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TEST REPORT

1014-PT-T0100-20

copy No. 1 of 2

Process gas chromatograph MAG

Date of issue:	April 30, 2020
Customer:	BRK Technologies s.r.o., Českobratrská 2864/3, Žižkov, 130 00 Praha 3, Czech Republic.
Manufacturer:	OOO NTF BACS, Russian Federation BRK Technologies s.r.o., Czech Republic
Measuring instrument:	Process gas chromatograph for determination of energy value of natural gas (annex to Decree No. 345/2002 Coll., as amended)
Type:	MAG KC 50.310-000
For Measurement:	Calorific value
Accuracy class:	A/0,5
Test specifications:	OIML R 140 Edition 2007 (E) Measuring systems for gaseous fuel 0111-OOP-C018-10 - Opatření obecné povahy pro procesní plynové
Test performed:	from september 2019 to april 2020

The results of the tests have been obtained by the following procedures reported in this Report and are related to the tested item, date, place and condition of the test only. The Test Report does not substitute any other document that may be required by national authorities to the relevant regulations.
The measurement equipment,date and place of the test, ambient and test conditions, result of the testing, statements of compliance and other relevant information are writen in the annex 1 and 2 of this Test Report.

Test by:

Ing. Jan Beránek

Český metrologický institut -10/2-

End of test report

Head of the regional inspectorate:

Ing. Vladimír Peršl

Contents:
In the following table the performed tests are indicated with the accompanying results, as well as the page number of annex 2 where the results are presented.

Tests:	passed	not applicable	annex 2 page
OOP 0111-OOP-C018-10			
OOP_5.3.1 Zkouška přesnosti	✓		1
OOP_5.3.2_Zkouška opakovatelnosti	✓		1
OIML_R140:2007			
10.2.7.4 adjustment interval and drift	✓		2
10.2.7.5 influence of the gas composition	✓		3
10.2.7.6 response time	✓		4
10.2.7.7 influence of gas supply	✓		5
A.4.1 Dry heat	✓		7
A.4.2 Cold	✓		7
A.4.3.a Damp heat - steady state	✓		8
A.4.3.b Damp heat cyclic test	✓		9
A.4.4 Vibration (random)	✓		10
A.4.5 Radiated radio-frequency electromagnetic field	✓		11
A.4.6 Conducted disturbances induced by radio-frequency field	✓		11
A.4.7 Electrostatic discharge:	✓		11
A.4.8 Surges on signal, data and control lines	✓		11
A.4.9 DC mains voltage variation		✓	
A.4.10 AC mains voltage variation	✓		11
A.4.11 AC mains voltage dips, short interruptions and voltage variations	✓		11
A.4.12 Bursts on AC and DC mains and on signal lines	✓		11
A.4.13 Surges on AC and DC mains power lines	✓		11

During the complete investigation the calibration mode of the PGC MAG was set manual.
The calibration frequency is stated in document - 0111-OOP-C018-10.

General information:

The technical specifications of the tested device for determining the energy value of natural gas:

- Manufacturer: OOO NTF BACS,
  Prospekt Kirova 10,
  443022, Samara,
  Russian Federation.
- Type designation: MAG KC 50.310-000
- Seriál number 0679345
- Accuracy class: Class A
- Temperature of environment for analytical part of MAG KC 50.310-000
  - 25°C to +60°C
- Power supply: 230V single phase

Approved firmware in Czech Republic with checksums (legally relevant software):

Main SW core: (CRC-32):	0x6528D89A
Main SW gui: (CRC-32):	0xB51F590A
AnalizCalc.dll: (CRC-32):	0x1BFEB1EF
RegressCacl.dll: (CRC-32):	0xF2532F35
DewPoint.dll: (CRC-32):	0x7F06F760
AddFunct.dll: (CRC-32):	0x18B1811B
Integral settings (CRC-32):	0xEB2841D9
Component parameters (CRC-32):	0x954ADCD6
Embedded formulas (CRC-32):	0xF5D47CE2
Additional formulas (CRC-32):	0x6CBA8755
Functions (CRC-32):	0x12A7AF65

The "Verifier" is used to check checksum for PGC without Local operation interface:
Legally relevant software: v1.0.0, CRC-32: 0x865CE475

Measuring ranges and minimum detection:

Compomnent:	min.		max
	content (10^{-2} mol/mol)		
methane	50	-	100
ethane	0,05	-	15
propane	0,05	-	10
2-methylpropane (i-butane)	0,01	-	4
butane (n-butane)	0,01	-	4
2,2-dimethylpropane (nep-pentane)	0,001	-	0,1
2-methylbutane (i-pentane)	0,005	-	2
pentane (n-pentane)	0,005	-	2
hexane (suma C_{6+})	0,005	-	1
nitrogen	0,05	-	15
carbon dioxide	0,01	-	10

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Test method:

Test
Applied

% RSD	max:	0,05	% rel.
Determinations CV (relative error)	max:	0,2	% rel.
Drift CV	max:	0,25	% rel.

% RSD:

$$\bar{x} = \frac{\sum_m^n x_i}{n}$$

$$s(x_i) = \sqrt{\frac{\sum_m^n (x_i - \bar{x})^2}{(n-1)}}$$

$$\% RSD = \frac{s(x_i)}{\bar{x}} * 100$$

Relative error calculation: $\delta_{rel} = \frac{([indicate\ value - tru\ value])}{tru\ value} * 100$

Drift calculation:

$$\text{drift} = \frac{([indicate\ value\ after - indicate\ value\ before])}{indicate\ value\ before} * 100$$

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Reference materials:

During the test of the meassuring device several reference materials ware used (specified below). For each reference materials the energy values were determined before starting

Conditions :

pressure:	101,33	kPa
$t_{measuring}$:	15	°C
$t_{combustion}$:	15	°C

Reference materials:

RM number:	466382	466378	984642	002450	036638	8076949	002409	466376	259004
components:									
methane	96,043	96,235	95,890	98,100	98,133	89,496	82,936	76,712	87,509
ethane	0,967	1,005	2,062	0,337	0,364	3,770	3,540	5,007	9,965
propane	0,754	0,723	0,522	0,199	0,189	0,960	1,488	1,948	1,991
2-methylpropane	0,097	0,093	0,097	0,150	0,136	0,203	0,798	0,477	0,151
butane	0,098	0,092	0,097	0,143	0,129	0,191	0,772	0,507	0,153
2,2-dimethylpropane	0,025	0,077	0,050	-	-	0,048	-	-	-
2-methylbutane	0,023	0,073	0,050	0,007	0,008	0,048	0,179	0,159	0,021
pentane	0,024	0,072	0,052	0,007	0,008	0,048	0,179	0,159	0,019
hexane (suma C_{6+})	0,013	0,070	0,050	0,012	0,006	0,048	0,082	0,065	0,000
carbon dioxide	0,508	1,007	0,533	0,149	0,133	1,416	4,051	4,995	0,027
nitrogen	1,448	0,553	0,595	0,893	0,895	3,772	5,974	9,972	0,163
CV (kWh/m^3)	10,557	10,664	10,735	10,520	10,514	10,556	10,470	9,982	11,664

The used reference materials are certified under ČSN EN ISO 17025 and 17034.
Calorific value are calculated in accordance with the ISO 6976:2016.

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The description of the test:

OOP_5.3.1 Zkouška přesnosti
OOP_5.3.2_Zkouška opakovatelnosti

At reference conditions the measurements and calculations of the measuring device are checked.
All accuracy tests are performed at laboratory conditions.

Results:

RM number:	984642	466382	.036638	8076949	.002409
Reference CV (kWh/m^3)	10,735	10,557	10,514	10,556	10,470
Measurement:					
1	10,735	10,560	10,514	10,560	10,478
2	10,735	10,561	10,515	10,560	10,479
3	10,736	10,560	10,515	10,561	10,479
4	10,735	10,560	10,515	10,560	10,478
5	10,736	10,560	10,515	10,557	10,479
Average:	10,735	10,560	10,515	10,560	10,479
%RSD	0,004	0,002	0,004	0,013	0,004
Relative error (%):	0,006	0,027	0,005	0,034	0,085
Test evaluation:					
%RSD	OK	OK	OK	OK	OK
Relative error (%):	OK	OK	OK	OK	OK

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The description of the test:

10.2.7.4 adjustment interval and drift

At reference conditions the measurements and calculations of the measuring device are compared over a drift period.

Results:

RM number:	984642	.002409	466376	8076949	466382
Reference CV (kWh/m^3)	10,735	10,470	9,982	10,556	10,557
Measurement:					
1	10,738	10,478	9,984	10,560	10,560
2	10,737	10,479	9,983	10,560	10,561
3	10,737	10,479	9,983	10,561	10,560
4	10,738	10,478	9,983	10,560	10,560
5	10,738	10,479	9,982	10,557	10,560
Average:	10,738	10,479	9,983	10,560	10,560
%RSD	0,002	0,004	0,007	0,013	0,002
Relative error (%):	0,026	0,085	0,007	0,034	0,027

Test evaluation:					
%RSD	OK	OK	OK	OK	OK
Relative error (%):	OK	OK	OK	OK	OK

RM number:	984642	.002409	466376	8076949	466382
Reference CV (kWh/m^3)	10,735	10,470	9,982	10,556	10,557
Measurement:					
1	10,734	10,469	9,982	10,554	10,555
2	10,734	10,467	9,982	10,556	10,555
3	10,734	10,468	9,982	10,557	10,555
4	10,734	10,468	9,982	10,556	10,555
5	10,733	10,470	9,983	10,557	10,555
Average:	10,734	10,468	9,982	10,556	10,555
%RSD	0,005	0,009	0,002	0,012	0,004
Relative error (%):	0,009	0,012	0,002	0,003	0,023

Test evaluation:					
%RSD	OK	OK	OK	OK	OK
Relative error (%):	OK	OK	OK	OK	OK

Test evaluation:

start	10,738	10,479	9,983	10,560	10,560
after (20 weeks):	10,734	10,468	9,982	10,556	10,555

drift CV (kWh/m^3)	0,035	0,098	0,005	0,031	0,050
	OK	OK	OK	OK	OK

The description of the test:

10.2.7.5 influence of the gas composition

The test shall be performed using at least two gases of different compositions having approximately the same calorific value.

has to be higher than 5 %.

the same calorific value.

Results:

RM number:	466382	8076949				
Content CH_4:	96,0	89,5				
Reference CV (kWh/m^3):	10,557	10,556				
Difference:			0,001	kWh/m^3	0,014	%
Measurement 1:	10,553	10,561				
Measurement 2:	10,553	10,560				
Measurement 3:	10,554	10,557				
Average:	10,553	10,559				
Difference (%):			-0,006	kWh/m^3	-0,056	%
%RSD:	0,005	0,018				
Relative error (%):	0,033	0,012				
Algebraic difference:					0,070	
Test evaluation:						
%RSD:	OK	OK				
Relative error (%):	OK	OK				

RM number:	984642	.002409				
Content CH_4:	95,9	82,9				
Reference CV (kWh/m^3):	10,735	10,470				
Difference:			0,265	kWh/m^3	2,470	%
Measurement 1:	10,734	10,479				
Measurement 2:	10,735	10,478				
Measurement 3:	10,735	10,479				
Average:	10,735	10,479				
Difference (%):			0,256	kWh/m^3	2,383	%
%RSD:	0,003	0,004				
Relative error (%):	0,002	0,088				
Algebraic difference:					0,087	
Test evaluation:						
%RSD:	OK	OK				
Relative error (%):	OK	OK				

The algebraic differences for both CV remained within 0,2%.

The description of the test:

10.2.7.6 response time

The response time of the measuring device is determine, during the test the measuring device is switched between two different gas which have different calorific value.

After getting stable results from one gas the 3-way valve is directly switched to the other reference gas.

Results:

				diff.	Relative error (%):
Measurement:		1	9,982	0,000	0,00
		2	9,982	0,000	0,00
Reference materials (number):	466376	3	9,982	0,000	0,00
Reference CV (kWh/m^3)	9,982	4	9,982	0,000	0,00
		5	9,983	0,000	0,00
Measurement (switching to the next gas):	259004				
Measurement:		1	11,619	0,045	0,39
		2	11,652	0,012	0,10
Reference materials (number):	259004	3	11,657	0,007	0,06
Reference CV (kWh/m^3)	11,664	4	11,659	0,005	0,05
		5	11,658	0,006	0,05
		6	11,658	0,006	0,05
		7	11,658	0,006	0,05
		8	11,657	0,006	0,05
		9	11,658	0,006	0,05
		10	11,657	0,007	0,06

				diff.	Relative error (%):
Measurement:		1	11,660	0,004	0,03
		2	11,660	0,004	0,03
Reference materials (number):	259004	3	11,661	0,003	0,02
Reference CV (kWh/m^3)	11,664	4	11,662	0,002	0,02
		5	11,663	0,001	0,01
Measurement (switching to the gas):	466376				
Measurement:		1	9,994	0,012	0,12
		2	9,990	0,008	0,08
Reference materials (number):	466376	3	9,986	0,004	0,04
Reference CV (kWh/m^3)	9,982	4	9,987	0,005	0,05
		5	9,985	0,003	0,03
		6	9,986	0,004	0,04
		7	9,986	0,004	0,04
		8	9,985	0,002	0,02
		9	9,985	0,002	0,02
		10	9,985	0,003	0,03

The description of the test:

10.2.7.7 influence of gas supply

The accuracy of the measuring device is tested, while applying different inlet pressures of the gas mixture under the test.

The pressure range for the device MAG:

carier gas:	min:	450 kPa	max:	650 kPa
sample:	min:	-	max:	300 kPa

If the limits are exceeded, the meter switches to safe mode.

Results:

- change in carrier gas pressure

RM number:	466382			
Reference CV (kWh/m^3)	10,557			
Pressure carier gas (kPa):	550	500	450	640
Measurement:				
1	10,557	10,553	10,554	10,555
2	10,553	10,553	10,554	10,554
3	10,553	10,553	10,554	10,554
4	10,554	10,554	10,554	10,554
5	10,552	10,553	10,553	10,554
Average:	10,554	10,553	10,554	10,554
%RSD	0,019	0,003	0,003	0,004
Relative error (%):	0,035	0,040	0,034	0,033
Test evaluation:				
%RSD	OK	OK	OK	OK
Relative error (%):	OK	OK	OK	OK

RM number:	984642			
Reference CV (kWh/m^3)	10,735			
Pressure carier gas (kPa):	550	500	450	640
Measurement:				
1	10,738	10,738	10,738	10,738
2	10,738	10,739	10,740	10,740
3	10,739	10,739	10,741	10,739
4	10,740	10,739	10,739	10,740
5	10,740	10,739	10,739	10,740
Average:	10,739	10,739	10,739	10,739
%RSD	0,011	0,007	0,009	0,009
Relative error (%):	0,038	0,038	0,042	0,043
Test evaluation:				
%RSD	OK	OK	OK	OK
Relative error (%):	OK	OK	OK	OK

The description of the test:

10.2.7.7 influence of gas supply

The accuracy of the measuring device is tested, while applying different inlet pressures under the test - change in sample or carrier gas pressure.

Results:

- change in sample gas pressure

RM number:	466382			
Reference CV (kWh/m^3)	10,557			
Pressure sample (kPa):	100	200	300	50
Measurement:				
1	10,555	10,556	10,554	10,557
2	10,554	10,554	10,555	10,555
3	10,555	10,554	10,555	10,556
4	10,555	10,556	10,554	10,555
5	10,556	10,556	10,555	10,554
Average:	10,555	10,555	10,555	10,555
%RSD	0,008	0,007	0,004	0,009
Relative error (%):	0,022	0,020	0,026	0,020
Test evaluation:				
%RSD	OK	OK	OK	OK
Relative error (%):	OK	OK	OK	OK

RM number:	984642			
Reference CV (kWh/m^3)	10,735			
Pressure sample (kPa):	100	200	300	50
Measurement:				
1	10,742	10,740	10,741	10,741
2	10,742	10,742	10,741	10,742
3	10,742	10,742	10,742	10,743
4	10,741	10,741	10,741	10,743
5	10,740	10,744	10,741	10,742
Average:	10,741	10,742	10,741	10,742
%RSD	0,007	0,012	0,003	0,007
Relative error (%):	0,063	0,064	0,060	0,069
Test evaluation:				
%RSD	OK	OK	OK	OK
Relative error (%):	OK	OK	OK	OK

The description of the test:

A.4.1 Dry heat

A.4.2 Cold

The measurements and calculations of the measuring device are checked at temperatures of +60°C and -25°C. Before and after the dry heat and cold test, the test at laboratory conditions are performed.

The dry heat test has been performed at +60°C because the tested device is possible use up to +60°C. However, OIML R140 applies an upper limit of +55°C.

Severity level 3:	dry heat	+55	°C
(specification)	cold	-25	°C

Results:

RM number:	466382			
Reference CV (kWh/m^3)	10,557			
Measurement:	before	+60°C	-25°C	after
1	10,558	10,552	10,562	10,564
2	10,557	10,552	10,562	10,565
3	10,557	10,552	10,562	10,565
4	10,557	10,552	10,562	10,565
5	10,558	10,552	10,562	10,567
Average:	10,557	10,552	10,562	10,565
%RSD	0,005	0,003	0,001	0,009
Relative error (%):	0,000	0,048	0,041	0,072
Test evaluation:				
%RSD	OK	OK	OK	OK
Relative error (%):	OK	OK	OK	OK

RM number:	.002450			
Reference CV (kWh/m^3)	10,520			
Measurement:	before	+60°C	-25°C	after
1	10,514	10,516	10,519	10,520
2	10,518	10,516	10,518	10,519
3	10,517	10,516	10,518	10,520
4	10,516	10,517	10,518	10,520
5	10,514	10,516	10,519	10,521
Average:	10,516	10,516	10,518	10,520
%RSD	0,014	0,003	0,003	0,006
Relative error (%):	0,043	0,038	0,019	0,005
Test evaluation:				
%RSD	OK	OK	OK	OK
Relative error (%):	OK	OK	OK	OK

The description of the test:

A.4.3.a Damp heat - steady state

During the test the measuring is operated at a temperature of +40°C and a relative humidity of 93%.

Severity level 2:	Temperature:	+40	°C
(specification)	Humidity:	93	% rel
	Duration:	4	days

Results:

RM number:	466382	
Reference CV (kWh/m^3)	10,557	
Measurement:	before	after
1	10,565	10,562
2	10,566	10,561
3	10,566	10,562
4	10,566	10,562
5	10,566	10,562
Average:	10,566	10,562
%RSD	0,002	0,004
Relative error (%):	0,079	0,042
Test evaluation:		
%RSD	OK	OK
Relative error (%):	OK	OK

RM number:	.002450	
Reference CV (kWh/m^3)	10,520	
Measurement:	before	after
1	10,520	10,517
2	10,520	10,518
3	10,520	10,519
4	10,521	10,518
5	10,519	10,519
Average:	10,520	10,518
%RSD	0,004	0,007
Relative error (%):	0,001	0,023
Test evaluation:		
%RSD	OK	OK
Relative error (%):	OK	OK

The description of the test:

A.4.3.b Damp heat cyclic test

The measuring device is exposed to two cyclic temperatures variations during 24 hours, between +55°C and +25°C, while the relative humidity variates between 93% and 95%. During the test condensing water on the measuring device.

Severity level 2: (specification) Temperature: +55 °C

Results:

RM number:	466382		
Reference CV (kWh/m^3)	10,557		
Measurement:	before	midle	after
1	10,564	10,565	10,565
2	10,565	10,566	10,566
3	10,565	10,565	10,566
4	10,565	10,565	10,566
5	10,567	10,566	10,566
Average:	10,565	10,565	10,566
%RSD	0,009	0,006	0,002
Relative error (%):	0,072	0,075	0,079
Test evaluation:			
%RSD	OK	OK	OK
Relative error (%):	OK	OK	OK

RM number:	.002450		
Reference CV (kWh/m^3)	10,520		
Measurement:	before	midle	after
1	10,520	10,520	10,520
2	10,519	10,520	10,520
3	10,520	10,520	10,520
4	10,520	10,520	10,521
5	10,521	10,520	10,519
Average:	10,520	10,520	10,520
%RSD	0,006	0,003	0,004
Relative error (%):	0,005	0,003	0,001
Test evaluation:			
%RSD	OK	OK	OK
Relative error (%):	OK	OK	OK

The description of the test:

A.4.4 Vibration (random)

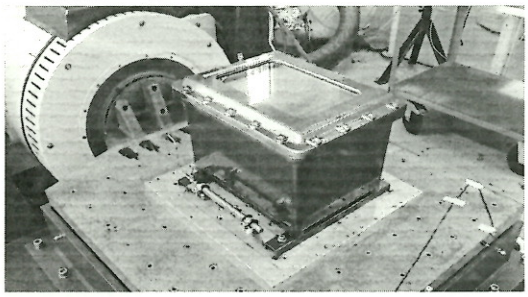
The measuring device is exposed to the following random vibrations:

Total frequence range:	10-150	Hz
Total RMS level:	1,6	ms^{-2}
ASD level 10-20Hz	0,05	m^2s^{-3}
ASD level 20-150Hz	-3	dB/octave
duration per axis:	2	min

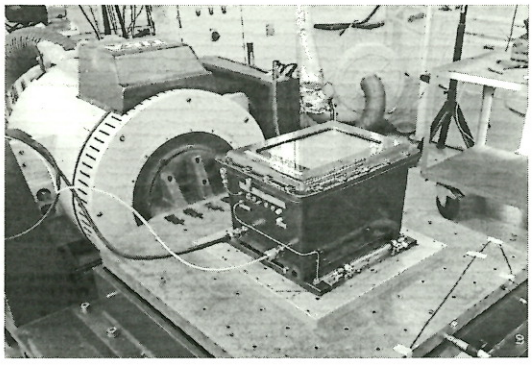
Results:

RM number:	466382	466378
Reference CV (kWh/m^3)	10,557	10,664
Measurement:		
1	10,559	10,667
2	10,559	10,666
3	10,560	10,666
4	10,560	10,666
5	10,561	10,666
Average:	10,560	10,666
%RSD	0,005	0,004
Relative error (%):	0,024	0,018
Test evaluation:		
%RSD	OK	OK
Relative error (%):	OK	OK

Axis: x

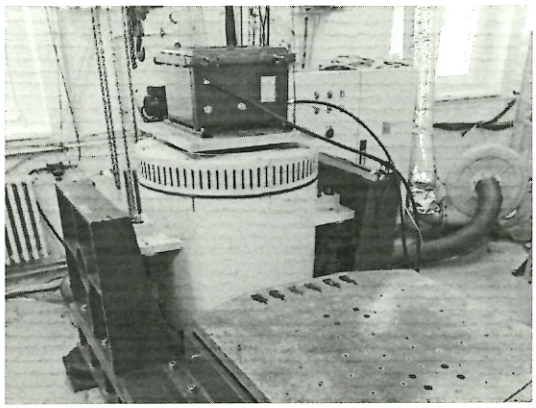


Axis: y



RM number:	466382	466378
Reference CV (kWh/m^3)	10,557	10,664
Measurement:		
1	10,553	10,665
2	10,552	10,665
3	10,554	10,665
4	10,554	10,665
5	10,554	10,666
Average:	10,554	10,665
%RSD	0,007	0,005
Relative error (%):	0,036	0,005
Test evaluation:		
%RSD	OK	OK
Relative error (%):	OK	OK

Axis: z



Test evaluation:

before the test	10,560	10,666
after the test	10,554	10,665
Relative error (%):	0,060	0,013
Test evaluation:		
Relative error (%):	OK	OK

The description of the test:

A.4.5 Radiated radio-frequency electromagnetic field
A.4.6 Conducted disturbances induced by radio-frequency field
A.4.7 Electrostatic discharge:
A.4.8 Surges on signal, data and control lines
A.4.10 AC mains voltage variation
A.4.11 AC mains voltage dips, short interruptions and voltage variations
A.4.12 Bursts on AC and DC mains and on signal lines
A.4.13 Surges on AC and DC mains power lines

Reference materials were used in the tests:

466378
466382

A description of each test is given in the protocol:

8551-PT-E0231-19

Results:
The maximum measured influence due to the disturbances was negligible.
The results of the device testing are presented in a separate document. The measurement conditions, etalon descriptions and measurement results are listed in the protocol.
Document: 8551-PT-E0231-19

Test:	results on protocol:	page
A.4.5 Radiated radio-frequency electromagnetic field	8551-PT-E0231-19	23
A.4.6 Conducted disturbances induced by radio-frequency field	8551-PT-E0231-19	34
A.4.7 Electrostatic discharge:	8551-PT-E0231-19	15
A.4.8 Surges on signal, data and control lines	8551-PT-E0231-19	20
A.4.10 AC mains voltage variation	8551-PT-E0231-19	9
A.4.11 AC mains voltage dips, short interruptions and voltage variations	8551-PT-E0231-19	11
A.4.12 Bursts on AC and DC mains and on signal lines	8551-PT-E0231-19	13
A.4.13 Surges on AC and DC mains power lines	8551-PT-E0231-19	20