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Version list

Version	Date	Author	Comment, Description
1	17.05.01	Brandl	initial

Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		
File:	TKU T-MAP.doc		Page 2 / 17

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Contents list	Page
1 General description	5
1.1 Function	5
1.2 Location of installation	5
1.3 Connector	5
1.4 Packaging	Error! Bookmark not defined.
2 Requirements	6
2.1 Mechanical requirements	6
2.2 Pressure output	6
2.2.1 Nominal characteristics	6
2.2.2 Maximum ratings	6
2.2.3 Accuracy and ratiometricity	6
2.2.3.1 Pressure error	6
2.2.3.2 Temperature error	7
2.2.3.3 Ratiometricity for a arbitrary but constant pressure and temperature	7
2.3 Temperature output	8
2.3.1 Nominal characteristics of NTC	8
2.3.2 Maximum ratings	9
3 Functional tests	10
3.1 Mechanical tests	10
3.1.1 Leak rate	10
3.1.2 Pressure cycle	10
3.2 Electrical tests	10
3.2.1 General	10
3.2.1.1 Pressure accuracy of measuring equipment	10
3.2.1.2 Temperature accuracy of measuring equipment	10
3.2.2 Supply current for pressure output	10
3.2.3 Transfer functions	11
3.2.3.1 Pressure	11
3.2.3.2 Temperature	11
3.2.4 Response time	11
3.2.4.1 Pressure	11
3.2.4.2 Temperature	11
3.2.5 Output ripple for pressure output	11
3.2.6 Ratiometricity for pressure output	11
4 Environmental tests	12
4.1 Overvoltage protection	12
4.2 Short circuit protection for pressure output	12
4.3 Sensor GND disconnection	12
4.4 Puncture strength	12
4.5 Aging in mechanically circulated air without load	12
4.6 Aging in mechanically circulated air under load	12
4.7 Temperature cycle test	12
4.8 Resistance to shock	12
4.9 Resistance to chemical agents	13
4.10 Sealing against dust and water spray	13
4.11 Resistance to engine cleaning	13
4.12 Thermal shock test	13
4.13 Endurance test	14
4.13.1 Vibration test	14
4.13.2 Temperature cycling	14
4.14 Resistance to environmental factors	15

Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		
File:	TKU T-MAP.doc		Page 3 / 17

4.14.1	Humidity cycling	15
4.14.2	Salt spray test	15
4.15	Drop test	15
4.16	Radiated interference	16
4.17	EMC with regard to sensor circuits	16
4.18	Results	16
5	Test flow	17

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Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		
File:	TKU T-MAP.doc		Page 4 / 17

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1 General description

1.1 Function

The Manifold Absolute Pressure Sensor with integrated Temperature Sensor (T-MAP-Sensor) is a capacitive manifold absolute pressure sensor in Surface- μ -Machining-Technology combined with a temperature sensor (NTC) used in automotive electronic engine control systems.

1.2 Location of installation

The component is used in a harsh automotive environment (engine compartment) direct mounted on intake manifold in a vertically angle of $0 \pm 80^\circ$ oriented in the length direction of the NTC. The component should be fixed by thread rolling screws with a diameter of the screw of 4 mm. The maximum permissible pressure on the mounting flange should not exceed 20 N/mm^2 .

1.3 Connector

4-pin connector according to 1 JO 900 962 (28.09.98) black, coding I

- Pin 1: GND
- Pin 2: $V_{\text{out}(T)}$, voltage output for temperature
- Pin 3: V_S , supply voltage
- Pin 4: $V_{\text{out}(p)}$, voltage output for pressure

Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		
File:	TKU T-MAP.doc		Page 5 / 17

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2 Requirements

2.1 Mechanical requirements

Dimensions and materials refer to drawing no. 653211.40.09

2.2 Pressure output

2.2.1 Nominal characteristics

$$V_{out(p)} = [(0.0429 * p[\text{kPa}]) - 0.3929] * V_S / 5$$

Operating temperature:	$-40^{\circ}\text{C} \leq T \leq +125^{\circ}\text{C}$
Storage temperature:	$-40^{\circ}\text{C} \leq T \leq +130^{\circ}\text{C}$
Operating pressure:	$15 \text{ kPa} \leq p \leq 120 \text{ kPa}$
Supply voltage:	$V_S = 5.0 \text{ V} \pm 0.25 \text{ V}$
Response time (10% to 90% of $V_{out(p)}$):	$t_R \leq 7 \text{ ms}$
Output noise ($\geq 1 \text{ kHz}$):	$< 10 \text{ mVpp}$
Load resistance:	$\geq 20 \text{ k}\Omega$
Input current at maximum supply voltage:	$I_S \leq 10.0 \text{ mA}$

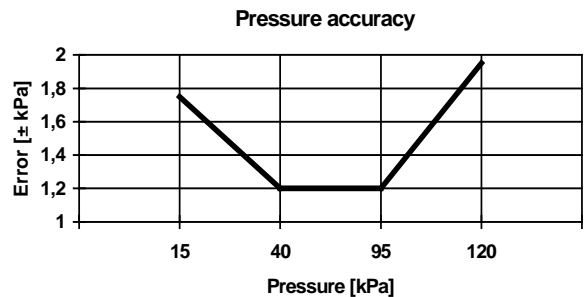
2.2.2 Maximum ratings

Operating temperature:	$-40^{\circ}\text{C} \leq T \leq +125^{\circ}\text{C}$
Pressure:	$p_{max} = 213 \text{ kPa}$ ($p_{max} = 400 \text{ kPa}$ for 100ms)
Supply voltage:	16.5 V for max. 1 h at 70°C

2.2.3 Accuracy and ratiometricity

2.2.3.1 Pressure error

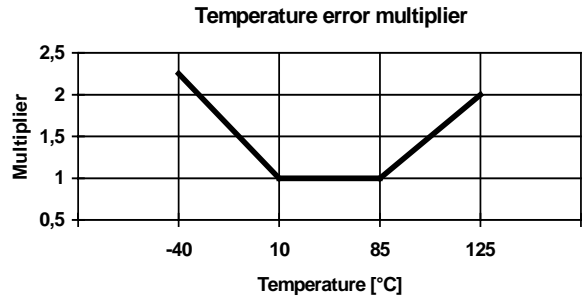
$40 \text{ kPa} \leq p \leq 95 \text{ kPa}$	$\pm 1.2 \text{ kPa}$
$p = 15 \text{ kPa}$	$\pm 1.75 \text{ kPa}$
$p = 120 \text{ kPa}$	$\pm 1.95 \text{ kPa}$



Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		
File:	TKU T-MAP.doc		Page 6 / 17

2.2.3.2 Temperature error

$10^{\circ}\text{C} \leq T \leq 85^{\circ}\text{C}$	1.0
$T = -40^{\circ}\text{C}$	2.25
$T = 125^{\circ}\text{C}$	2.0



2.2.3.3 Ratiometricity for a arbitrary but constant pressure and temperature

$$V_{out(p1, V_s)} / V_{out(p1, V_{snom})} = V_s / V_{snom} \pm 0.005$$

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Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		
File:	TKU T-MAP.doc		Page 7 / 17

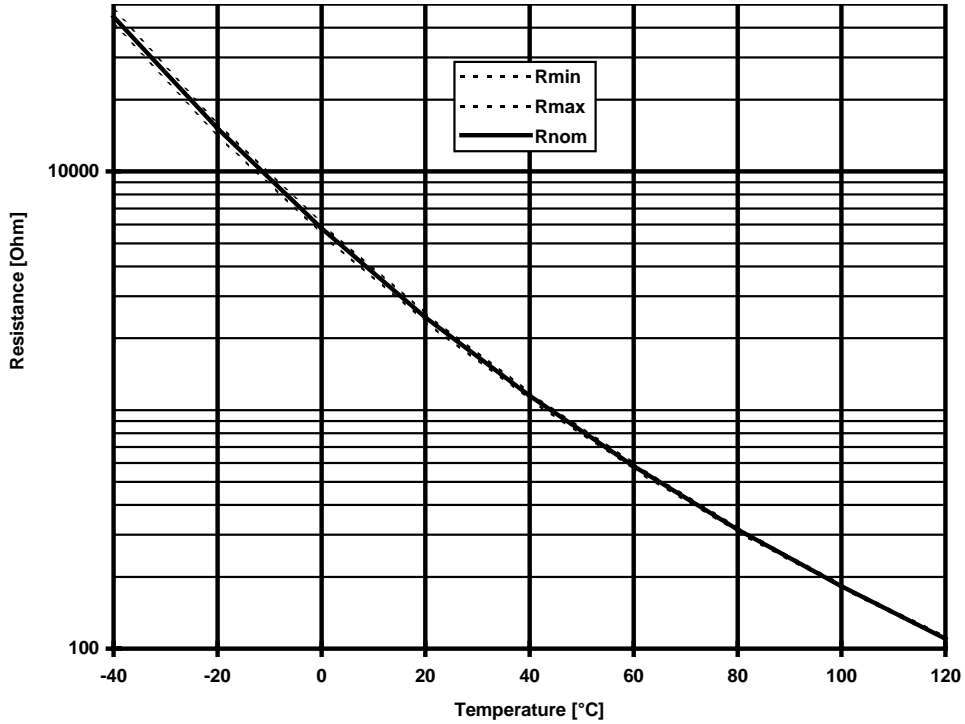
2.3 Temperature output

2.3.1 Nominal characteristics of NTC

Response time:

$t_R \leq 12 \text{ s}$

T [°C]	R _{nom} [Ω]	R _{min} [Ω]	R _{max} [Ω]
-40	44373	41255	47492
-30	25572	23935	27209
-20	15141	14260	16022
-10	9202	8716	9689
0	5774	5497	6050
10	3714	3553	3875
20	2448	2353	2544
25	2014	1940	2089
30	1671	1613	1730
40	1150	1114	1186
50	816.7	794.0	839.3
60	583.1	568.9	597.4
70	426.7	417.6	435.8
80	315.8	310.0	321.6
90	238.1	234.4	241.8
100	182.8	180.4	185.1
110	141.2	139.8	142.6
120	110.3	108.9	111.8
130	87.4	86.0	88.8



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Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		
File:	TKU T-MAP.doc		Page 8 / 17

2.3.2 Maximum ratings

Operating temperature:

$-40^{\circ}\text{C} \leq T \leq + 125^{\circ}\text{C}$

Storage temperature:

$-40^{\circ}\text{C} \leq T \leq + 130^{\circ}\text{C}$

Supply voltage:

$V_s = 5.25\text{ V}$, through a $2\text{ k}\Omega$ serial resistor

Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		Page 9 / 17
File:	TKU T-MAP.doc		

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3 Functional tests

3.1 Mechanical tests

3.1.1 Leak rate

The transducer measurement cavity shall not leak at a rate greater than 1.7 kPa in 30 s when a volume of 77 cm³ is attached to the sensor pressure port at any operating pressure.

3.1.2 Pressure cycle

Subject the sensor to 10.000 cycles of overpressure, 0.5 s at 213 kPa alternating with 0.5 s atmospheric pressure. After the test the sensor must fulfill the specification.

3.2 Electrical tests

3.2.1 General

Sensor shall be operated for minimum of 3.0 s before testing.
 A sensor is considered to be at defined temperature following a 30 min soak at that temperature.

Ambient pressure:	95 ... 105 kPa
Room temperature (RT):	20 ... 26°C
Power supply voltage:	5.0 V
Power supply voltage accuracy:	± 0.005 V
Output voltage accuracy of measuring equipment:	0.1 % of reading

Modules must be free of condensation before electrical testing.

3.2.1.1 Pressure accuracy of measuring equipment

Applied pressures:	± 0.2 kPa
Measuring accuracy:	± 0.1 kPa

3.2.1.2 Temperature accuracy of measuring equipment

For pressure controls:	± 3 K
For temperature controls:	± 1 K
Measuring accuracy:	± 0.5 K

3.2.2 Supply current for pressure output

This test should be performed with minimum load impedance. Measure supply current in pin supply voltage. Insure that sensor does not exceed max. current for V_{Smax} .

Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		
File:	TKU T-MAP.doc		Page 10 / 17

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3.2.3 Transfer functions

3.2.3.1 Pressure

Measure output voltage at the following pressures and temperatures.

p[kPa]: 15/40/67.5/95/120
 T[°C]: RT/10/-40/85/125/RT

Results must lie within allowable error limits times error band multiplier for operating temperature.

3.2.3.2 Temperature

Measure output resistance value at the following temperatures.

T[°C]: RT/10/-40/85/125/RT

Results must lie within allowable error limits.

3.2.4 Response time

3.2.4.1 Pressure

Response time is defined as the time required for the output voltage to change from 10% to 90% of the final steady state value following a step change in pressure input (from 15 kPa to ambient pressure).

3.2.4.2 Temperature

The sensor is fully immersed in a bath at 25°C ± 0.5 K during 30 min.
 The sensor is transferred in less than 2 s in a bath at 40° C ± 0.5 K always fully immersed.
 The response time is the time necessary to reach the resistive value it has at 34.5°C.

3.2.5 Output ripple for pressure output

Measure at 70°C with resistive load of 20 kΩ on the pressure output.
 Requirement: maximum output ripple 10 mVpp

3.2.6 Ratiometricity for pressure output

Measure output voltage at p_{max} and supply voltages $V_{S\ nom}$, $V_{S\ min}$, $V_{S\ max}$.

Requirement: For each 1% change in V_S output will change $(1 \pm 0.1) \%$.

Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		
File:	TKU T-MAP.doc		Page 11 / 17

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4 Environmental tests

4.1 Overvoltage protection

Test duration 1 h at 16.5 V and minimum load resistance at pressure output and atmospheric pressure
 The requirements for the performance of functions shall be satisfied during continuous operation.
 However, tolerance shifts are permissible. Tolerances shall be met after long term operation.

4.2 Short circuit protection for pressure output

30 min at 5.25 V, 70°C and ambient pressure test short circuit protection of $V_{out(p)}$ to GND and $V_{out(p)}$ to V_s

4.3 Sensor GND disconnection

The sensor must tolerate without damage and with a load of 47 kΩ from the pressure output to GND a disconnection of the GND at atmospheric pressure with a supply voltage of 5.0 V.

4.4 Puncture strength

1 min at 500 VAC and 70°C each pin against housing

4.5 Aging in mechanically circulated air without load

48 h at maximum storage temperature (130°C)

4.6 Aging in mechanically circulated air under load

24 h at minimum operating temperature (-40°C)
 acclimatization period >1 h
 24 h at maximum operating temperature (125°C)
 test done at ambient pressure, sensor switched on constantly at standard connection

4.7 Temperature cycle test

40 cycles each
 1 h no load at minimum operating temperature (-40°C)
 2 h with load acclimatization from minimum to maximum operating temperature (125°C)
 1 h with load at maximum operating temperature (125°C)
 2 h no load acclimatization from maximum to minimum operating temperature (-40°C)

test done at ambient pressure, sensor switched on constantly at standard connection

4.8 Resistance to shock

Peak acceleration: 40 g

Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		
File:	TKU T-MAP.doc		Page 12 / 17

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Duration of shock: 11 ms
 Shape of shock: half-sinusoidal
 Number of shocks: 1 in each direction x,y,z with different parts
 Test temperature: room temperature

4.9 Resistance to chemical agents

Apply reactants: a)...q) without c) with a soft paintbrush
 Subsequent penetrate 48 h at upper operating temperature, reactants b, j, n, q penetrate at room temperature

No defects permissible after completion of exposure

4.10 Sealing against dust and water spray

Test according to DIN 40050-9
 Type of protection IP5K4K

4.11 Resistance to engine cleaning

Test according to DIN 40050-9
 Boiler pressure: 100 bar
 Water temperature: 80°C
 Distance to spray nozzle: 150mm
 Number of cycles: 30, nozzle movement -90°...+90°...-90° with 10 cycles/min

Component in mounted position with connector plugged in
 Cold-cleaning agent sprayed on the component and soaked for 30 min
 cleaning the component by steam jet for 5 s, break 5 s

The parts shall continue to perform its function properly after testing

4.12 Thermal shock test

288 cycles without load each
 start at room temperature
 ≤10 s acclimatization to maximum operating temperature (125°C)
 20 min conditioning at maximum operating temperature (125°C)
 ≤10 s acclimatization to minimum operating temperature (-40°C)
 40 min conditioning at minimum operating temperature (-40°C)

Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		
File:	TKU T-MAP.doc		Page 13 / 17

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4.13 Endurance test

1. cycles (1 in each main plane of the device) vibration test see 4.13.1 covered with 168 h temperature change (21 cycles) see 4.13.2
2. 656 h conditioning at maximum operating temperature
3. 176 h (22 cycles) temperature change see 4.13.2

4.13.1 Vibration test

method and procedure according to IEC 60068 part 2-6

Lines and hose connections shall be properly mounted and supported in accordance with installation conditions.

Duration: 24 h
 Frequency sweep time: 1 oct./min; log

Frequency (Hz)	amplitude of excursion (mm)	amplitude of acceleration (m/s ²)
20		50
80	0,177	
200		280
220		280
240		160
320		160
340		125
440		125

4.13.2 Temperature cycling

Temperature cycling according to IEC 60068 part 2-14 Nb

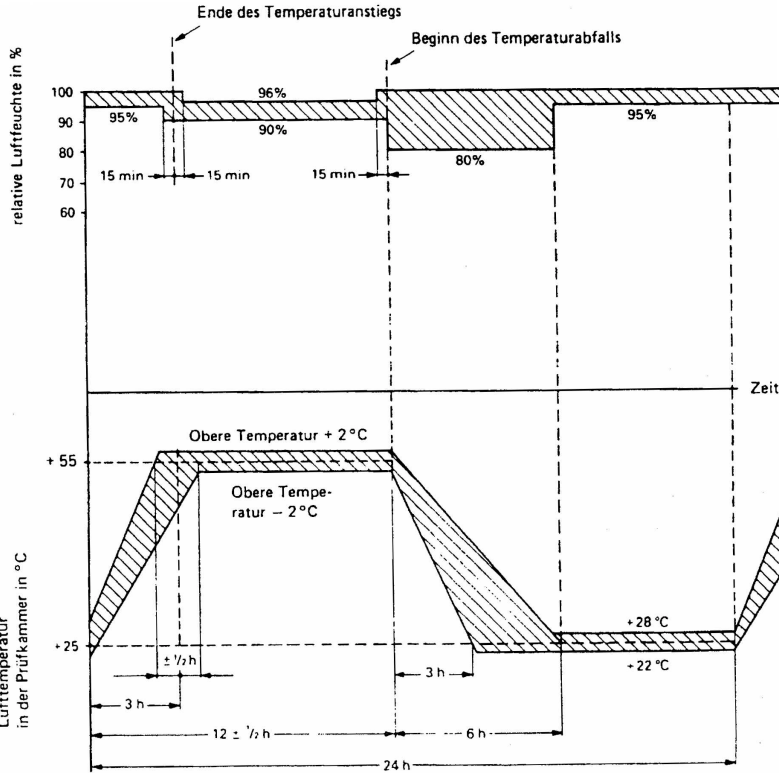
Low temperature: -40°C
 High temperature: +125°C
 Dwell time at high temperature: 5 h
 Dwell time at low temperature: 1 h
 Acclimatization time: 1 h

Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		
File:	TKU T-MAP.doc		Page 14 / 17

4.14 Resistance to environmental factors

4.14.1 Humidity cycling

6 cycles according to DIN IEC 60068 part 2-30 Db, version 2



sequence of cycles

4.14.2 Salt spray test

Subsequently the humidity cycling test there is testing of environmental compatibility according to DIN 50 021-SS for 144 h

4.15 Drop test

Subject the sensor to a drop test from a height of 1 m on to a concrete floor. Each test specimen must be subjected to two drop tests in two load directions. Three specimen should be used to test all load directions.

The sensor is required to survive the drop test without concealed damage.

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Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		
File:	TKU T-MAP.doc		Page 15 / 17

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4.16 Radiated interference

Sensor mounted on VW Vero card at the end raised for 9cm in TEM cell
 Voltage supply and measuring of output signal by filter
 Frequency range: 1...400 MHz
 Field intensity: 100 V/m
 Modulation: 80 %
 Frequency for modulation: 60 Hz
 Maximum deviation by interference ± 0.25 V

4.17 EMC with regard to sensor circuits

Sensor with wiring harness but without vehicle electrics imitation and control unit in capacitive coupling
 pincers CDN 500
 Input of control unit imitated by RC component 21.5 k Ω / 100 nF
 Test pulse 3a and 3b with Schaffner Generator NSG 500 B
 Maximum deviation by interference ± 0.25 V

4.18 Results

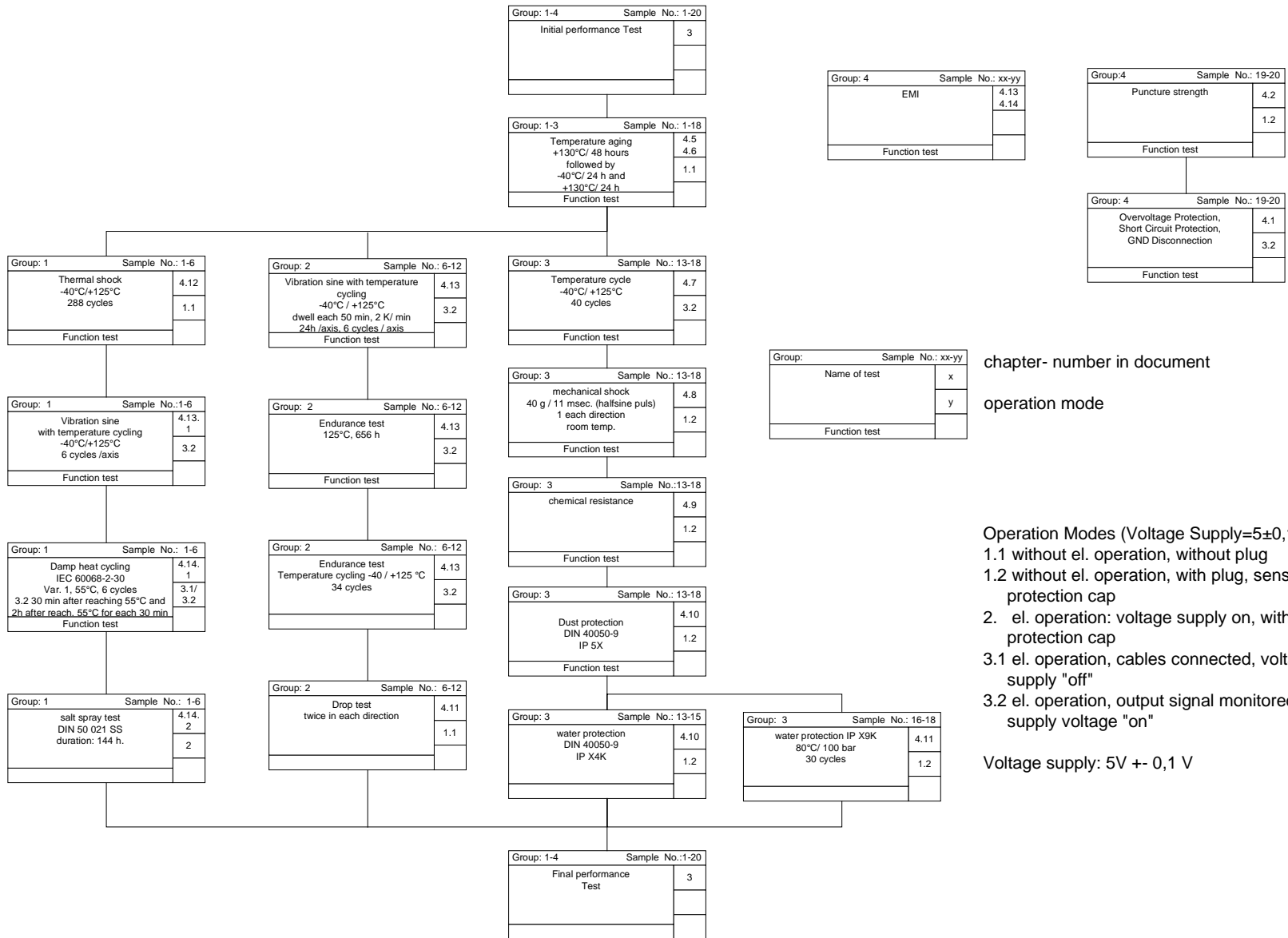
All units have to meet the electrical performance requirements after these tests.

Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx xx.xx.		
File:	TKU T-MAP.doc		Page 16 / 17

5 Test flow

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chapter- number in document
 operation mode

- Operation Modes (Voltage Supply=5±0,1V)
- 1.1 without el. operation, without plug
 - 1.2 without el. operation, with plug, sensor with protection cap
 2. el. operation: voltage supply on, with protection cap
 - 3.1 el. operation, cables connected, voltage supply "off"
 - 3.2 el. operation, output signal monitored supply voltage "on"

Voltage supply: 5V +- 0,1 V

Author:	Error! Reference source not found.	Specification for MAP Sensor	TMAP
Version:	1 ECO 15xxxx	XX.XX.	
File:	TKU T-MAP.doc		
Page	17 / 17		