	-0,024	-0,010
		0,8c	-0,026	-	-	-
	6	1	-0,014	-0,010	-0,017	-0,018
		0,5i	-0,008	-0,005	-0,015	-0,003
		0,8c	-0,015	-	-	-
	5	1	-0,015	-0,011	-0,019	-0,021
		0,5i	-0,011	-0,007	-0,015	-0,013
		0,8c	-0,019	-	-	-
	4	1	-0,014	-0,013	-0,019	-0,011
		0,5i	-0,007	-0,011	-0,019	-0,002
		0,8c	-0,016	-	-	-
	3	1	-0,016	-	-	-
		0,5i	-0,011	-	-	-
		0,8c	-0,020	-	-	-
	2,5	0,5i	-	-0,017	-0,028	-0,009
	2	1	-0,030	-0,029	-0,036	-0,039
		0,5i	-0,026	-0,025	-0,039	-0,024
		0,8c	-0,031	-	-	-
	1,5	1	-0,016	-	-	-
	1,2	1	-0,023	-0,004	-0,040	-0,030
		0,5i	-0,017	-0,014	-0,029	-0,016
		0,8c	-0,028	-	-	-
	1	1	-0,025	-0,006	-0,045	-0,028
		0,5i	-0,019	-0,014	-0,035	-0,016
		0,8c	-0,029	-	-	-
	0,5	1	-0,040	-0,026	-0,064	-0,038
		0,5i	-0,039	-0,038	-0,060	-0,028
		0,8c	-0,041	-	-	-
	0,4	1	-0,012	-	-	-
	0,25	1	-0,022	-0,005	-0,055	-0,034
		0,5i	-0,018	-	-	-
		0,8c	-0,028	-	-	-
	0,2	1	-0,030	-	-	-
		0,5i	-0,024	-0,032	-0,071	-0,031
		0,8c	-0,031	-	-	-
	0,1	1	-0,013	-0,019	-0,021	-0,031
		0,5i	-0,037	-0,059	-0,064	-0,057
		0,8c	-0,004	-	-	-
	0,05	1	-0,038	-0,050	-0,060	-0,049
		0,5i	-0,074	-0,109	-0,131	-0,101
		0,8c	-0,024	-	-	-
	0,02	1	-0,028	-	-	-
		0,5i	-0,146	-	-	-

Etalonarea a fost efectuată de: Dorin Flămînzeanu

Rezultatele etalonării: pentru funcția de măsurare a erorilor contoarelor monofazate de energie electrică activă.

Erori de măsurare în schema de conexiune monofazată.			
$U_{aplicat}$ în V	$I_{aplicat}$ în A	cos φ	*Erori absolute* în %
			L3
230	120	1 0,5i 0,8c	-0,020 0,010 -0,031
	100	1 0,5i 0,8c	-0,025 0,000 -0,039
	80	1 0,5i 0,8c	-0,025 -0,002 -0,037
	60	1 0,5i 0,8c	-0,022 0,001 -0,034
	40	1 0,5i 0,8c	-0,034 -0,014 -0,049
	30	1 0,5i 0,8c	-0,030 -0,034 -0,047
	20	1 0,5i 0,8c	-0,029 0,006 -0,042
	15	0,5i	0,006

(continuă)

Etalonarea a fost efectuată de: Dorin Flămînzeanu

Rezultatele etalonării:

(continuare)

Erori de măsurare în schema de conexiune monofazată.			
$U_{aplicat}$ în V	$I_{aplicat}$ în A	cos φ	*Erori absolute* în %
			L3
230	10	1	-0,028
		0,5i	0,011
		0,8c	-0,049
	5	1	-0,014
		0,5i	0,027
		0,8c	-0,031
	4	1	-0,008
		0,5i	0,035
		0,8c	-0,021
	3	1	-0,008
		0,5i	0,039
		0,8c	-0,018
	2,5	0,5i	0,041
	2	1	-0,011
		0,5i	0,045
		0,8c	-0,025
	1,5	1	0,014
	1,2	1	-0,025
		0,5i	-0,002
		0,8c	-0,023
	1	1	-0,020
		0,5i	0,007
		0,8c	-0,016
	0,5	1	-0,016
		0,5i	-0,002
		0,8c	-0,021
	0,4	1	-0,017
	0,25	1	-0,018
		0,5i	-0,002
		0,8c	-0,012
	0,2	1	-0,016
		0,5i	-0,006
		0,8c	-0,010
	0,1	1	0,043
		0,5i	0,074
		0,8c	0,075
	0,05	1	0,098
		0,5i	0,184
		0,8c	0,145
	0,02	1	0,302
		0,5i	0,536

Etalonarea a fost efectuată de: Dorin Flămînzeanu

Rezultatele etalonării: pentru funcția de măsurare a erorilor contoarelor trifazate de energie electrică reactivă.

Erori de măsurare în schema de conexiune cu 3 conductoare.			
$U_{aplicat}$ în V	$I_{aplicat}$ în A	sin φ	*Erori absolute* în %
			L1 – L3
3x100	10	1	-0,024
		0,5i	-0,023
	6	1	-0,015
		0,5i	-0,014
	5	1	-0,016
		0,5i	-0,014
		0,25i	-0,012
	1,2	1	-0,024
		0,5i	-0,016
	1	1	-0,023
		0,5i	-0,021
		0,25i	-0,020
	0,5	1	-0,031
		0,5i	-0,032
	0,25	1	-0,016
		0,5i	-0,009
	0,2	1	-0,021
		0,5i	-0,012
		0,25i	0,003
	0,1	1	-0,012
		0,5i	0,017
	0,05	1	-0,025
		0,5i	0,002
	0,02	1	-0,019

Etalonarea a fost efectuată de: Dorin Flămînzeanu

Rezultatele etalonării: pentru funcția de măsurare a erorilor contoarelor trifazate de energie electrica reactivă.

Erori de măsurare în schema de conexiune cu 4 conductoare.						
$U_{aplicat}$ în V	$I_{aplicat}$ în A	sin φ	*Erori absolute* în %			
			L1, L2, L3	L1	L2	L3
3x57,7/100	10	1	-0,011	-0,004	-0,005	-0,012
		0,5i	-0,023	-0,009	-0,012	-0,026
	6	1	-0,002	-0,001	-0,003	0,000
		0,5i	-0,011	-0,005	-0,008	-0,013
	5	1	-0,003	0,000	-0,002	-0,005
		0,5i	-0,014	-0,005	-0,008	-0,015
		0,25i	-0,036	-	-	-
	1,2	1	-0,016	0,000	-0,026	-0,015
		0,5i	-0,025	0,006	-0,044	-0,028
	1	1	-0,015	-0,003	-0,026	-0,011
		0,5i	-0,028	0,002	-0,044	-0,024
		0,25i	-0,040	-	-	-
	0,5	1	-0,029	-0,015	-0,039	-0,016
		0,5i	-0,037	-0,013	-0,054	-0,025
	0,25	1	-0,015	0,001	-0,027	-0,018
		0,5i	-0,022	-	-	-
	0,2	1	-0,019	-	-	-
		0,5i	-0,030	0,014	-0,052	-0,026
		0,25i	-0,020	-	-	-
	0,1	1	-0,003	0,005	0,004	-0,009
		0,5i	0,016	0,025	0,027	0,004
	0,05	1	-0,021	-0,009	-0,018	-0,011
		0,5i	0,003	-	-	-
	0,02	1	0,004	-	-	-

Erori de măsurare în schema de conexiune cu 4 conductoare.						
$U_{aplicat}$ în V	$I_{aplicat}$ în A	sin φ	*Erori absolute* în %			
			L1, L2, L3	L1	L2	L3
3x230/400	120	1	-0,006	-0,003	-0,011	-0,011
		0,5i	-0,019	-0,008	-0,024	-0,017
	100	1	-0,006	-0,001	-0,010	-0,006
		0,5i	-0,019	-0,006	-0,016	-0,019
	80	1	-0,009	0,000	-0,008	-0,017
		0,5i	-0,016	-0,003	-0,013	-0,021
	60	1	-0,010	-0,004	-0,015	-0,011
		0,5i	-0,018	-0,007	-0,018	-0,012
	40	1	-0,007	0,001	0,003	-0,007
		0,5i	-0,014	-0,005	-0,003	-0,007
	30	1	-0,012	-0,007	-0,005	-0,005
		0,5i	-0,017	-0,007	-0,014	-0,001
		0,25i	-0,021	-	-	-
	20	1	-0,011	-0,003	-0,005	-0,023
		0,5i	-0,022	-0,009	-0,013	-0,039
		0,25i	-0,031	-	-	-

Etalonarea a fost efectuată de: Dorin Flămînzeanu

Rezultatele etalonării: pentru funcția de măsurare a erorilor contoarelor trifazate de energie electrica reactivă

Erori de măsurare în schema de conexiune cu 4 conductoare.						
$U_{aplicat}$ în V	$I_{aplicat}$ în A	sin φ	*Erori absolute* în %			
			L1, L2, L3	L1	L2	L3
3x230/400	10	1	-0,011	-0,003	-0,008	-0,012
		0,5i	-0,018	-0,003	-0,020	-0,025
		0,25i	-0,029	-	-	-
	6	1	-0,003	0,000	-0,006	-0,002
		0,5i	-0,009	-0,004	-0,011	-0,014
		0,25i	-0,017	-	-	-
	5	1	-0,005	-0,001	-0,007	-0,003
		0,5i	-0,012	-0,003	-0,011	-0,016
		0,25i	-0,020	-	-	-
	4	1	-0,005	-0,004	-0,006	0,002
		0,5i	-0,013	-0,006	-0,017	-0,012
		0,25i	-0,028	-	-	-
	3	1	-0,007	-0,006	-0,009	0,002
		0,5i	-0,016	-0,009	-0,019	-0,012
	2	1	-0,013	-0,010	-0,014	-0,016
		0,5i	-0,023	-0,011	-0,028	-0,025
		0,25i	-0,028	-	-	-
	1,5	1	-0,001	0,002	0,002	-0,013
		0,5i	-0,012	-	-	-
	1,2	1	-0,015	0,003	-0,028	-0,017
		0,5i	-0,024	0,009	-0,046	-0,029
	1	1	-0,015	0,001	-0,029	-0,013
		0,5i	-0,026	0,005	-0,050	-0,026
		0,25i	-0,036	-	-	-
	0,5	1	-0,029	-0,013	-0,045	-0,011
		0,5i	-0,036	-	-	-
	0,25	1	-0,013	-0,002	-0,032	-0,006
		0,5i	-0,014	-	-	-
	0,2	1	-0,018	-	-	-
		0,5i	-0,022	0,003	-0,057	-0,018
		0,25i	-0,027	-	-	-
	0,1	1	-0,007	-0,005	-0,010	-0,012
		0,5i	0,010	0,010	0,003	-0,004
	0,05	1	-0,027	-0,028	-0,043	-0,016
		0,5i	-0,004	-	-	-
	0,02	1	-0,024	-	-	-

Etalonarea a fost efectuată de: Dorin Flămînzeanu

Rezultatele etalonării: pentru funcția de măsurare a erorilor contoarelor monofazate de energie electrică reactivă.

Erori de măsurare în schema de conexiune monofazată.			
$U_{aplicat}$ în V	$I_{aplicat}$ în A	sin φ	*Erori absolute* în %
			L3
230	120	1	-0,018
		0,5i	-0,037
	100	1	-0,017
		0,5i	-0,035
	80	1	-0,016
		0,5i	-0,026
	60	1	-0,009
		0,5i	-0,019
	40	1	-0,009
		0,5i	-0,017
	30	1	-0,011
		0,5i	-0,012
		0,25i	-0,006
	20	1	-0,016
		0,5i	-0,037
		0,25i	-0,059

Etalonarea a fost efectuată de: Dorin Flămînzeanu

Rezultatele etalonării: pentru funcția de măsurare a erorilor contoarelor trifazate de energie electrica reactivă

Erori de măsurare în schema de conexiune monofazată.			
$U_{aplicat}$ în V	$I_{aplicat}$ în A	sin φ	*Erori absolute* în %
			L3
230	10	1 0,5i 0,25i	-0,012 -0,029 -0,044
	6	1 0,5i 0,25i	-0,012 -0,035 -0,047
	5	1 0,5i 0,25i	-0,013 -0,033 -0,047
	4	1 0,5i 0,25i	-0,011 -0,028 -0,042
	3	1 0,5i	-0,009 -0,029
	2	1 0,5i 0,25i	-0,034 -0,013 -0,026
	1,5	1 0,5i	-0,027 -0,011
	1,2	1 0,5i 0,25i	-0,033 -0,013 -0,044
	1	1 0,5i 0,25i	-0,049 -0,013 -0,039
	0,6	1	-0,044
	0,5	1 0,5i	-0,020 -0,020
	0,4	1	-0,040
	0,25	1 0,5i	-0,011 -0,012
	0,2	1 0,5i 0,25i	-0,030 -0,017 -0,030
	0,1	1 0,5i	-0,042 -0,023
	0,05	1 0,5i	-0,037 -0,041
	0,02	1	-0,061

Etalonarea a fost efectuată de: Dorin Flămînzeanu

Rezultatele etalonării: pentru funcția de generare controlată a tensiunii electrice în curent alternativ în circuitul pentru măsurare, la frecvența f = 50 Hz

Valoare programată în V	Valoare convențional adevărată în V			Incertitudine de măsurare în V
	L1	L2	L3	
57,70	57,69	57,68	57,70	0,05
220,0	219,99	219,93	219,99	0,20
230,0	229,98	229,93	229,99	0,20

Rezultatele etalonării: pentru funcția de generare controlată a curentului electric în curent alternativ în circuitul pentru măsurare, la frecvența f = 50 Hz

Valoare programată în A	Valoare convențional adevărată în A			Incertitudine de măsurare în A
	L1	L2	L3	
0,0010	0,0010	0,0010	0,0010	
0,0020	0,0020	0,0020	0,0020	0,0010
0,0030	0,0030	0,0030	0,0030	
0,0040	0,0040	0,0040	0,0040	
0,0050	0,0050	0,0050	0,0050	
0,0100	0,0100	0,0100	0,0100	
0,0150	0,0150	0,0150	0,0150	
0,0200	0,0200	0,0200	0,0200	
0,0250	0,0250	0,0250	0,0250	
0,030	0,0300	0,0300	0,0300	
0,050	0,0500	0,0500	0,0500	
0,100	0,1000	0,1000	0,1000	
0,200	0,2000	0,2000	0,2000	
0,300	0,3000	0,3000	0,3000	
0,500	0,5000	0,5000	0,5000	
1,000	0,9999	0,9999	0,9999	
2,000	1,9996	1,9995	1,9995	0,0020
2,500	2,4995	2,4995	2,4995	0,0025
5,00	4,999	4,999	4,999	0,005
6,00	5,999	5,999	5,999	0,006
10,00	9,998	9,999	9,999	0,010
20,00	19,995	19,995	19,998	0,020
30,00	29,994	29,994	29,996	0,030
40,00	39,992	39,993	39,993	0,040
60,00	59,99	59,99	60,00	0,06
80,00	80,00	80,00	80,00	0,08
100,0	99,99	99,99	100,01	0,10
120,0	120,00	119,99	120,01	0,12

Etalonarea a fost efectuată de: Dorin Flămînzeanu

Rezultatele etalonării: pentru funcția de defazare controlată a curentului generat față de tensiunea generată, la frecvența f = 50 Hz;

Valori programate			Valoare convențional adevărată în °		
Tensiune în V	Curent în A	Unghi în °	L1	L2	L3
57,7	1	323	323,0	323,0	323,0
		0	0,0	0,0	0,0
		14	14,0	14,0	14,0
		30	30,0	30,0	30,0
		60	60,0	60,0	60,0
		90	90,0	90,0	90,0
57,7	5	323	323,0	323,0	323,0
		0	0,0	0,0	0,0
		14	14,0	14,0	14,0
		30	30,0	30,0	30,0
		60	60,0	60,0	60,0
		90	90,0	90,0	90,0
230	5	323	323,0	323,0	323,0
		0	0,0	0,0	0,0
		14	14,0	14,0	14,0
		30	30,0	30,0	30,0
		60	60,0	60,0	60,0
		90	90,0	90,0	90,0
230	10	323	323,0	323,0	322,9
		0	0,0	0,0	-0,1
		14	14,0	14,0	13,9
		30	30,0	30,0	29,9
		60	60,0	60,0	59,9
		90	90,0	90,0	89,9

Incertitudinea de măsurare: pentru tensiune electrică şi curent electric: conform tabelelor
pentru unghi de defazaj: 0,3°
pentru energie electrică: 0,030% (pt I > 50 mA)
0,050% (pt I ≤ 50 mA)

Incertitudinea de măsurare a energiei este relativă la valoarea energiei aparente din circuit.

Nota 1 : Incertitudinea atribuită este incertitudinea extinsă obținută prin multiplicarea incertitudinii standard cu factorul de extindere $k = 2$ şi a fost estimată în conformitate cu GUM. Standardul român echivalent cu GUM este SR Ghid ISO/CEI 98-3:2010-Incertitudine de măsurare Partea 3: Ghid pentru exprimarea incertitudinii de măsurare.
Valoarea măsurandului se află în intervalul de valori indicat cu un nivel de încredere de 95 %.

Nota 2 : Rezultatele sunt trasabile la Sistemul Internațional de Unități (SI).
Trasabilitatea măsurărilor este realizată şi menținută prin comparări şi etalonări internaționale, în acord cu SR EN ISO/CEI 17025 :2005.
România este membră a Convenției Metrului, iar INM este co-semnatar al MRA

Informații suplimentare: Instalația utilizează ca etalon de referință un contor static trifazat, tip SRS 121.3, seria 38605.
Etalonarea pentru contoare monofazate a fost efectuată pe faza L3 la bornele de conectare a contoarelor care au conexiune galvanică între circuitele de curent şi cele de tensiune, MSVT(Multi Secondary VoltageTransformer).

Etalonarea a fost efectuată de: Dorin Flămînzeanu
Încheierea certificatului de etalonare.

TechnoTeam
Bildverarbeitung GmbH

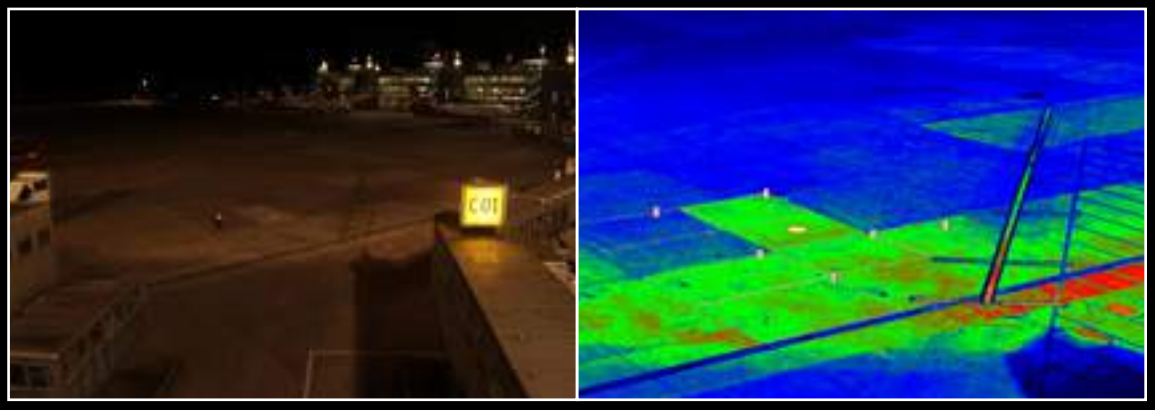
CAMERA PHOTOMETER

based on the Canon EOS70D digital reflex camera

LMK

mobile air

Measuring the luminance distribution and horizontal illumination on the airports apron



Canon 70D

(DSLR)

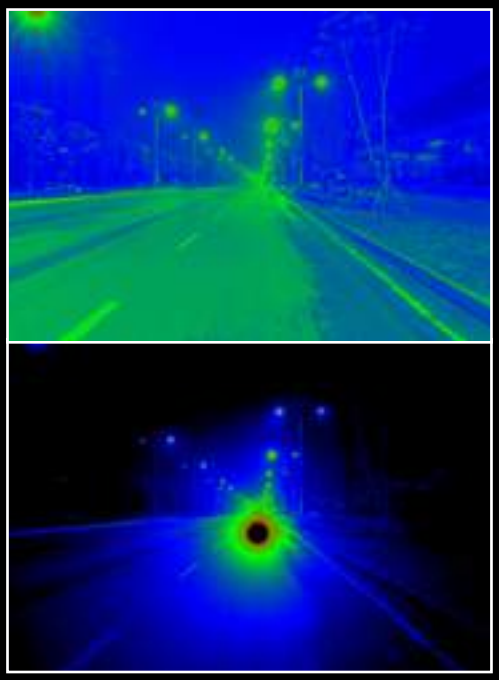
SIGMA 4.5mm/2.8 EX DC
Circular Fisheye

Glare evaluation

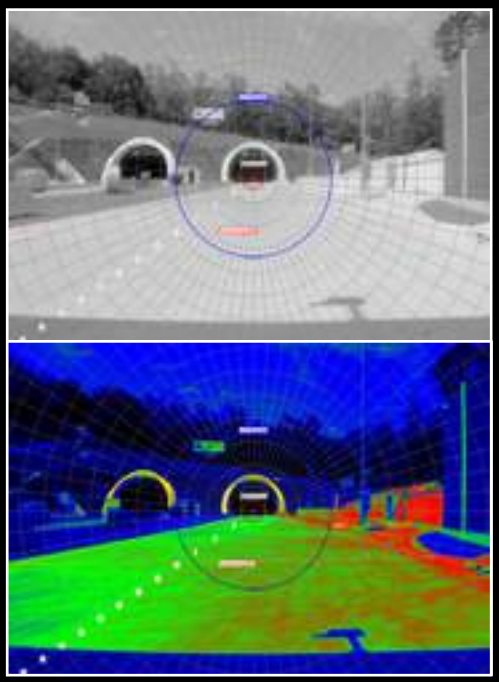
The LMK mobile air allows easy measuring and verification of existing standards and real lighting applications concepts with regards to full illumination, glare, ergonomics and hazards.

- Glare assessment based on the TI - method for artificial road lighting (EN13201)
- Performing the L20° measures for artificial lighting at tunnel entrances (CIE Publ. 88)
- Determining glare values for artificial outdoor lighting like at sports facilities or lighted outdoor advertisement. For example the maximum tolerable luminance (LAI) or equivalent veiling luminance
- Glare assessment of artificial indoor lighting (UGR, DGP, GR)

Determination of glare using the TI – method for artificial road lighting

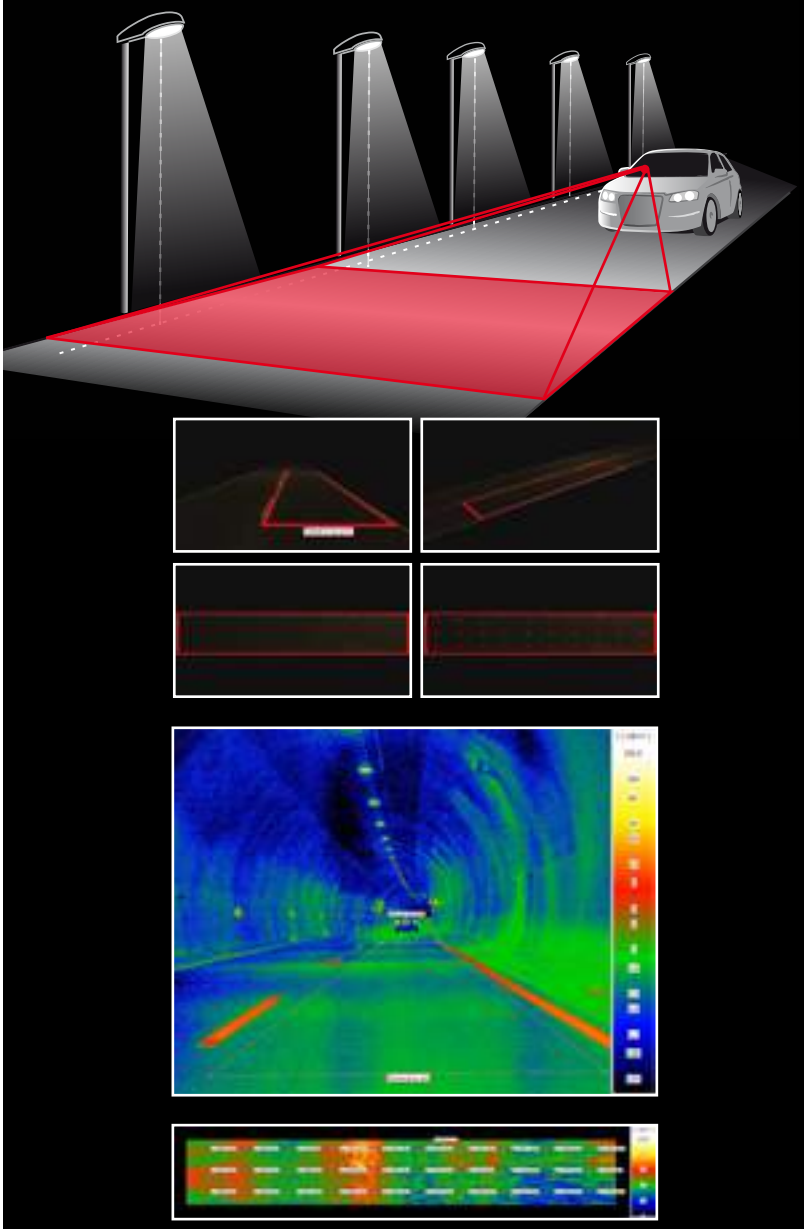


Measuring the L20° luminance of the approach zone in front of tunnel entrances



LMK mobile air

Standard based analysis of the road luminance using LMK LabSoft



Measuring Roads and Tunnels

The LMK mobile air allows a smart and quick evaluation and verification of luminance values relevant to security of public traffic ways by using intelligent software tools.

- Assessment of the luminance values (i.e. according to EN13201) on road and tunnels
- Checking the visibility of transport users, road signs and markers among various weather conditions
- Reviewing the luminance level and the illumination of other public traffic ways

Further Applications

The LMK mobile air is very-well suited for fast and easy assessment for luminances in outdoor areas, roads and public places in an urban environment.

- Quick and easy determination of the highlighting on facades and gladdings – and other vertical surfaces
- Evaluation of the luminance distribution on illuminated surfaces like airport apron – and other horizontal planes

Another application is the assessment of luminance levels and distribution in indoor environments. Also the determination of perceptible contrasts helps to assess the quality of existing conditions for any visual task.

Restrictions

- Can not be used for measuring coloured light sources (i.e. LED)
- Limited use for measuring modulated light sources with strong modulation

LMK mobile air

Electronics

Sensor / Resolution	CMOS Canon APS-C with 5566(H) x 3706(V)
File format	14 Bit RAW - data as uncompressed Bayer structure
PC-Interface	CR2 image file transfer via USB 2.0 to the PC

Measurement results

Luminance image resolution	2748(H) x 1834(V)
Dynamic resolution	Single measurement: 1:4000 High-Dyn measurement: 1:30000 (1/1000 s < ti < 8 s)

Configuration

Selection of measuring range	selecting aperture value, exposure time and ISO speed
Measuring distance	> ca. 280mm
Focus	automatic focus / manual focus
Aperture values	F4 - F11 (calibrated for luminance measurements) in 1/3 steps
Focal length	17mm - 50mm stepless
Viewing angle	focal length 17mm: 65°(H) x 45°(V) focal length 50mm: 28°(H) x 19°(V)
Exposure time	30s - 1/1000s

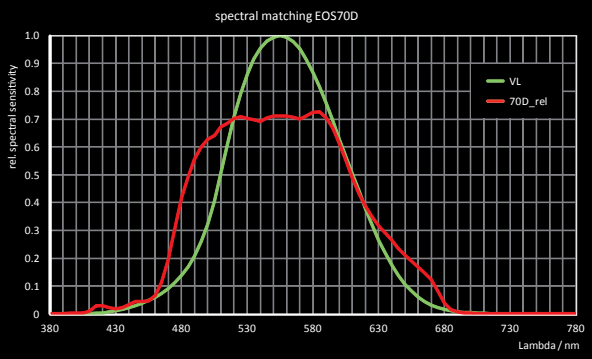
Measurement

Light sensitivity (typical full scale)

aperture	4	4	11
ISO	100	1600	100
t_i= 0.001 s	12 kcd/m²	750 cd/m²	90 kcd/m²
t_i= 3.0 s	4 cd/m²	0.2 cd/m²	30 cd/m²

V(λ)-matching

numerical transformation from R,G,B – sensor data



Integral spectral mismatch in % for several lamp types / spectra

Halogen metal discharge lamps	2-9%
High pressure sodium discharge lamp	7-13%
Fluorescent lamp	8-10%
LED white	5-12%

Calibration uncertainty ΔL in %

ΔL = 2.5% (standard illuminant A)

Repeatability ΔL in %

ΔL = 0.5 … 2%

Uniformity ΔL in %

ΔL ± 2% (f_{22} ≤4%)

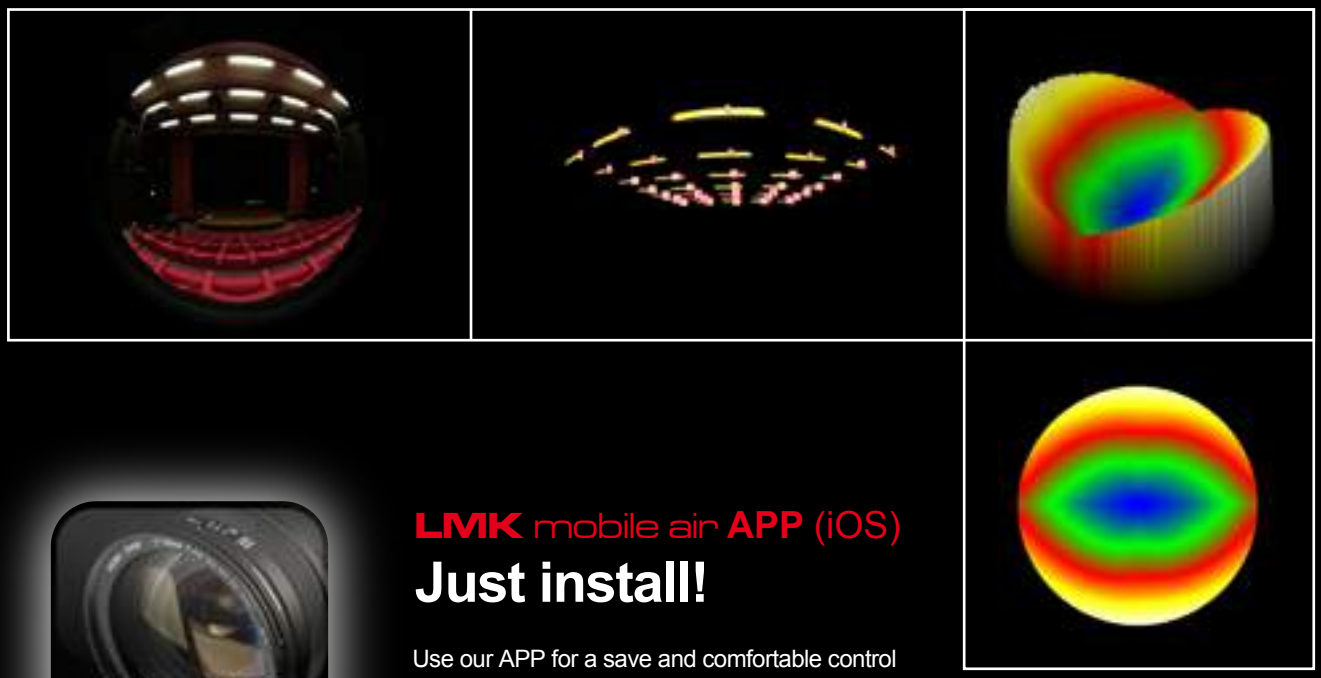
Measuring uncertainty ΔL in % (standard illuminant A)

Ti\Av	4	5.6	8	11
1 ms	6.6	7.0	7.2	7.8
2.5 ms	5.0	5.3	5.5	6.2
25 ms	4.8	5.2	5.4	6.0
0.25 s	4.8	5.2	5.4	6.0
2.5 s	4.8	5.2	5.4	6.0

Operating data

Memory	SDHC card memory chip 16GB (ca. 21MB per image)
Operating system	Windows 10/8/7
Software	LMK LabSoft (monochrome luminance analysis software)

Determination of the UGR or the DGP for indoor lighting



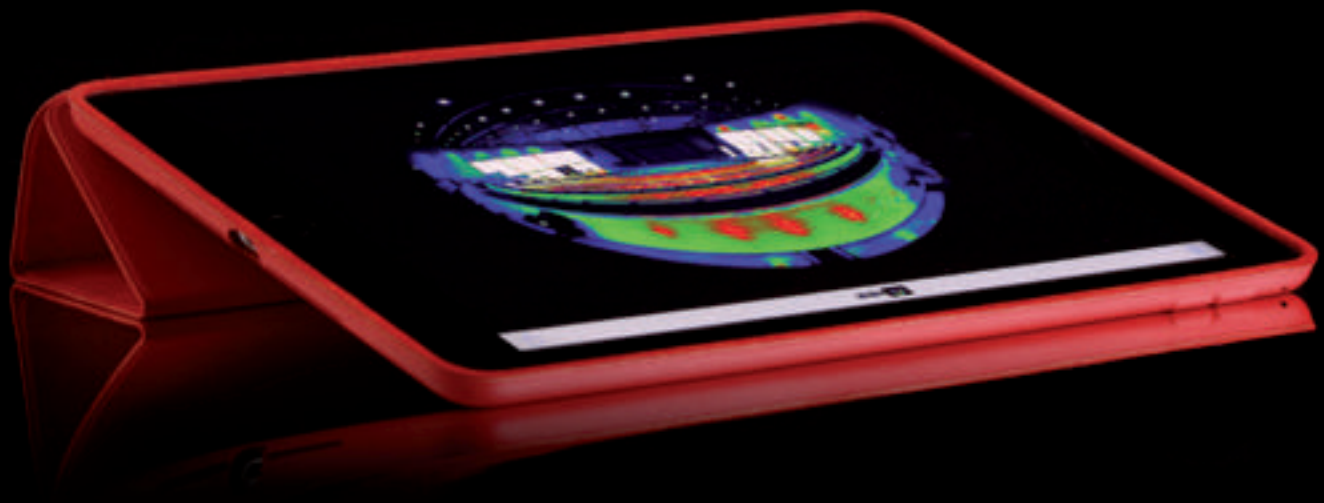
LMK mobile air APP (iOS)

Just install!

Use our APP for a save and comfortable control of your **LMK** mobile air**.** The functional diversity of a digital mirror reflecting camera often overstrains the user. Using our App all valid settings are predefined and can be adjusted very quick and easy. Thus incorrect and faulty measuring results are almost impossible.

If you are already using iPad you can directly download this App from the AppStore and start working immediately.

Alternatively it is possible to order the iPad optionally with the **LMK** mobile air product bundle. In this case the App is already installed and instantly usable.



Components

Lens

Sigma [17-50mm F2.8 EX DC OS HSM]
Sigma [70-200mm F2.8 II EX DG APO HSM]
Sigma Fisheye [4.5mm F2.8 EX DC HSM]
(incl. lens hood and dust cover)

Transport

Mobility case + carrying strap
Transport case **Techno**Team
Wide strap

Power supply

2 x Lithium-Ion Akku [LP-E6]
Battery charger [LC-E6] + power plug
Compact mains adapter [ACK E6]

Cable / Interface

Stereo-AV-Cable
USB Interface cable

Memory card

SDHC card 16GB

Software

EOS Digital Solution (CD ROM)
LMK Labsoft measuring software (CD ROM)

Manual / Certification

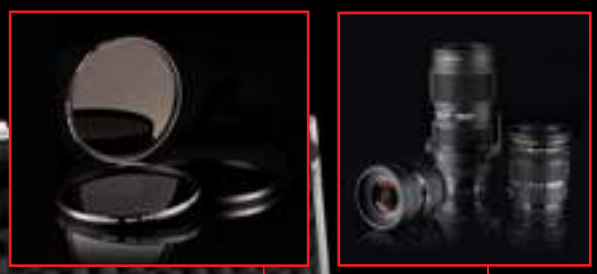
Manual Canon EOS 70D
Manual **LMK** mobile air
Manual **LMK** Labsoft
Calibration certification

Optional

additional SDHC card 16GB
Remote control RC6
Tripod
Sucking tripod "Cullmann"
Neutral density filter - single or set
(opt. density: 1.0; 2.0; 3.0)
Sigma Fisheye [4.5mm F2.8 EX DC HSM]
Sigma [70-200mm F2.8 II EX DG APO HSM]

LMK
mobile air

Canon 70D (DSLR)
Sigma 17-50mm F2.8 EX DC OS HSM



LMK mobile air Set

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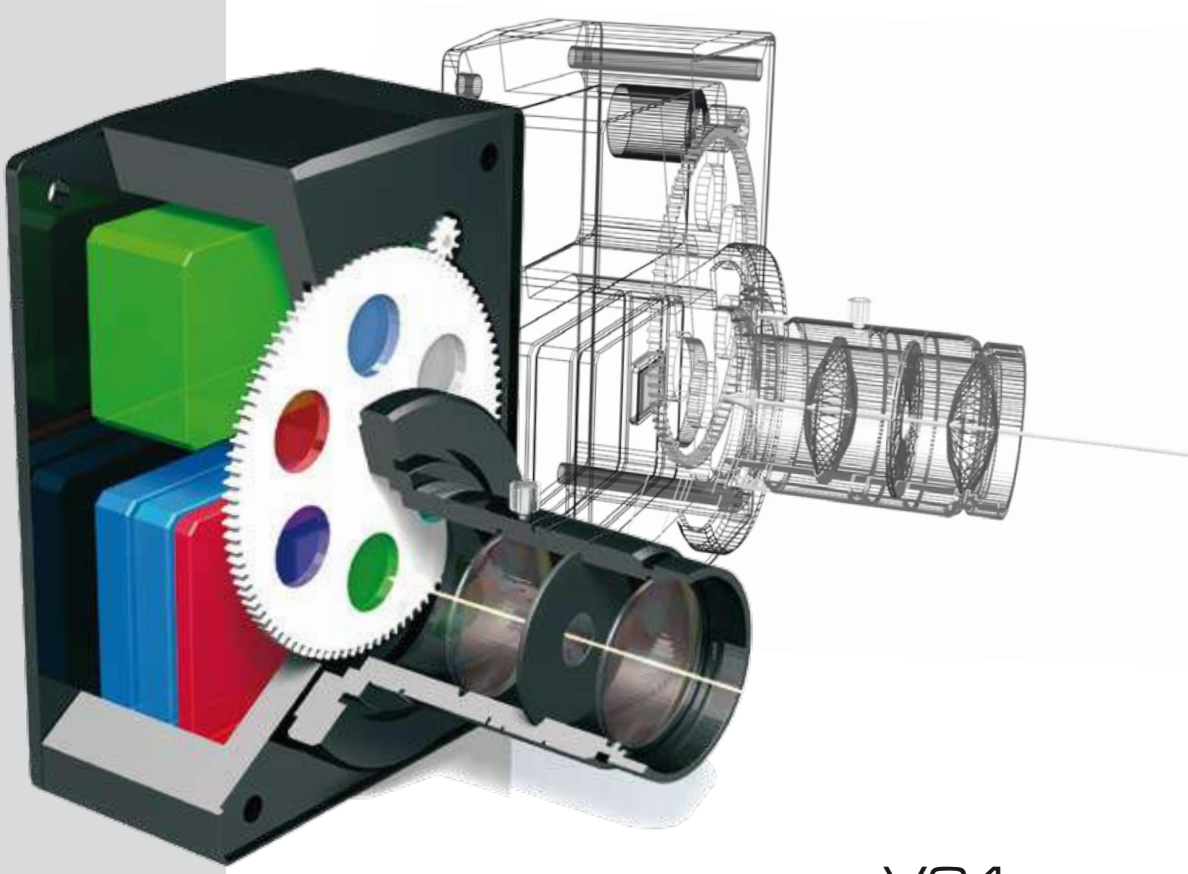


V2.1

VIDEO PHOTOMETER

IMAGING LIGHT AND
COLOUR MEASURING TECHNIQUE

LMK

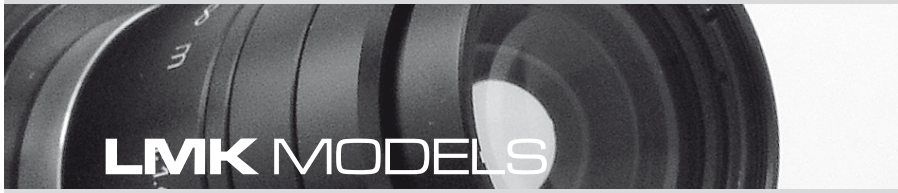
LMK models

The centrepiece of the **LMK** family is the luminance measuring camera type **LMK** 5, using selected and matched CCD matrix sensors made by Sony®.

The current available model types are **LMK** 5 and the **LMK** 5 color.

The measurement system is compact and the operation of the **LMK** 5 via Windows OS operated PC is very simple and flexible. The used PC interface works over GigaBit – Ethernet connector.

For even more flexible and less stationary applications, the **LMK** mobile air is available. It is based on high-quality digital single-lens reflex cameras of the Canon EOS series. Thus, the users have at their disposal a luminance measuring system which is easy to operate and for solving mobile measuring tasks.



LMK 5 color and **LMK** 5

LMK mobile air

Introduction

The spatially resolved analysis of light sources and illuminated scenes is getting more and more important. The complex evaluation of those scenes requires the knowledge of the luminance distribution within the whole field of view or at least in many selected parts of it. Solving the necessary measuring tasks by point by point measuring either takes an enormous amount of time or is only possible within a coarse raster grid or is not possible at all. Thus, the development of spatially resolved radiation receivers, in particular CCD matrix cameras, has enabled the user to solve measuring problems such as measurements for glare evaluation according to the UGR method, the analysis of visibility conditions in the road traffic at night, immission analyis of glare sources, the determination of contrasts in illuminated scenarios like workspaces or directly on light sources (e.g. lamps/ luminaires, displays, night design, indicators).

- measuring of luminous and illuminated surfaces
- determination of luminous and background-lit symbols
- data for simulations in the development of lamps, luminaires and headlamps
- capturing of complex illumination and light distribution situations
- cataloguing and presentation

VIDEO PHOTOMETER

IMAGING LIGHT AND COLOUR MEASURING TECHNIQUE

Advantages

- complex evaluation of luminous and illuminated scenes by means of the photograph of a spatially-resolved luminance distribution
- simultaneous recording of a large number of connected measuring data
- easy data analysis at a glance

Result data

- luminance distributions in measuring images L(x,y)
- derived lighting-engineering parameters such as illuminance distribution E(x,y) and luminous intensity distribution I(x,y)
- luminance data in various formats
- statistical data for being used in calculation programs (e.g. EXCEL®, MatLAB®, LabVIEW®)

Technical data

Sensor:

CCD - imaging matrix system
1380 x 1030 pixel *or* 2448 x 2050 pixel

Resolution (dynamic):

Single picture measurement: 1:1100 (~ 61 dB)
Multi picture measurement: 1:3600 (~ 71 dB)
High Dynamic measurement: 1:10000000 (~140 dB)
A/D conversion: 14 bit

Measurement time:

Starting with 1 sec. up to 15 sec. for different luminances, depending on adjusted exposure time

Measurement accuracy:

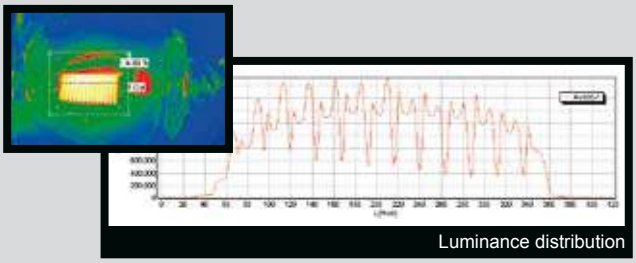
$\Delta L < 3$ % (for standard illuminant A)
$\Delta x,y < 0.0020$ (for standard illuminant A)

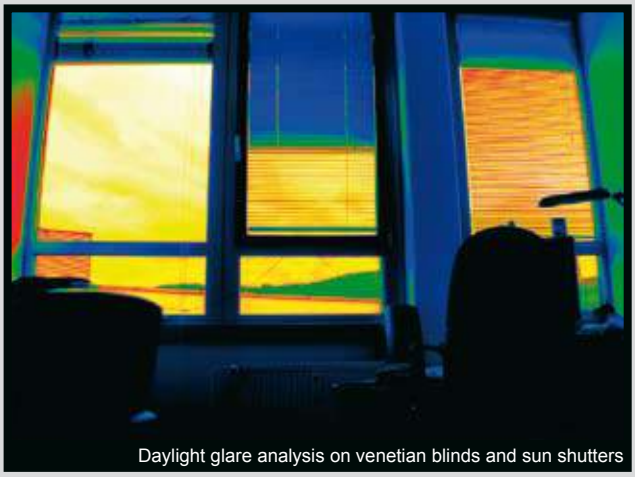
Spectral matching:

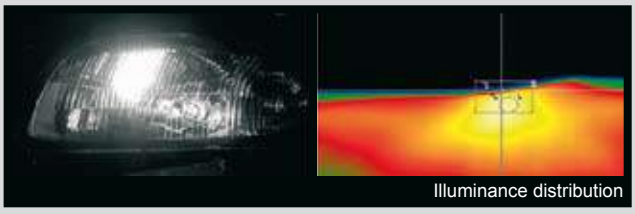
with full size filter matched to V(λ)-function for measuring luminances

arranged with X(λ)-, V(λ)- and Z(λ)-filter for measuring colour values; additionally C(λ)-, V'(λ)-, BLH (blue light hazard) and IR-filter are available

LMK


Luminance distribution


Daylight glare analysis on venetian blinds and sun shutters


Illuminance distribution


Measurement of coloured LED

Imaging measuring of luminances

The measurement of luminance distributions L(x,y) allows the complex evaluation of numerous lighting-engineering devices (lamps, luminaires, projectors and light control systems), as well as the evaluation of illumination scenes. The imaging luminance measuring technology allows the acquisition of both photometric parameters and geometrical data, enabling the user to determine further lighting-engineering quantities (luminous intensity, illuminance).
For describing lighting-engineering objects, not only simulation data but also various measuring data are necessary:

- description of luminous and illuminated surfaces of lamps and lighting fixtures by their luminance distributions L(x,y)
- determination of contrasts and spatial contrast rendering function (CRF)
- deriving additional photometrical or recognition data throughout geometrical analysis like illuminance, luminous intensity or glare data
- deducing the illuminance or luminous intensity distribution (LID) on illuminated surfaces (by use of diffuse Lambertian reflectance and fixed geometrical setup) by means of the luminance distribution

Colorimetric measuring data

The imaging measurement and determination of colour and chromaticity values, for example of lamps and lighting fixtures, is gaining more and more importance. Using the **LMK color** camera adapted to the colour matching functions of the 2° CIE standard observer (CIE 1931) by a filter wheel, not only luminances but also tristimulus values can be determined. This permits the imaging measurement of chromaticity coordinates, which can be given in different colour spaces. Therefore it is possible to solve tasks a lot faster compared to classical colour measuring techniques.

- describing the colour distribution on luminous and illuminated surfaces or symbols by means of the chromaticity coordinates x,y
- determining the dominant wavelength λ_{dom} and the correlated colour temperature (CCT in Kelvin) of LEDs and lamps

Night vision design

The dashboard, cockpit and ambient night vision design of the automotive and avionic industry offers manifold applications for the imaging luminance and colour measuring technology.

- brightness and uniformity of backlit symbol illumination
- colour, colour rendering and colour shift of functional backlit or ambient illumination
- brightness, uniformity and contrasts on screens and displays

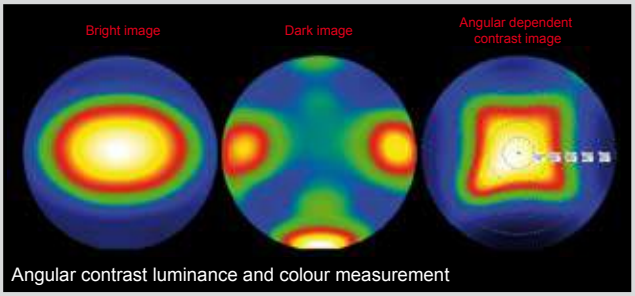
For this purpose, **TechnoTeam** has designed application adapted software tools for recording and determining low luminances of smallest symbols.
Therefore the Symbol object measures the mean luminance of backlit surfaces – using adaptive algorithms to set a classifying luminance threshold, thus offering more adaptive solutions.

Display analysis

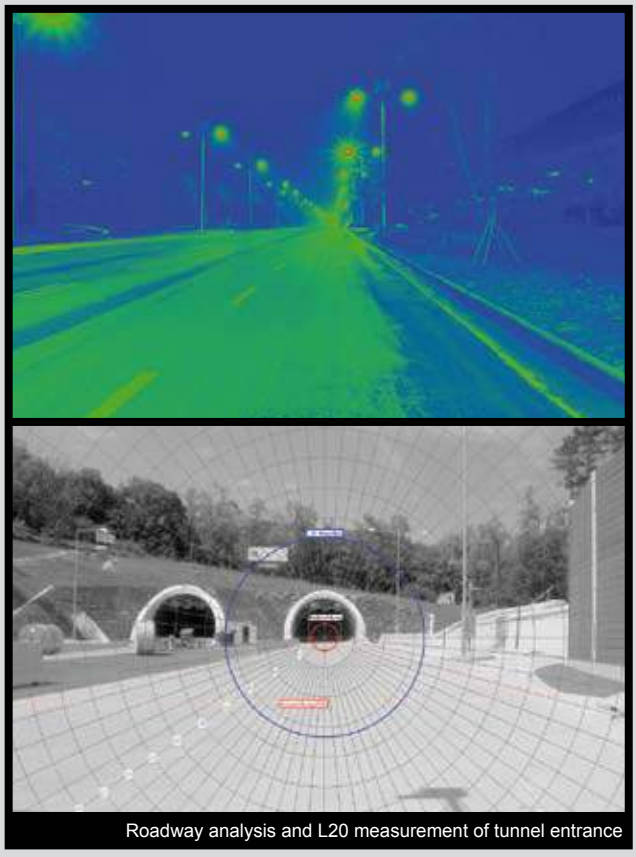
The imaging light and colour measuring technology is exceptionally well suited for analysing or checking the rendering characteristics and quality features of flat panel displays (FPD).

- checking the uniformity of backlit background luminance according to existing standards
- evaluating the angle-dependent contrast distribution on FPD (by means of a Conoscopic lens and Application close software tool)
- determining defect pixels of FPD
- BlackMURA analysis according to German Automotive OEM Work Group Displays
- Sticking image analysis of FPD

Brightness and uniformity of backlit symbol illumination – symbol



Angular contrast luminance and colour measurement



Roadway analysis and L20 measurement of tunnel entrance

UGR analysis of indoor lighting applications

Outdoor lighting

The **LMK** measuring system is very well suited to make measurements in an urban environment, on public places and spaces, on roadways or any other artificially illuminated infrastructure in order to produce data for checking and maintaining lighting design.

- checking the luminance, colour rendering and colour shift of large luminous boards and information carriers with regard to their visibility and perceptibility
- glare evaluation and determination of the visibility distance of lighting installations
- determination of the luminance distribution according to DIN EN 13201 for roadways
- performing the L20 luminance measurement of tunnel portals (CIE Publ. 88)
- checking the recognizability of roadway markings under varying weather conditions

Used in a moving car the **LMK** camera also allows for dynamic roadway luminance analysis.

Indoor lighting

The **LMK** measuring system allows spatially resolved measurements to verify existing standards and design projects to be made in a simple and fast way with regard to full illumination, ergonomics and well-being.

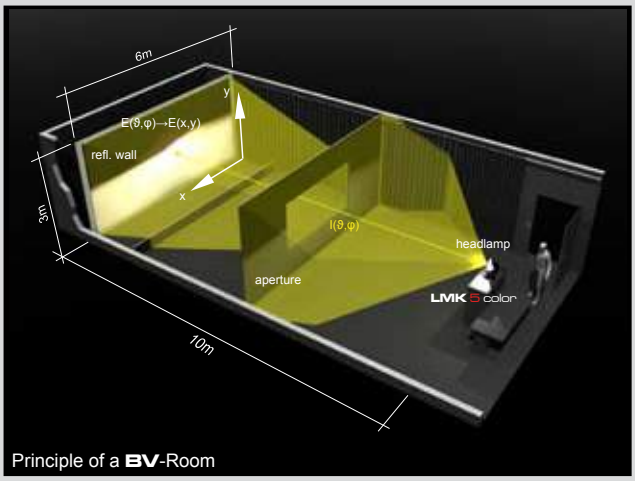
- evaluation of brightness and colour distribution and perception in rooms, offices or other indoor spaces
- glare evaluation on window surfaces, daylight systems and artificial light sources (GR, UGR, DGP)
- determination of brightness dynamics and contrast ratios (CRF)
- determination of the horizontal illuminance distribution related to ergonomic and economic aspects of workplaces and spaces
- evaluation of circadian activation potentials of artificial lighting with regard to the health and well-being of humans
- checking and maintaining emergency and safety lighting according to existing standards

Measuring headlamps

Being the supplier of measuring equipment for a large number of manufacturers of lighting and illumination devices and maintaining close contacts to its scientific environment, the **Techno**Team company has gained experience in handling both lowest and highest luminances, thus is in a position to offer solutions adapted to very special applications.

- determination of the illuminance distribution on plane surfaces
- calculation of the luminous intensity distribution of headlamps
- measurement of the colour scale and colour deviations, e.g. on bright and dark edges in the projected image of a headlamp
- verification and observance of guidelines for car headlamps by means of prescribed measuring points (e.g. HV; AK31; B50L and many more)
- automatic alignment on measurement grids and positioning of measurement spots (automatic elbow-point detection)
- calibrated for and supported by our products **KMP** and **BV**-Room

By means of the **LMK** camera, it is possible to take street lighting measurements also out of a car in motion.

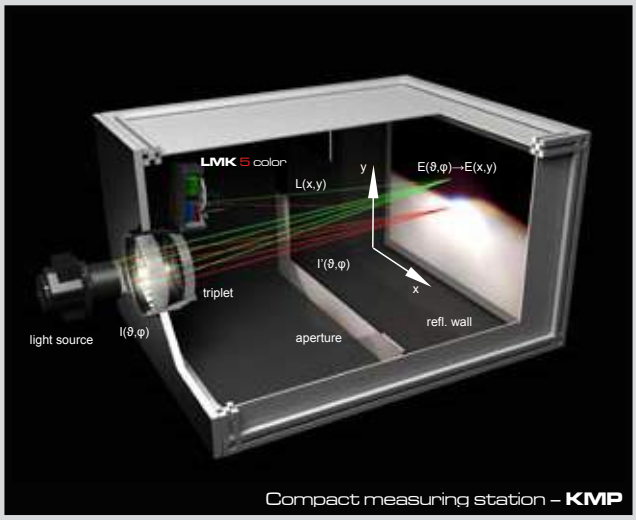


Principle of a **BV**-Room

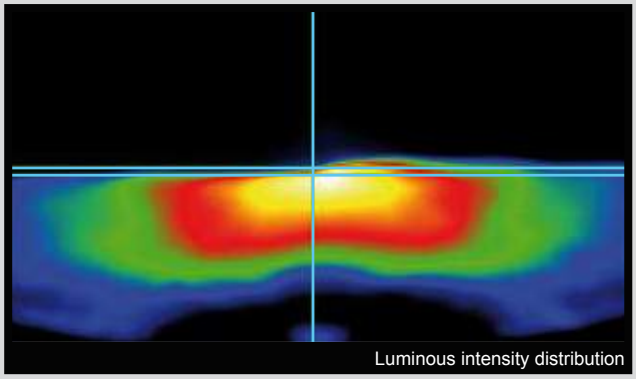

Measuring object – automotive headlamp

Compact measuring station **KMP**

The **KMP** is a realisation of the principle of the indirect luminous intensity measurement without the need of a specially adapted laboratory room. A measuring object positioned in front of the optical system of the **KMP** illuminates a reflective wall with Lambertian characteristics, which is placed in the focal plane of the optical system. Thus the reflected luminance distribution or colour distribution can be measured by using the **LMK** or **LMK** color, inside the **KMP**. The optical system of the **KMP** reduces the measuring distance to less than 1 m while maintaining the observance of the photometrical limiting distance. The geometrical and photometric relations between the light source (in spherical coordinates) and the reflective wall (in camera coordinates) are known, therefore the luminous intensity distribution I(ϑ, ϕ) can be calculated automatically from the image of the luminance L(x, y).



Compact measuring station – **KMP**


Luminous intensity distribution

LMK

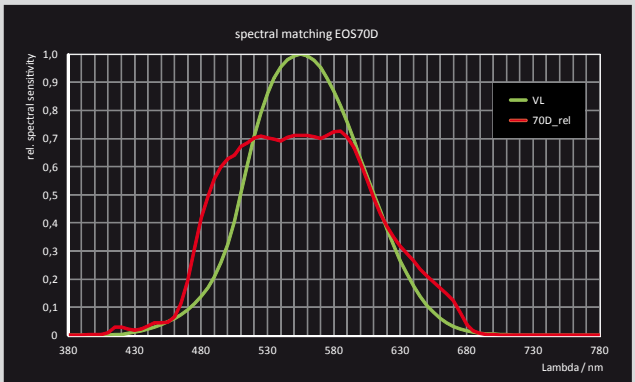
LMK MODELS

The application of high-quality digital cameras in the **LMK** system allows for easy and fast capturing of luminance images. For evaluating the images, the complete functionality of the **LMK** LabSoft software can also be utilized.

LMK mobile air Set

Ti\Av	4	5,6	8	11
1 ms	6,6	7,0	7,2	7,8
2,5 ms	5,0	5,3	5,5	6,2
25 ms	4,8	5,2	5,4	6,0
0,25 s	4,8	5,2	5,4	6,0
2,5 s	4,8	5,2	5,4	6,0

Table of measurement uncertainty for **LMK** mobile air



Halogen metal discharge lamps	2-9%
High pressure sodium discharge lamp	7-13%
Fluorescent lamp	8-10%
LED white	5-12%

Quality of spectral matching of the **LMK** mobile air

1 Calibration according to DIN 5032 Part 6 using a luminance standard led back from the Physical-Technical Federal Institute

LMK mobile air

Sensor

CMOS Canon APS-C
[5566 (H) x 3706 (V)]
effective Pixel [2748 (H) x 1834 (V)]
(resolution of the luminance image)
[14 Bit RAW
data with Bayer structure, uncompressed]

Dynamic range

Single picture measurement [SinglePic]
[1:4000 (~60 dB)]
High Dynamic measurement [HighDyn]
[1:32000 (1/1250 sec. ≤ ti ≤ 8 sec)]

Data transmission

SDHC memory card and/or USB 3.0

Metrological specifications

Spectral matching
[numerical weighting of the RGB tristimulus values (multiplying matrices)]

Focal length / Visual field angle

FishEye:
Focal length [4.5mm: ca. 180°(circular)]

Standard:
Focal length [17mm: ca. 74.6°(H) x 49,7°(H)]
Focal length [50mm: ca. 27.8°(H) x 18.6°(H)]

Tele:
Focal length [70mm: ca. 14.6°(H) x 10°(H)]
Focal length [200mm: ca. 5,9°(H) x 3,9°(H)]

Selection of measuring range

Selecting aperture,
exposure time and ISO speed.

Calibration uncertainty[1]

ΔL [< 2.5%]

Uniformity

ΔL [< 2%]

Fields of application

research and development (R&D) applications
solid state lighting (SSL) - outdoor/indoor
glare assessment

Fields of application

Can not be used for measuring coloured light sources (e.g. LED)

Limited use for measuring modulated light sources with strong modulation

LMK mobile air
APP (iOS)
Just install!

LMK 5

Sensor

[14 Bit digital, progressive scan]

LMK 5-1

CCD Sony [ICX 285 AL (2/3")]
effective Pixel [1380 (H) x 1030 (V)]

LMK 5-5

CCD Sony [ICX 655 AL (2/3")]
effective Pixel [2448 (H) x 2050 (V)]

Dynamic range

Single picture measurement (SinglePic)
[1:1100 (~61 dB)]
Multi picture measurement (MultiPic;10 pics)
[1:3600 (~71 dB)]
High Dynamic measurement
[1:10000000 (~140 dB)]

Data transmission

Gigabit Ethernet Interface(GigE®)

Metrological specifications

V(λ) [$f_1' < 3.5\%$[1]]

Measuring quantities

Luminance [L (cd/m²)]
Further measuring quantities can optionally be defined via scaling factors.

Measuring range

Setting the luminance measuring ranges by choosing the integration time from 100 µs...15 s
Accuracy rating depending on lens (aperture number = k), e.g.:
1ms ...appr. 1800 cd/m² & 3s ...appr. 0.6 cd/m² (k = min.)
1ms ... 60000 cd/m² & 3s ... appr. 20 cd/m² (k = max.)
Higher luminances can be achieved using optional neutral density filters.

Calibration uncertainty[2]

fix focused lenses ΔL [< 2%]
focusable lenses ΔL [< 2.5%]

Repeatability[3]

ΔL [< 0.1%]

Measuring accuracy

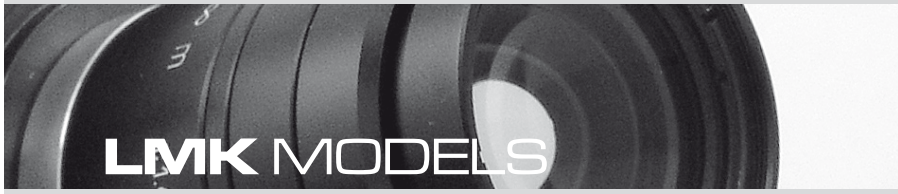
ΔL [< 3% (for standard illuminant A)]

Uniformity

ΔL [< 2%]

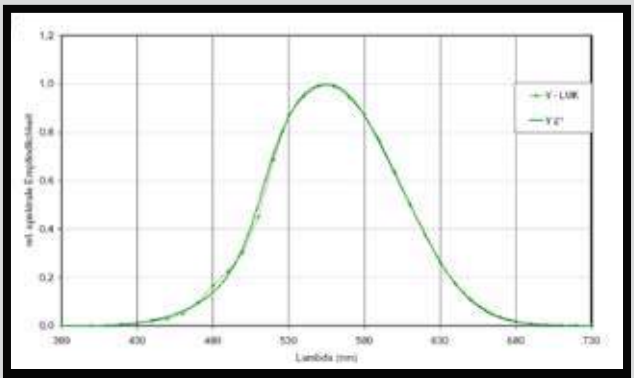
Fields of application

laboratory measurements, field measurements, industry automation



The **LMK 5** is a digital CCD matrix camera system equipped with a precise analogue electronic system for signal generation.
Each camera is equipped with carefully manufactured full filter in order to achieve a high-quality V(λ)-matching for determining luminances.

LMK 5



Spectral matching of the **LMK 5**

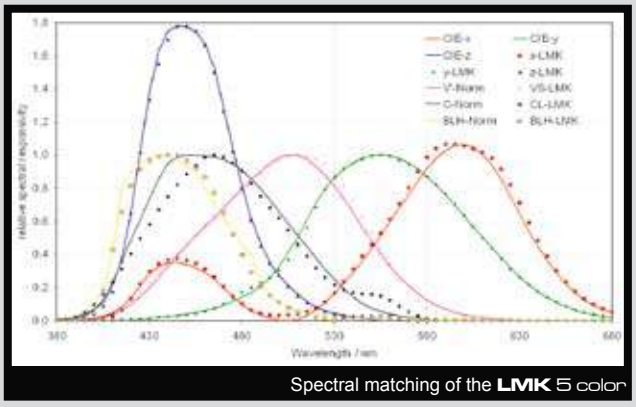
1 Measurements according to DIN 5032 Part 6/CIE Pub. 69 | 2 Calibration according to DIN 5032 Part 6 using a luminance standard led back from the Physical-Technical Federal Institute | 3 Measurement performed on a stabilized white LED light source L=100cd/m². Mean value over 100 Pixel; repeatability as variability of the mean value.

LMK MODELS

The **LMK** 5 color is equipped with a filter wheel for colour measurements, adapted to the colour matching functions of the 2° CIE standard observer (CIE 1931).
Thus, luminances and additional colour or chromaticity data can be measured. The filter wheel allows a total of 6 full glass filters to be incorporated, with 4 filters being necessary for the colour measurement.

In addition, the measuring system can also be equipped with filters for the scotopic luminance V´(λ), the circadian function of action C(λ), an IR - filter (measurements in the NIR range 780-1000 nm) a BLH (blue light hazard), or a clear glass filter.

LMK 5 color



Spectral matching of the **LMK** 5 color

1 Measurements according to DIN 5032 Part 6/CIE Pub. 69 | 2 Dominant wavelength, saturation, correlated color temperature | 3 Calibration according to DIN 5032 Part 6 using a luminance standard led back from the Physical-Technical Federal Institute | 4 Measurement performed on a stabilized white LED light source L=100cd/m². Mean value over 100 Pixel; repeatability as variability of the mean value. | 5 Measured value based on 30 test colors with different spectral distributions based on ROSCO color filters

LMK 5 color

Sensor

[14 Bit digital, progressive scan]

LMK 5-1 color
CCD Sony [ICX 285 AL (2/3")]
effective Pixel [1380 (H) x 1030 (V)]

LMK 5-5 color
CCD Sony [ICX 655 AL (2/3")]
effective Pixel [2448 (H) x 2050 (V)]

Dynamic range

Color High Dynamic measurement
[1:10000000 (~140 dB)]

Data transmission

Gigabit Ethernet Interface(GigE®)

Metrological specifications

V(λ) [f_1 < 3.5%[1]]; X(λ) [f^*_1 < 4%]
Z(λ) [f^*_1 < 6%]; V´(λ) [f^*_1 < 6%]

Measuring quantities

Luminance: L (cd/m²), chromaticity coordinates: x,y, Supported colour spaces: RGB, XYZ, sRGB, EBU-RGB, User, Lxy, Luv, Lu'v', L*u*v*, C*h*s*uv, L*a*b*, C*h*ab, HIS, HSV, HSL, WST[2]
Further measuring quantities can optionally be defined via scaling factors.

Measuring range

Setting the luminance measuring ranges by choosing the integration time from 100 µs...15 s
Accuracy rating depending on lens (aperture number = k), e.g.:
1ms ...appr.7500 cd/m² & 3 s ...appr. 2.5 cd/m² (k = min.)
1ms ... 60000 cd/m² & 3 s ...appr. 20 cd/m² (k = max.)
Higher luminances can be achieved using optional neutral density filters.

Calibration uncertainty[3]

fix focused lenses ΔL [< 2%]
focusable lenses ΔL [< 2.5%]

Repeatability[4]

ΔL [< 0.1%]
Δx,y [< 0,0001]

Measuring accuracy

ΔL [< 3% (for standard illuminant A)]
Δx,y [< 0.0020 (for standard illuminant A)]
Δx,y [< 0.0100 (set of test colours)[5]]

Uniformity

ΔL [< 2%]

Fields of application

laboratory measurements, field measurements, industry automation

LMK LabSoft software

Additionally to all camera systems of the **LMK** family, the **LMK** LabSoft is supplied.
The measuring software offers a large number of possible applications when using the luminance measuring systems, as well as for data evaluation and processing.

Ease of operation is guaranteed to the user through the integration of task-specific capture functions.

SinglePic-capture - allows a luminance image to be taken very quickly.

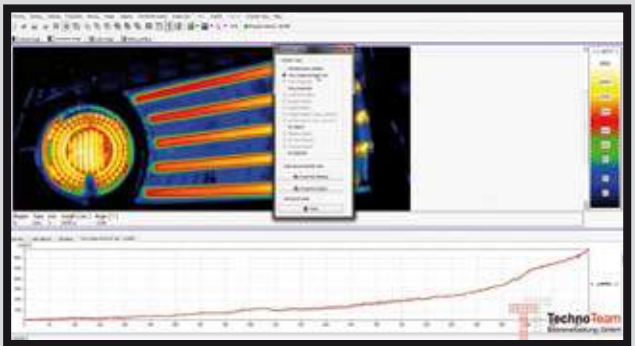
MultiPic-capture - allows the repeated capture of several single images so as to eliminate statistical measuring errors through averaging.

HighDyn-algorithm - allows the capture of a luminance image composed of single images at various integration times so as to realize a higher dynamic range.

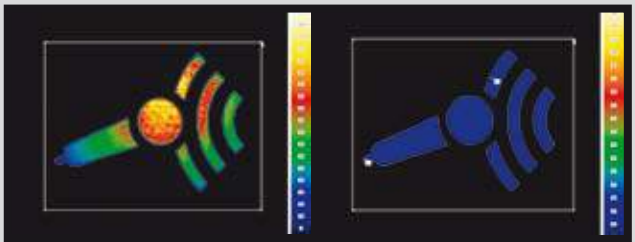
For the visualization of the measuring results, the user can choose, among other things, from a freely scalable pseudocolouring as well as several logarithmic representations. Pre-made and freely scalable point, line, circular and rectangular cursors allow the measuring data to be accessed in a quick and flexible way. The definition of measuring regions by means of geometrical basic shapes facilitates the evaluation process. In addition, they provide many auxiliary means for the statistical evaluation of the data (tables, sectional diagrams, histograms, and photometric evaluation algorithms).
Furthermore, the software offers a function for an automatical detection of regions by means of luminances. This is both useful and advantageous for detecting complex geometrical structures.

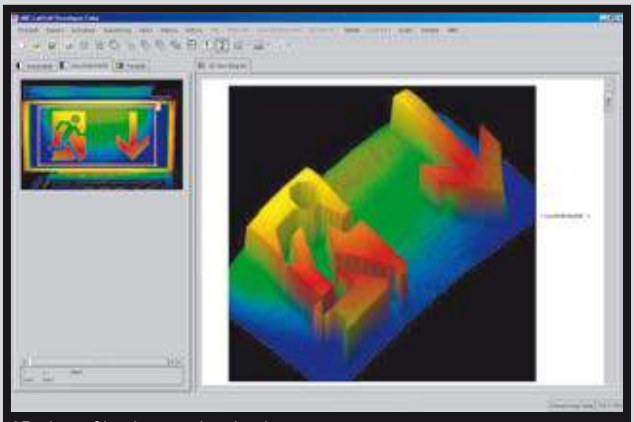
An integrated report function allows for the export of measurement and evaluation data to MS Word® and MS Excel®. Thus it offers a simple and comfortable way for communicating and sharing measurement results. Furthermore a standard or individual printing template can be created for report printing.

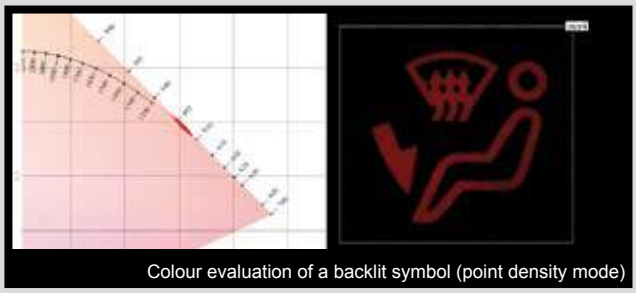
The **LMK** LabSoft software provides a big variety of data formats for the export and import of image and measuring data, for example for MATLAB®, LabVIEW® and SPEOS®. The data exchange with Microsoft Office® products and other software programs is ensured by functions of the Windows® clipboard.



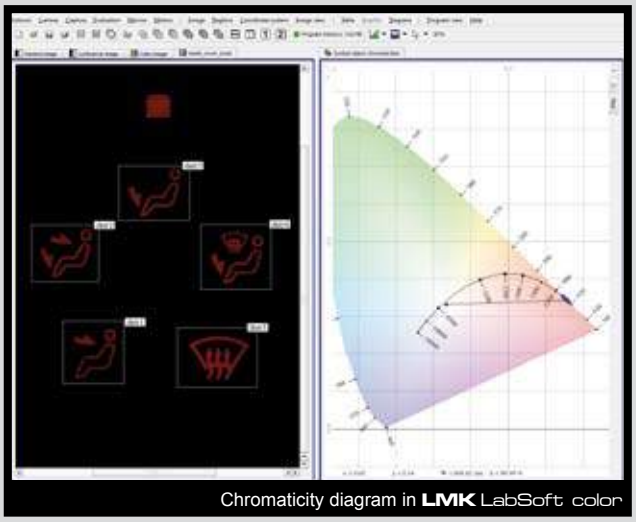
Sectional view statistic tool in **LMK** LabSoft


Luminance image (left) and statistical symbol detection (right)

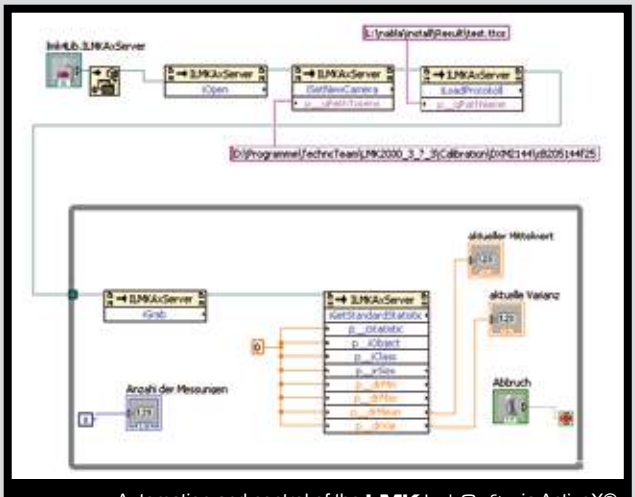

3D view of luminance drawing in **LMK** LabSoft



Colour evaluation of a backlit symbol (point density mode)



Chromaticity diagram in **LMK** LabSoft color



Automation and control of the **LMK** LabSoft via ActiveX®

LMK LabSoft color software package

With the **LMK** LabSoft color the complete functionality of the luminance measuring software **LMK** LabSoft is available for the assessment of chromaticity values out of three channel colour images. The measured X,Y,Z colour values can be converted into different colour spaces (e.g. RGB, XYZ, sRGB, EBU-RGB, Lxy, Luv, L*a*b*, HIS, HSV). In case of measuring LEDs or lamps a colour space showing the dominant wavelength, the colour saturation and the correlated colour temperature is available. It is possible to calculate colour distances and colour differences in several colour spaces.
With the colour symbol object-chromaticity coordinates can be matched to their luminance levels. So it is easier to detect regions for a colourimetric evaluation (e.g. backlit symbols) with respect to a luminance threshold.

The user can exert an influence on the calibration data and change the algebra of matrices. Therefore it is possible to adjust the **LMK** system for an own colour space or for balancing the **LMK** system with own reference quantities. In this way the spectral matching can be adapted to specific measurement tasks (e.g. LED measurements).

Throughout the measurement in several channels X, Y, Z and V´(λ) and optional C(λ) or BLH (Blue Light Hazard) and the subsequent image processing different radiation measurements for different perception models can be made (e.g. mesopic brightness perception).

LMK LabSoft extended software package

With this version of the **LMK** LabSoft software the possibilities for an interaction and automation of the image processing procedures are rapidly increased. By using an ActiveX® Interface the **LMK** LabSoft and its essential functionalities can be controlled by several other software applications. The assessement of the image and measurement data can be done directly via the host application. Therefore, the software can easily be integrated into existing workflows.

Version packages of LMK LabSoft

LMK LabSoft

With the measurement and analysis software **LMK** LabSoft **Techno**Team provides a consistently ongoing analysis software development. This can be seen as the result of an intensive exchange of experience with our customers and so we can enhance our evaluation functionalities continously. Thus the functionalities for the documentation and the reporting of the measurement results are now totally compatible with MS Office®.
Our customers can directly profit from this development during the whole life-time of their **LMK** systems with free of charge software updates.

LMK LabSoft simple

The **LMK** LabSoft simple package offers a measurement system which includes the known camera hardware in combination with only essential software components at a lower price.
Therefore, all video photometer systems can be equipped with the **LMK** LabSoft simple software. This software is reduced to several selected basic functionalities.

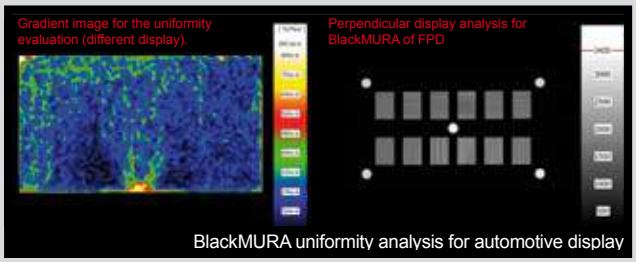
Software functionality	LMK LabSoft simple	LMK LabSoft
Image capture		
Live image (grey scale value)	x	x
Exposure adjustment	x	x
Image capture (SinglePic, MultiPic, HighDyn, Color HighDyn)	x	x
Capturing modulated light	x	x
Live luminance image SinglePic, HighDyn, Color HighDyn		x
Capturing measurement series *(manual, time controlled, mechanical controlled)*		x
Representation of images *(Pseudo-colours, ISO colours, scaling)*	x	x
Working with images *(load, save, delete, copy, print)*	x	x
Displaying measuring values by means of cursors (standard, rectangle, circle, line, circular ring, cross, zoom)	x	x
Measurement regions *(load, save, copy, paste, group, print)*	x	x
Measuring value indication using inspectors		
Standard statistics *(standard evaluation, histogram, sectional view, time statistics, luminance object, integral object, symbol object, arc object, filament object)*	x	x
Report function *(create, load, save, print)*	x	x
Evaluation images and image processing		
Additional evaluation images	1	N
Physical parameters and units	x	x
Assigning list of regions		x
Assigning image tab windows		x
Image arithmetics		x
Coordinate transformation		x
Projective rectification - orthophotographs	x	x
ISO lines in luminance images	x	x
Colour images and colour metrics		
Colour space and measuring values	x	x
Calculation of colour differences	x	x
Decomposition of colour images into colour extract images		x
Composition of colour extract images into colour images		x
Test colour images		x
Measurement protocols *(create, load, save, comments)*	x	x
Automation via ActiveX®		
ActiveX® programming interface	●	●
Running IPED – autom. image processing macros		●
Additional software addon		
Motor control		●
BlackMURA - display measurement		●
Sticking image – display analysis		●
LID – luminous intensity distribution measurement		●
CCM – conoscopic contrast measurement		●
EN13201 – street analysis		●

x available ● optional available

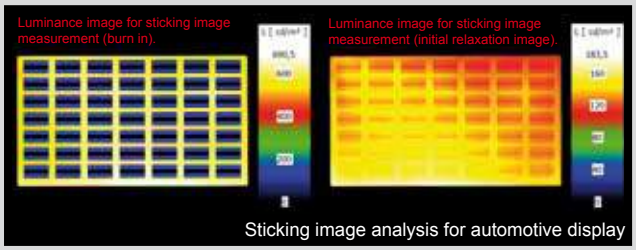
LMK LabSoft AddOn user application software

For more frequent applications with complex analysis steps **Techno**Team developed a number of additional and optional software tools for **LMK** LabSoft. Thus the user has a fast and easy access on specific measurement results and data. **LMK** LabSoft AddOn are not available for the **LMK** LabSoft simple version. Some of them are free of charge.

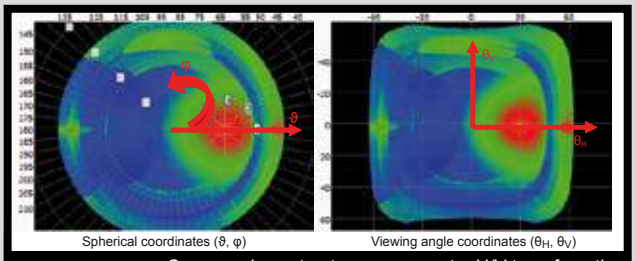
- **LMK** BlackMURA supplies the analysis of display screen quality according to the black-level uniformity.
  Thus the package is providing an extension to the functions of the **LMK** LabSoft for realising a gradient filter detection of particular non-uniformity on the display screen.
- **LMK** Sticking image supplies the analysis of display screen quality according to the three-level burn-in method developed by Dr. Lauer.
- **LMK** Conoscopic contrast measurement – CCM
  The software package allows the user to perform the application of angular contrast determination of display in an easy way. It provides the capability of H/V angular coordinates conversion as well as the definition of measurement regions and points in the ϑ,ϕ and ϑ_H, ϑ_V angular coordinate system.
- **LMK** motor controls allows the control and automation of external motion units. Several control standards via RS232 interface are implemented.



BlackMURA uniformity analysis for automotive display



Sticking image analysis for automotive display



Conoscopic controst measurement – H/V transfomation

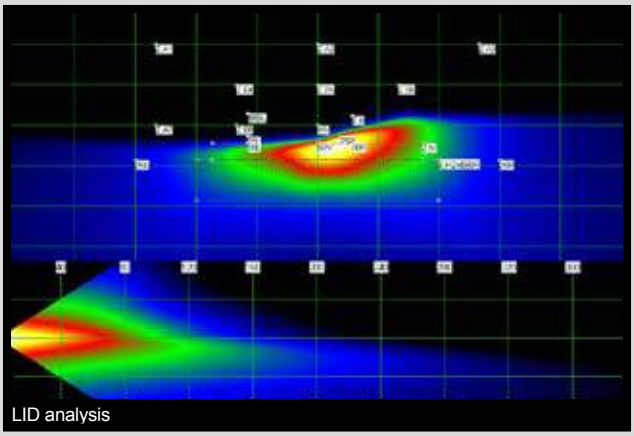
LMK LabSoft-AddOn user application software

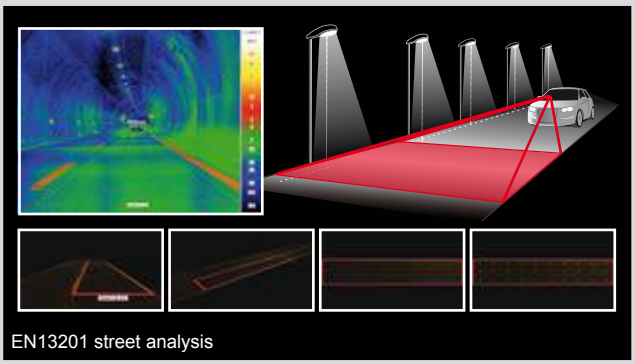
For more frequent applications with complex analysis steps **Techno**Team developed a number of additional and optional software tools for **LMK** LabSoft. Thus the user has a fast and easy access on specific measurement results and data. **LMK** LabSoft AddOn's are not available for the **LMK** LabSoft simple version. Some of them are free of charge.

LMK LID analysis is an additional functionality for analysing luminous intensity distributions especially of headlamps. It enables the user to transform the measured luminance image into the corresponding luminous intensity or illuminance distribution. Here the illuminance can be determined either on a plane (e.g. on a projection wall located at a distance of 10 m) or on a hemisphere (e.g. 25 m radius for ECE).

LMK EN13201 street analysis is an additional package for measuring road lighting in a fast and easy way. The user is able to acquire all parameters necessary for the DIN EN 13201 standard by one single capture. The measured luminance values will then be processed by the software for further use. Also the user is able to determine important quantities such as the vertical illuminance, the solid angle of the glare source, and the veiling luminance according to common standards. Therefore the disability glare for road lighting conditions can be calculated - Threshold increment (TI).

LMK UGR contains a data package which allows the fast and easy assessment of UGR parameters. Using the software, the user is able to determine glare entrance quantities such as the glare and the adaptation luminance level, the vertical illuminance, the solid angle and the position index of the glare sources.
Based on these quantities the unified glare rating (UGR) and almost all other glare sensations can be calculated.


LID analysis


EN13201 street analysis

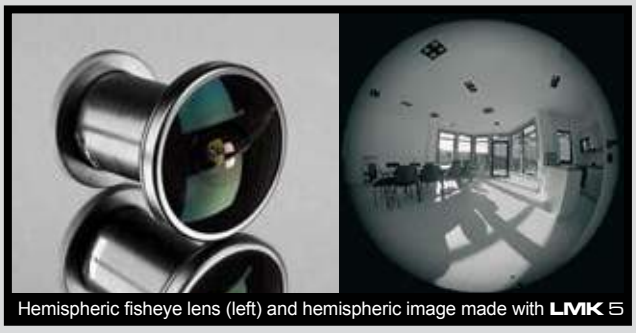

UGR analysis

ACCESSOIRES

aperture (f=mm)	min. measuring distance (mm)	least field of view (circa)	least field of view (mm x mm)	field of view with a distance of 500 mm	field of view with a distance of 1000 mm
8	500	60°(H) x 56°(V)	520 x 390	520 x 390	1125 x 845
16	185	30°(H) x 22°(V)	85 x 64	270 x 203	540 x 407
25	220	20°(H) x 15°(V)	58 x 44	160 x 120	360 x 275
50	280	10°(H) x 7°(V)	32 x 23	75 x 56	160 x 120

Further lens solutions with other viewing types can be realized on request.

Available lenses for **LMK** 5



Hemispheric fisheye lens (left) and hemispheric image made with **LMK** 5

Special imaging systems - Conoscopic lens and Macro lens (left) and **LMK**

1 measuring distance = lens - leasing edge of camera

Lenses

Various focusable lenses with a fixed aperture for different focal lengths f´= 8 mm, 16mm, 25 mm, 50 mm are on offer. These lenses have a low stray light level. They are individually set and optimized by **Techno**Team for the application of the customer. For an integration time of 3 sec., the sensitivity of these lenses is up to 1cd/m² measurement range end value. Furthermore all those lenses can be ordered with a fix focus for fixed measurement distances.

Special imaging systems

For small object fields or tasks with high magnifying a various set of of macro lenses is available. With a modular construction system **Techno**Team is able to realise many different small object fields at various distances.

The hemispherical lens allows the capture of an object field at a field angle of ±92°. This FishEye lens can be used for capturing complex illumination situations, for example in the case of the evaluation of interiors.

For determining the radiation characteristic in a smaller field of view, for example for determining the angle-dependent contrast of displays, the hypercentric conoscopic lens is offered. It can be used to record the luminance within an angular range of ± 60° of the object.

Neutral density filters

ND-filters with different transmissions ranging from 0.5 … 0.00001 enhance the measurement range of the CCD camera to be increased for the measurement of very high luminances.

Spectral matching filters

TechnoTeam does already offer the following spectral matching filters functions: C(λ); V'(λ); BLH; IR 780 and IR 715 for built inside the **LMK** 5 color.

L³-standard

With the **L³-standard TechnoTeam** offers coloured standards for Luminance, Luminous flux and Luminous intensity based on LED.
The stability of the photometric quantities is achieved through a temperature control containing a Peltier device and an intensity control containing a spectrally matched photodiode. In the closed housing, which has an exchangeable end cover, a pre-aged and selected high-power LED is used for each **L³-standard** operated at about 2/3 of the rated current.

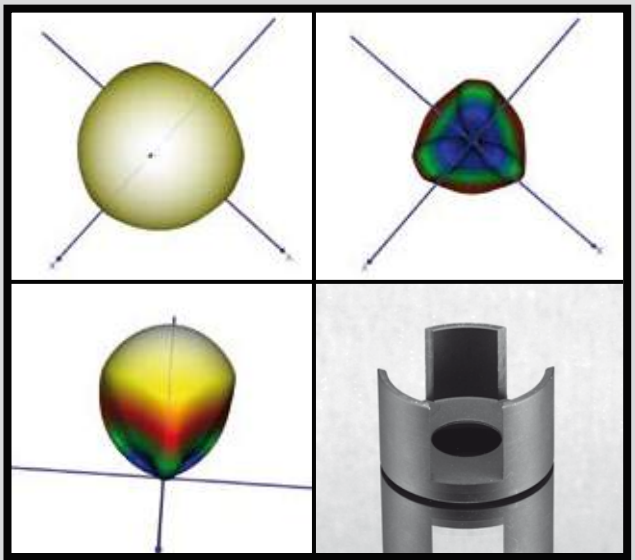
- high stability of the luminance (**<1%/100h**)
- high stability of the dominant wavelength/ colour (**<1nm/100h**)
- stable function independent of the room temperature (**15°C up to 30°C**)
- homogeneous luminance across the outlet opening (**<2% inhomogenity**)
- standard equipment in red, green, blue, yellow, orange, white
- USB interface for reading the current operation status (serial number, working hours, temperature, …)

In addition to the standard colours, also other colours can be supplied on customer's request. For this, the customer shall select, in cooperation with the **TechnoTeam**, the type of LED.
For each **L³-standard TechnoTeam** provides a certification for the factory calibration. For the traceability of the photometric data of the LED luminance standards it is possible to calibrate the devices at a national metrology institute (e.g. PTB (D) or METAS (CH)).

Battery Pack

For extending the running time and making the **LMK 5** more flexible in use the Battery Pack is available. The stable housing can be mounted directly and carries an battery that can deliver the **LMK 5** up to 6 hours with electrical power.


L³-standard with optional accessories


Different views of a LID measured with a crown cover

Battery Pack mounted on **LMK 5** color

AUTOMATION

Movement unit

Using a stationary movement unit for the handling of the **LMK** 5 camera enables the user to place the **LMK** with a high accuracy and reproducibility towards the object to be measured.
TechnoTeam offers a range of linear, rotating and turning axis movement units.

The motor and motion control of the movement unit can fully be integrated to the **LMK** LabSoft software using the **LMK** Motor control software (see page 15).

LMK 5 color with 5 axis movement unit

LMK & ROBFLOW®
New Measuring Robotics System

The **LMK** 5 camera device and the **ROB**FLOW® software means a combination of an Imaging Luminance Measuring Photometer with a Measuring Robotics System for the determination and analysis of objective quality characteristics in brightness, colour and other visibility or recognition requirements. The **ROB**FLOW® software is designed for high quality industrial robots of several manufacturers, provides freely programmable movement curves with haptic control and regulation to ensure a broad range of applications and provides the user with highest possible flexibility in its functions.

Robotic measuring components for luminance and colour measurement:

- Robotic arm with control interface
- **LMK** colorimeter or photometer
- Measuring-robotic software **ROB**FLOW®

Multi-sensor fitting for efficient testing processes:

- **LMK** colorimeter or photometer for optical backlit symbol or display testing
- Force-Feedback sensor for haptic testing
- Laser line sensor for mechanical profile and slit dimension control
- Acoustic sensor for testing haptic noises

BATTENBERG
ROBOTIC MEASURING

LMK 5 color and optical test equipment

LMK 5 color mounted on LBR light-weight robotic arm

LMK

AUTOMATION

Light Checker using **LMK** in automation

The Light Checker software is a semi-automatic stand-alone system for quality management inside or at the end of a production line.

Symbol Checker

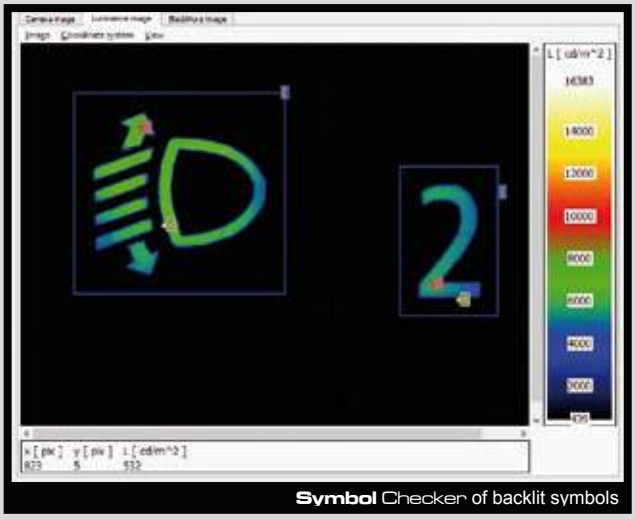
The application enables the user to automatically measure mean, maximum and the minimum luminance of an automatically detected symbol. By using the integrated symbol teaching, the user can create reference symbol data to determine symbol quality:

- **Average of luminance:** as an average value for the automatically detected complete backlit symbol
- **Uniformity:** is calculated with the minimum, average value and maximum of the luminance within the symbol, determined with a measuring spot of a variable pixel-size.
- **Position:** as the average of the segment centroids, calculated out of the contour of the segment. The determination of the contour is sub pixel exact.
- **Structure width:** geometrical measurement of symbol segments with parallel outer lines. With the calculated distances over an iterative calculated average value the structure width of the symbol is determined.
- **Symbol quality:** percentage matching of the symbol with the recognized reference pattern.

LED Checker

The application enables the user to automatically measure luminance of LEDs and also colour distance between the LEDs. For several applications, like emergency lights, the measurement results of each LED is of interest:

- **Average of luminance:** as an average value for the automatically measured light source
- **Colour and chromaticity:** colour data in manifold color spaces for classifying LED
- **Position:** as the average of the segment centroids, calculated out of the contour of the segment.



Symbol Checker of backlit symbols

LED and halogen spot lamps

Light Checker
Using **LMK** in automation

The Light Checker Software is a semiautomatic stand-alone system for quality management inside or at the end of a production line.

LID Checker

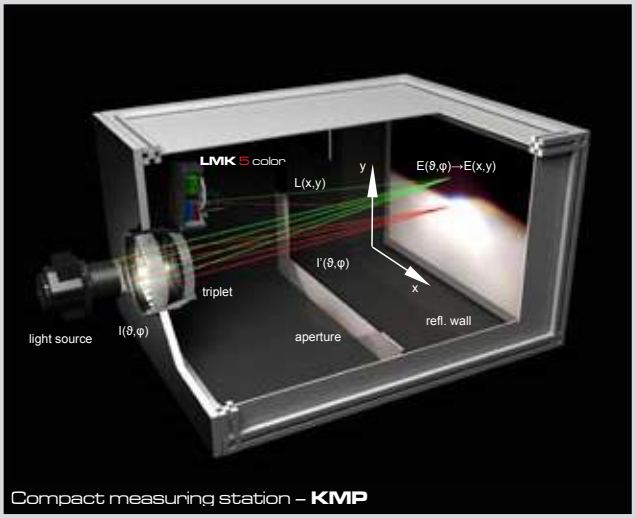
The application is especially designed for measuring headlamps and is available with our products compact measuring station **KMP** and **BV**-Room. **Techno**Team provides an interactive user interface for applying test specifications in automated measurements. It is possible to define various measurement regions including their tolerance values. Algorithms for automated elbow point detection and ReAim are included. In addition, the resulting measurement values can be summarized in individual protocols. The **LID** Checker also supports the TCP/IP interface for the communication with a process control system for fully automatic measurements:

- **Luminous intensity distribution**: Available for fixed geometry and angular distribution ranges
- **Measurement Regions**: verification and observance of guidelines for car headlamps by means of prescribed measuring points e.g. HV; AK31; B50L and many more

Display Checker

The application enables the user to automatically measure display uniformity, mean, maximum and minimum luminance:

- **BlackMURA analysis AddOn**: Enables the user to additionally get the gradient image of the measured display and the BlackMura value, which equals the maximum gradient.
- **Sticking image analysis AddOn**: Features essential functions for applying measurement series and regions for analysing the sticking image phenomena.

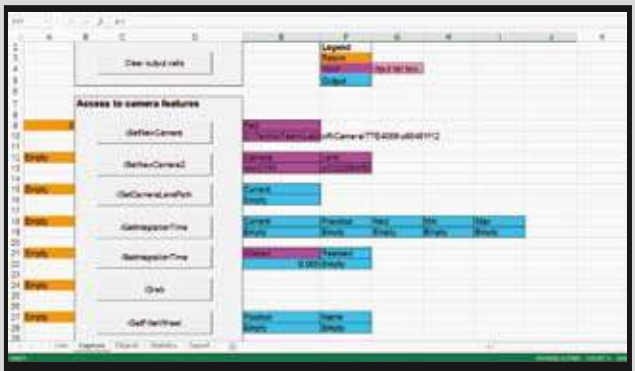


Compact measuring station – **KMP**

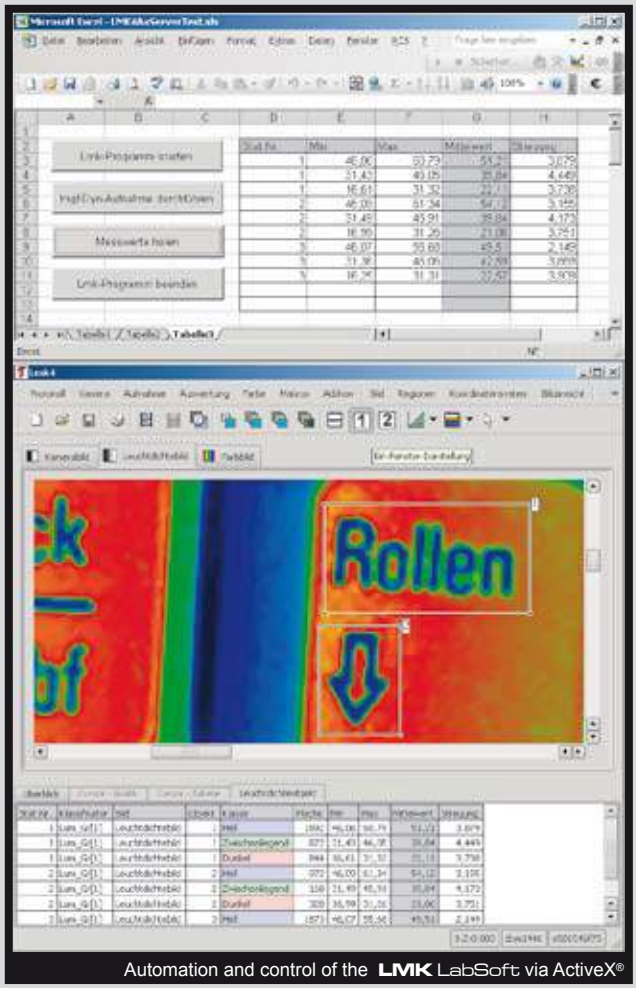

Measuring object – airfield lighting


Measuring object – automotive head lamp

SOFTWARE



Automation and control of the **LMK** LabSoft via ActiveX®



Automation and control of the **LMK** LabSoft via ActiveX®

Programming interface **LMK** LabSoft extended

The **LMK** LabSoft extended has an ActiveX® interface available and can be controlled by a host application with ActiveX® capability (e.g. MS Excel®, LabView®, MATLAB®). In this way it is possible to use the functionality of the **LMK** LabSoft as a server for other applications.

All capturing modes will be provided: capturing Live camera images; SinglePic-, Multi- Pic- and HighDyn-algorithm for the capturing and calculation of luminance images; Colour-High-Dyn-algorithm for calculation of colour values by using a **Techno**Team **LMK** 5 color filter camera.

By using the interface all statistical operators e.g. luminance, integral and symbol object are available. So directly after the image capturing the currently measured data can be imported into the host application e.g. Excel spread sheet analysis. In addition it is possible to open and save already prepared protocol files with parameterised statistic objects via ActiveX®.

On customer request it is possible to extend the interface to all functions of the functionality provided in the interactive use of the **LMK** LabSoft.

References (abstract)

Adam Opel AG I Audi AG I BMW AG I Daimler AG I Dr. -Ing. h.c. F. Porsche AG I Ford AG I SEAT, S.A. I ŠKODA AUTO a.s.I VW AG II ALPINE ELECTRONICS GmbH I Automotive Lighting GmbH I Behr-Hella Thermocontrol GmbH I Blaupunkt GmbH I Bosch-Gruppe Motometer GmbH I Continental Automotive AG I Delphi Packard Deutschland GmbH I DST Dräxlmaier Systemtechnik GmbH I Goodrich Lighting Systems GmbH I Hella KG Hueck & Co. I Leopold Kostal GmbH I Marquardt GmbH I TRW Automotive Electronics & Components & Co. KG I Valeo Auto-Electric Hungary LLC I VISTEON Deutschland GmbH I Ansorg GmbH I AE Austria Email I Lehner WerkMetall Jürgen Lehner GmbH I D. Swarovski & Co. Lichtlabor I Diemer & Fastenrath OHG I GE Hungary ZRt. I OSHINO Lamps GmbH I OSRAM GmbH I OSRAM Opto Semiconductors GmbH & Co. OHG I Philips GmbH I Philips Lighting B.V. I RZB-Leuchten I TRILUX-LENZE GmbH+Co. KG I Siteco Beleuchtungstechnik GmbH I Zumtobel GmbH I BOE-LA Siebdrucktechnik GmbH I Bosch Siemens Hausgeräte GmbH I Braun GmbH I Cherry GmbH I Comtronic GmbH I Fresnel Optics GmbH I Hella Aerospace GmbH I Optrex Europe GmbH I Siemens AG I BGIA Berufsgenossen-schaftliches Institut für Arbeitssicherheit I HVBG Hauptverband der gewerblichen Berufsgenossen-schaften e.V. I Fraunhofer Institut Solare Energie-systeme I VBG Verwaltungsberufsgenossenschaft I Autobahnamt Thüringen I BASt Bundesanstalt für Straßenwesen I LANUV Landesamt für Natur, Umwelt und Verbraucherschutz Nordrhein-Westfalen I Magistrat der Stadt Wien I METAS Bundesamt für Metrologie (CH) I BTU Cottbus I Carl-v.-Ossietzky Universität Oldenburg I EFI Trontheim I ETH Zürich Institut für Hygiene und Arbeitsphysiologie I FH Aachen Solar Institut Jülich I FH Biberach I FH Göttingen I FH Jena I Technische Universität Berlin I Technische Universität Dresden I Technische Universität, Ilmenau I Universität der Bundeswehr Hamburg I Universität Dortmund I Universität Paderborn I Universität Teheran

V2.1

LMK

VIDEO PHOTOMETER

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TechnoTeam
Bildverarbeitung GmbH

LMK
mobile air

QUICK START GUIDE

LMK mobile air CONTROL ELEMENTS

QUICKSTART **GUIDE**

STEP **01**

Switch-on the camera

Switch the main switch to **ON**.

STEP **02**

Setting the manual mode

Set the mode dial to **M**.

STEP **03**

Activating the Auto focus

Set the AF-mode switch on the lens socket to **AF**.

STEP **04**

Deactivating the Image stabilizer

Set the OS-mode switch on the lens socket to **OFF**.

STEP **05**

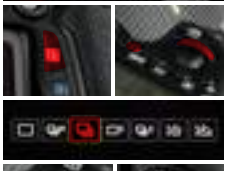
Setting the RAW-image capture mode

Press [**MENU**]. Select the first tab by using [☁]. Use [▼▲] and go to the sub-menu „**Quality**“. Press [**SET**] and use [☁] to select the "**RAW**" option. Press [**SET**] to finalize the process.

STEP **06**

Activating Continuous shooting

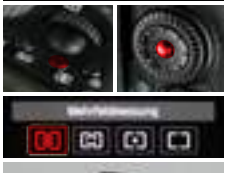
By pressing [**Q**], the camera control on the main display appears. Now, press [**DRIVE**] and select symbol ⧉ on the display by using [☁]. Press [**SET**] to confirm.



STEP **07**

Switch-on Evaluative metering

By pressing [**Q**] , the camera control on the main display appears. Now, press [⧇] and select symbol ⧇ on the display by using [☁]. Press [**SET**] to confirm.



STEP **08**

Using tripod

Follow the instructions in the manual for the tripod.

STEP **09**

Adjusting the Auto Exposure Bracketing AEB

Press [**MENU**]. Select the third tab by using [☁]. Use [▼▲] and go to the sub menu "**Expo.comp./AEB**". Press [**SET**] and use [☁] to shift the red bars to the maximum range. Press [**SET**] to finalize the process.

CAUTION: After powering off the camera, this setting must be repeated. This is also due to the automatic standby mode.

STEP **10**

Adjusting the exposure time

By pressing [**Q**], the camera control on the main display appears. In the second field of the top line of the display, the exposure time is displayed. Slightly press the **Shutter button** to activate the exposure level indicator. Use the [☁] to set the correct exposure time.

CAUTION: For measuring luminances only exposure time values in a range from 1/250 to 30 are valid.

STEP **11**

Adjusting the ISO gain value

By pressing [**Q**], the camera control on the main display appears. Now, press [**ISO**] and select one ISO gain value on the display by using [☁].

CAUTION: For measuring luminances only the ISO values **100**, **200**, **400**, **800** and **1600** are calibrated. The **AUTO** mode is not allowed.

STEP **12**

Adjusting the aperture value

By pressing [**Q**], the camera control on the main display appears. In the third field of the top line of the display, the aperture value is displayed. Slightly press the **Shutter button** to activate the exposure level indicator. Use the [◉] to set the correct aperture value.

CAUTION: For measuring luminances only aperture values in a range from **F4** to **F11** are calibrated.

STEP **13**

Image capturing

Fully press the **Shutter button** to start the automatic capture of 3 images.

LEGEND: ☁ Main dial ◉ Fast dial ◄►▼▲ Arrowkeys ⧉ Drive mode selection ⧇ Evaluative metering

Red labeled section headers are showing steps that has to be repeated every time according to environmental conditions. All other steps must be done once a time. For further system operation please read also the manual of the manufacturer and note the security advices.

ADDITIONAL **HINTS**

HINT **A**

Setting the exposure time/aperture value using LiveView

Press [**START/STOP**] to show the view finder on the display. The exposure time and the aperture value are prompted on the bottom of the display and can be changed using [ ] and [ ].

CAUTION: For using this function the **Live view shoot.** must be enabled.

HINT **B**

Activating the Touch-Mode

Alternatively you can set steps 05 to 12 using the Touch-Mode. Press the [**Q**]-key or the **Q-button** on the display. Now all functions are indicated as 'active' on the display. The first touch is showing the tool tip for the function. With the second touch you can set the function.

HINT **C**

Activating remote controlled shooting

Press [**Q**], the camera control on the main display appears. Now, press [**DRIVE**] and select symbol on the display by using [ ]. Press [**SET**] to confirm. Now, you can shoot images with a time delay (10 sec) by the remote controller.

LEGEND: Main dial | Drive mode selection | Touch-Mode | Fast dial

BIROUL ROMÂN DE METROLOGIE LEGALĂ
INSTITUTUL NAȚIONAL DE METROLOGIE
NATIONAL INSTITUTE OF METROLOGY
INSTITUT NATIONAL DE MÉTROLOGIE

Acest certificat corespunde cu capabilitatile incluse in Anexa C a MRA elaborate de BIPM. Conform MRA, toate institutele participante isi recunosc reciproc valabilitatea certificatelor de etalonare emise pentru domeniile si incertitudinile de masurare specificate in Anexa C a MRA.
Pentru detalii suplimentare, a se vedea http://www.bipm.org

CERTIFICAT DE ETALONARE
Nr. 03.01 – 323/2015

Obiect: Multimetru digital

Producător: Keithley

Tip: 2002

Serie / număr: 0590454

Beneficiar: 

Comanda nr : 3939/12.08.2015

Număr de pagini: 5

Data etalonării: 20.08.2015

Ştampila INM **Data:** **Şef de laborator**

20.08.2015 **ing.Liliana Cîrneanu**

Notă: Fără aprobarea INM, acest certificat de etalonare nu poate fi reprodus decât integral.
Certificatele de etalonare fără semnături şi ştampilă originale sunt nule.

INM Şos. Vitan-Bârzeşti 11 • Sector 4 • Bucureşti 042122 • România
Tel: (+4021) 334 48 30; 334 50 60 • Fax: (+4021) 334 53 45; 334 55 33 • E-mail: office@inm.ro • www.inm.ro

Metoda de etalonare: Comparație directă, PS-01-3.1-INM,
Etaloane utilizate: calibrator multifuncțional tip Fluke 5730A, seria 2941503, certificat de etalonare: G1LV-0048/2015, emis de UME-Turcia; rezistoare etalon de valoare unică, fabricație ZIP Krasnodar, certificat de etalonare 03.01-468/2014, emis de INM;

Condiții de măsurare: -temperatura: 23,5 °C ± 0,5 °C
-umiditatea relativă: 58,0 % ± 2,5 %
-etalonarea funcției de măsurare a rezistenței electrice a fost efectuată cu «4 fire» pe intervalele 20 Ω ÷ 2 MΩ şi cu «2 fire» pe intervalele 20 MΩ ÷ 200 MΩ;

Condiții de referință: - temperatura: (23 ± 2) °C
- umiditatea relativă: (50 ± 15)%

Rezultatele etalonării: pe funcția de măsurare a tensiunii electrice în curent continuu

Valoare aplicată	Interval nominal	Valoare indicată	Eroare absolută	Incertitudine de măsurare
(mV)		(mV)	(μV)	(μV)
20,0000	200 mV	19,9999	-0,1	1,2
100,0000		100,0003	0,3	1,2
200,0000		200,0003	0,3	1,7
-200,0000		-200,0005	-0,5	1,7
(V)		(V)	(μV)	(μV)
0,200000	2 V	0,200000	0	3
1,000000		1,000001	1	6
2,000000		2,000004	4	10
-2,000000		-2,000006	-6	10
(V)		(V)	(mV)	(mV)
2,00000	20 V	2,00000	0	0,03
-2,00000		-2,00000	0	0,03
6,00000		6,00000	0	0,03
10,00000		9,99999	-0,01	0,04
14,00000		13,99999	-0,01	0,08
18,00000		17,99998	-0,02	0,10
20,00000		19,99999	-0,01	0,11
-20,00000		-20,00001	-0,01	0,11
20,0000	200 V	20,0000	0	0,3
100,0000		100,0002	0,2	0,7
200,0000		200,0006	0,6	1,5
-200,0000		-200,0010	-1,0	1,5
100,000	1000 V	100,000	0	4
500,000		500,002	2	6
1000,000		1000,003	3	8

(continuă)

Etalonarea a fost efectuată de: Marciana Simionescu

Rezultatele etalonării: pe funcția de măsurare a curentului electric şi a rezistenței electrice în curent continuu

(continuare)

Valoare aplicată	Interval nominal	Valoare indicată	Eroare absolută	Incertitudine de măsurare
(μA)	200 μA	(μA)	(μA)	(μA)
20,000		20,000*	0	0,010
200,000		200,005	0,005	0,014
-200,000		-200,006	-0,006	0,014
(mA)	2 mA	(mA)	(μA)	(μA)
0,20000		0,20001	0,01	0,03
2,00000		1,99999	-0,01	0,10
-2,00000		-2,00001	-0,01	0,10
2,0000	20 mA	2,0000	0	0,3
20,0000		20,0004	0,4	1,1
-20,0000		-20,0008	-0,8	1,1
20,000	200 mA	20,002	2	3
200,000		200,017	17	16
-200,000		-200,020	-20	16
(A)	2 A	(A)	(mA)	(mA)
0,20000		0,20000	0	0,03
1,00000		0,99998	-0,02	0,10
2,0000		1,9999	-0,1	0,6
(Ω)	20 Ω	(Ω)	(mΩ)	(mΩ)
1,00000		1,00002	0,02	0,05
10,00000		10,00004	0,04	0,07
10,0000	200 Ω	9,9995	-0,5	0,5
100,0000		99,9990	-1,0	1,0
(kΩ)	2 kΩ	(kΩ)	(Ω)	(Ω)
0,100000		0,099999	-0,001	0,003
1,000000		1,000001	0,001	0,008
1,00000	20 kΩ	0,99999	-0,01	0,03
10,00000		9,99995	-0,05	0,08
10,0000	200 kΩ	9,9998	-0,2	0,3
100,0000		99,9990*	-1,0	1,5
(MΩ)	2 MΩ	(MΩ)	(kΩ)	(kΩ)
0,100000		0,099999*	-0,001	0,005
1,000000		0,999996*	-0,004	0,025
1,00000	20 MΩ	1,00000*	0	0,15
10,0000		9,9996*	-0,4	0,5
10,0000	200 MΩ	9,9996*	-0,4	2,5
100,000		99,995*	-5	20

(continuă)

Etalonarea a fost efectuată de: Marciana Simionescu

Rezultatele etalonării pe funcția de măsurare a tensiunii electrice în curent alternativ:

(continuare)

Valoare aplicată	Frecvența	Interval nominal	Valoare indicată	Eroare absolută	Incertitudine de măsurare
mV	Hz	mV	mV	mV	mV
20,000	50	20 – 200	19,978	-0,022	0,007
200,000			199,833	-0,167	0,028
V	Hz	V	V	mV	mV
0,200000	50	0,2 – 2	0,199720	-0,280	0,028
2,00000			1,99887	-1,13	0,20
2,0000	50	2 – 20	1,9977	-2,3	0,3
4,0000			3,9948	-5,2	0,3
6,0000			5,9924	-7,6	0,4
8,0000			7,9905	-9,5	0,6
10,0000			9,9888	-11,2	0,7
12,0000			11,9881	11,9	0,8
14,0000			13,9870	-13,0	1,0
16,0000			15,9860	-14,0	1,1
18,0000			17,9853	-14,7	1,3
20,0000			19,9848	-15,2	1,4
20,0000	50	20 – 200	19,9731	-26,9	1,4
200,000			199,897	-103	14
V	Hz	V	V	V	V
200,000	50	200 – 750	199,853	-0,147	0,020
750,00			749,86	-0,14	0,09

(continuă)

Etalonarea a fost efectuată de: Beatrice Ruşescu

Rezultatele etalonării pe funcția de măsurare a curentului electric în curent alternativ:

(continuare)

Valoare aplicată	Frecvența	Interval nominal	Valoare indicată	Eroare absolută	Incertitudine de măsurare
µA	Hz	µA	µA	µA	µA
20,000	50	20 – 200	19,988*	-0,012	0,013
200,000			199,803*	-0,197	0,050
mA	Hz	mA	mA	µA	µA
0,2000	50	0,2 – 2	0,19981*	-0,19	0,05
2,0000			1,9981	-1,9	0,5
2,0000	50	2 – 20	1,9981	-1,9	0,5
20,000			19,984	-16	5
mA	Hz	mA	mA	mA	mA
20,000	50	20 – 200	19,989	-0,011	0,005
200,000			199,920	-0,080	0,050
A	Hz	A	A	mA	mA
0,20000	50	0,2 - 2	0,19974	-0,26	0,05
0,40000			0,39939	-0,61	0,13
0,60000			0,59904	-0,96	0,20
0,80000			0,79872	-1,28	0,26
1,0000			0,9985	-1,5	0,3
1,2000			1,1982	-1,8	0,4
1,4000			1,3981	-1,9	0,5
1,6000			1,5979	-2,1	0,5
1,8000			1,7978	-2,2	0,6
2,0000			1,9978	-2,2	0,7

*Valorile măsurate nu sunt incluse în anexa C a MRA, elaborată de BIPM.

Incertitudinea de măsurare: conform tabelului

Nota 1 : Incertitudinea atribuită este incertitudinea extinsă obținută prin multiplicarea incertitudinii standard cu factorul de extindere $k = 2$ şi a fost estimată în conformitate cu GUM. Standardul român echivalent cu GUM este SR Ghid ISO/CEI 98-3:2010 - Incertitudine de masurare Partea 3: Ghid pentru exprimarea incertitudinii de măsurare.
Valoarea măsurandului se află în intervalul de valori indicat, cu un nivel de încredere de 95 %.

Nota 2 : Rezultatele sunt trasabile la Sistemul Internațional de Unități (SI).
Trasabilitatea măsurărilor este realizată şi menținută prin comparări şi etalonări internaționale, in acord cu SR EN ISO/CEI 17025 : 2005.
România este membră a Convenției Metrului iar INM este co-semnatar al MRA.

Etalonarea a fost efectuată de: Beatrice Ruşescu

Incheierea certificatului de etalonare