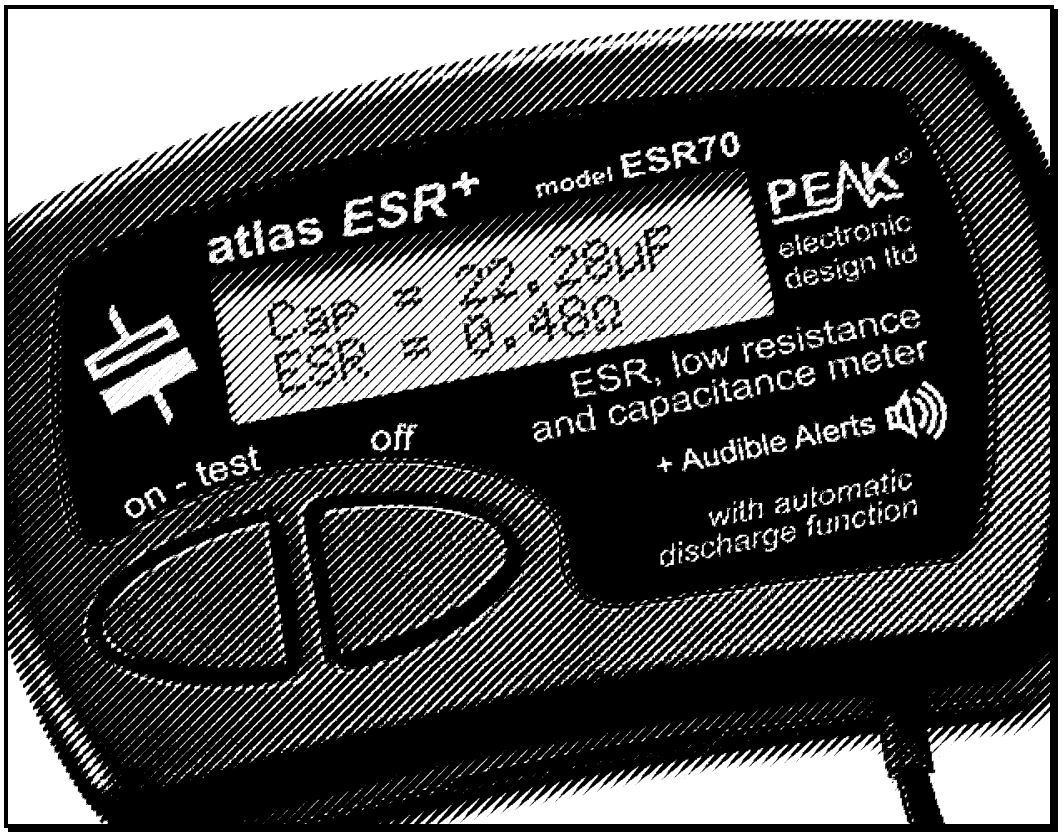
GB60/70-11

Atlas *ESR* and *ESR*+

Equivalent Series Resistance and Capacitance Meter

Model ESR60/ESR70



Designed and manufactured with pride in the UK

User Guide

In the interests of development, information in this guide is subject to change without notice - E&OE

CE

PEAK®
electronic design ltd

Want to use it now?

We understand that you want to use your ***Atlas ESR*** right now. The unit is ready to go and you should have little need to refer to this user guide, but please make sure that you do at least take a look at the notices on page 4!

Contents Page

Introduction

The ***Atlas ESR*** is an advanced instrument designed specifically for the analysis of capacitor equivalent series resistance (in *or* out of circuit). In addition it will, where possible, display the capacitance of the device under test.

Summary Features:

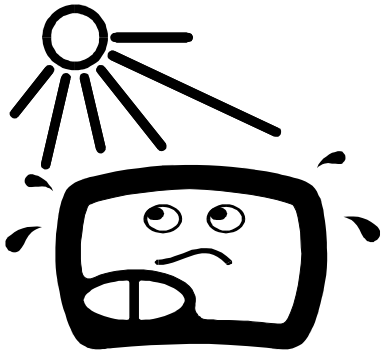
- ESR measurement range 0 to 40Ω (20Ω for ESR60).
- ESR resolution as low as 0.01Ω.
- Capacitance range 1µF to 22000µF.
- Can be used for low-ohms resistance checking too.
- Integrated controlled discharge circuitry reduces the need for the user to manually discharge capacitors before test.*
- Use in or out of circuit for ESR and low-ohms resistance measurement.
- The ESR70 features audible alerts for quick user-feedback of ESR test status.
- Automatic analysis start when component is detected.
- Automatic and manual power-off.

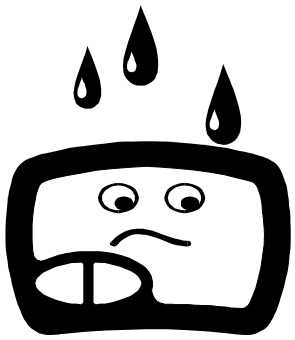
* Note:
The discharge circuitry exists to ensure that a charged capacitor is less likely to damage the unit. For example, if the capacitor under test has a potential of a few tens of volts across it, the charge is removed automatically. It is the user's responsibility to ensure that any dangerously charged capacitors are safely discharged before connection to the unit.

Important Considerations

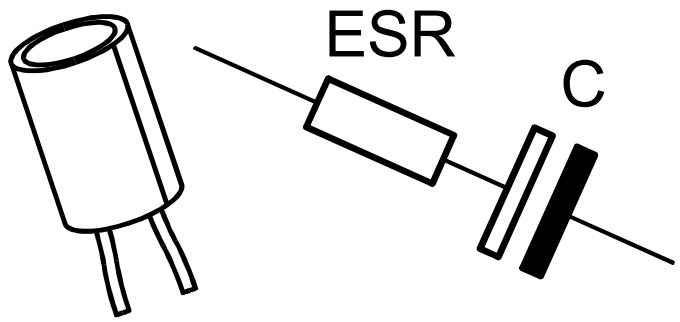
Please observe the following guidelines:

- This instrument must NEVER be connected to powered equipment/components.
- It is the user's responsibility to ensure that any dangerously charged capacitors are safely discharged before connection to the unit.
- To allow the self-protection mechanism to function, always ensure that the *Atlas ESR* has completed any analysis before connecting the test probes to a component.
- Failure to comply with these warnings may result in personal injury, damage to the equipment under test, damage to the *Atlas ESR* and invalidation of the manufacturer's warranty.
- Avoid rough treatment, hard knocks and extreme temperatures.
- This unit is not waterproof.





Notes on ESR



ESR (Equivalent Series Resistance), as its acronym implies, is the value of resistance that is effectively in series with an ideal capacitor.

No capacitor is ideal of course, the detailed equivalent circuit of a typical capacitor is very complex. For many electrolytic capacitors however, the most important parameters regarding the capacitor's performance is the capacitance and the ESR.

An increase in ESR (due to age, abuse or temperature cycling) can result in poor capacitor performance. The capacitor becomes less "ideal" and starts to dissipate more power, an ideal capacitor of course dissipates zero power.

Capacitor manufacturers typically quote the ESR of their products at 100kHz, which is the same test frequency used by the ***Atlas ESR.***

Sometimes, manufacturers quote ESR at 100Hz or 120Hz as the capacitors may be aimed at rectified mains power applications. ESR is generally not very frequency dependent however, so it can be reasonably considered equivalent to readings taken at 100kHz.

Note: The ***Atlas ESR*** automatically ignores the reactance of the capacitor. So although a 1µF capacitor would have a reactance of about 1.6Ω at 100kHz, the displayed value of ESR should be the true ESR value (the real bit of resistance that is in series with the reactance).

Analysing Capacitors

The ***Peak Atlas ESR*** is designed to analyse capacitor ESR in or out of circuit. The two test probes can be connected to the component any way around. Remember though that in-circuit testing can result in less accurate readings.

Important: To minimise risk of damage to the unit, make sure that the ***Atlas ESR*** has completed any previous analysis before attaching the test probes to the capacitor. This ensures that the built-in protection circuit is ready for any charge that may be present on the capacitor.

The ***Atlas ESR*** must first be switched on by briefly pressing the **on-test** button.

The unit will start a component analysis when it detects that the open circuit probes have been applied to a component or when **on-test** button is re-pressed.

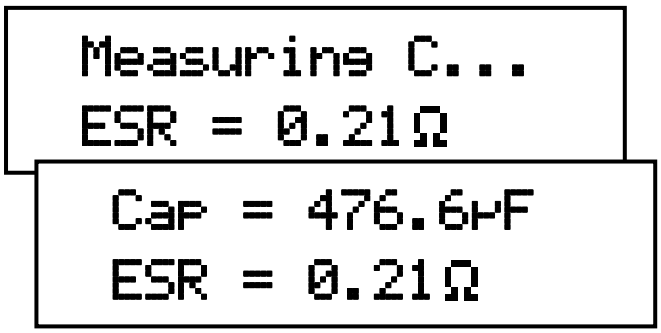
If the capacitor is charged (<50V), the ***Atlas ESR*** will attempt to discharge the capacitor while showing the progress of the procedure:

If the ***Atlas ESR*** cannot recognise the component connected to the test probes, or the capacitance is out of range, the following message may be displayed:

Analysing Capacitors continued…

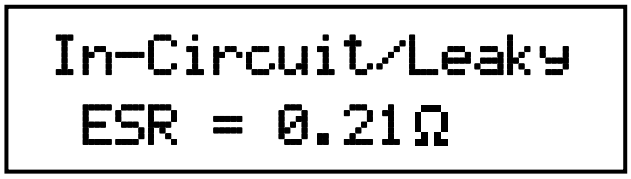
The ESR analysis typically takes under 2 seconds to complete, followed by up to around 10 seconds for the capacitance measurement (depending on the characteristics of the capacitor).

As soon as a valid ESR reading has been obtained, the ESR value is displayed while the instrument proceeds to measure the capacitance.

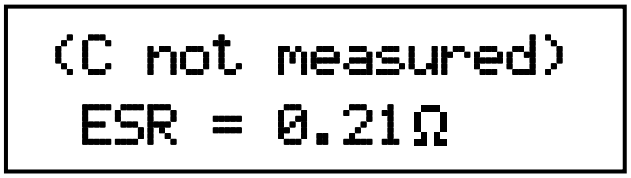


If the presence of external circuitry did not adversely affect the capacitance measurement, the capacitor value will be displayed.

If the capacitance could not be determined (perhaps it is in-circuit or a "leaky" capacitor), the display will only show the value of ESR measured.



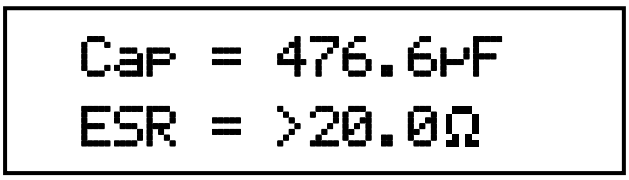
It is not necessary to wait for the capacitance measurement to complete if you're not interested in the capacitance value. If the probes are removed from the component under test before the capacitance measurement has completed, the display will confirm that the capacitance has not be measured:



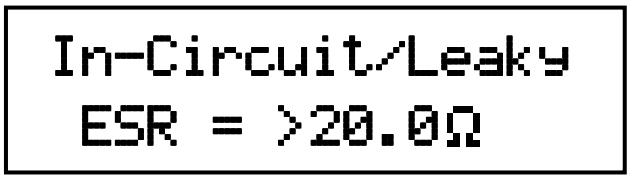
It can be useful to disconnect the probes before the capacitance measurement has completed if you're wanting to simply check the ESR of multiple components in succession.

Analysing Capacitors continued…

In the event that ESR exceeds the maximum that can be measured, the display may show:



or



The ESR measurement range is automatically determined during the analysis. Typically, the resolution for ESR measurement is as shown in the table below:

ESR Value	Automatically selected test current	Nominal measured resolution
0.00 Ω – 2.00 Ω	20mA	0.01 Ω
2.0 Ω – 20.0 Ω*	2mA	0.1 Ω
20.0 Ω – 40.0 Ω*	1mA	0.2 Ω

Although the measurement resolution is generally determined by the absolute value of the ESR (as shown in the above table), low capacitance values can result in a poorer ESR measurement resolution.

* The maximum ESR measurement is limited to 20Ω for the model ESR60 and 40Ω for the model ESR70.

If measuring capacitors connected in parallel, the ESR reading will effectively be the value of all the ESRs in parallel, not just the ESR of the capacitor in contact with the probes.

Typical ESR Values:

	10V	16V	25V	35V	63V	160V	250V	400V	630V
4.7µF	42.0Ω	35.0Ω	29.0Ω	24.0Ω	20.0Ω	16.0Ω	13.0Ω	11.0Ω	8.5Ω
10µF	20.0Ω	16.0Ω	14.0Ω	11.0Ω	9.3Ω	7.7Ω	6.3Ω	5.3Ω	4.0Ω
22µF	9.0Ω	7.5Ω	6.2Ω	5.1Ω	4.2Ω	3.5Ω	2.9Ω	2.4Ω	1.8Ω
47µF	4.2Ω	3.5Ω	2.9Ω	2.4Ω	2.0Ω	1.60Ω	1.30Ω	1.10Ω	0.85Ω
100µF	2.0Ω	1.60Ω	1.40Ω	1.10Ω	0.93Ω	0.77Ω	0.63Ω	0.53Ω	0.40Ω
220µF	0.90Ω	0.75Ω	0.62Ω	0.51Ω	0.42Ω	0.35Ω	0.29Ω	0.24Ω	0.18Ω
470µF	0.42Ω	0.35Ω	0.29Ω	0.24Ω	0.20Ω	0.16Ω	0.13Ω	0.11Ω	0.09Ω
1000µF	0.20Ω	0.16Ω	0.14Ω	0.11Ω	0.09Ω	0.08Ω	0.06Ω	0.05Ω	0.04Ω
2200µF	0.09Ω	0.08Ω	0.06Ω	0.05Ω	0.04Ω	0.04Ω	0.03Ω	0.02Ω	0.02Ω
4700µF	0.04Ω	0.04Ω	0.03Ω	0.02Ω	0.02Ω	0.02Ω	0.01Ω	0.01Ω	0.01Ω
10000µF	0.02Ω	0.02Ω	0.01Ω	0.01Ω	0.01Ω	0.01Ω	0.01Ω	0.01Ω	0.00Ω
22000µF	0.01Ω	0.01Ω	0.01Ω	0.01Ω	0.00Ω	0.00Ω	0.00Ω	0.00Ω	0.00Ω

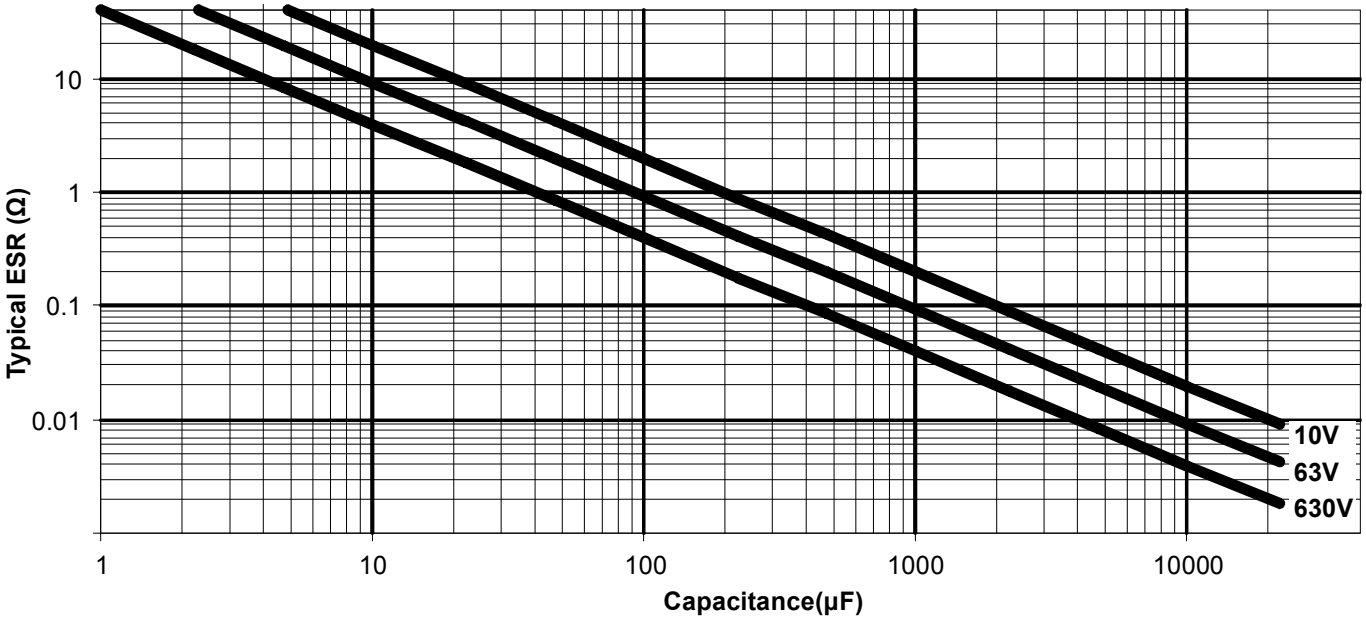
Remember, lower ESR is better.

Typical Values of ESR continued…

It is not possible to provide a definitive rule for values of ESR that are acceptable for all situations. **However, a table of typical ESR figures for a range of capacitance and voltage ratings is shown on the previous page.**

The expected value of ESR largely depends on the capacitance value and the voltage rating of the capacitor but also depends on temperature ratings and other factors. Some capacitors are manufactured to exhibit very low ESR values, whilst conventional low cost parts are likely to exhibit higher values but still be acceptable.

As a guide only, the following log-scaled graph shows "typical" values of ESR for a range of different capacitance and voltage ratings.



Please note that the figures shown on the previous page are only **typical** figures for standard grade electrolytics at room temperature, please verify readings against expected values for the particular type of capacitor you are testing.

For any particular capacitance and voltage rating,
a lower ESR reading is generally better than a higher ESR reading. For good quality capacitors it is common for the ESR readings to be much lower than the figures shown in the previous table.

Audible Alerts (Model ESR70 only)

The ESR70 unit can produce audible tones to assist the user.

The various tones are summarised below:

Condition / Operation	Sound Type
Start Analysis	Short Blip
End Analysis	Short Blip
Measured ESR > 40Ω	High-Low "Beep Barp"
Measured ESR < 5.0Ω	Single Bell "Ping"
Measured ESR < 1.0Ω	Double Bell "Ping-Ping"

You can switch audible alerts on or off by holding down the **on-test** button for about 2 seconds when powering up the unit from off. Depending on whether the sound function was already on or off, one of the following messages will be displayed to confirm that you have changed the sound mode:

Probe Compensation

To ensure good repeatable readings, particularly for low values of ESR, it may be necessary to occasionally perform a simple Probe Compensation procedure. This procedure is easiest to perform with the gold plated croc clips fitted.

1. Ensure the unit is switched off.

2. Press and hold down the **on-test** button for about 5 seconds until the following message is displayed*:

3. The unit will then ask you to short the probes together (by interlocking the jaws of each croc clip). Then press the **on-test** button.

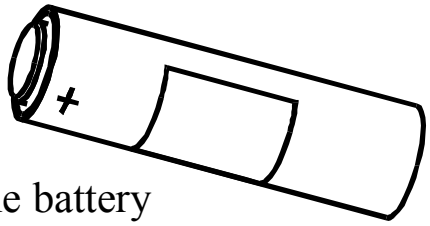
4. After a short delay the display will confirm that the procedure is complete and then switch off.

If the following message is displayed then the probes may not have been correctly shorted during the above proecedure. **This message may also be displayed if any of the probe connections are faulty.**

It is useful to test the integrity of the probe compensation by measuring a fixed resistor of 1Ω and 10Ω to verify the correct ESR reading respectively.

* NOTE: For the ESR70, the sound on/off mode will be entered while holding the button down, keep the button held down and the unit will proceed to the probe compensation mode.

Care of your Atlas *ESR*



The ***Peak Atlas ESR*** should provide many years of service if used in accordance with this user guide. Care should be taken not to expose your unit to excessive heat, shock or moisture. Additionally, the battery should be replaced at least every 12 months to reduce the risk of leak damage.

If a low battery warning message appears, replacement of the battery is essential.

Immediate replacement of the battery is EXTREMELY IMPORTANT as the built-in protection mechanism may not function correctly if the battery condition is poor and therefore render your unit susceptible to damage from even low energy charged capacitors.

The ***Atlas ESR*** will not operate if a low battery condition is encountered.

New batteries can be purchased from many retailers and directly from Peak Electronic Design Ltd or an authorised agent. The rear label on the instrument will tell you the type of battery required.

Battery type (for 12V edition): L1028, 23A, V23A, GP23A, MN21 or a good quality 12V alkaline equivalent (28mm long x 10mm diameter).

Battery type (for AAA edition): AAA cell (Alkaline, NiMh or Lithium-Iron-Disulphide).

Battery access: To replace the battery, place the unit face down on a clean smooth surface and unscrew the three screws to remove the rear panel. Remove the old battery and insert a new one, taking care to observe the correct polarity. Carefully replace the rear panel and ensure you don't pinch the test leads. Do not over-tighten the screws.

Appendix A - Troubleshooting

Problem	Cause / Possible Solution
ESR value when probes are shorted is not close to 0Ω	Perform a probe compensation.
Display shows `Removing trace charge`	This message is displayed if the ***Atlas ESR*** has detected that the attached capacitor may be exhibiting "Soakage" or "Dielectric Absorption", this is quite normal. The instrument then ensures that the capacitor is very well discharged and helps to prevent voltage developing across the capacitor after the normal discharge procedure has completed.
Display shows `Auto discharge taking too long!`	The unit attempts to remove charge from the capacitor using a controlled discharge procedure. If this takes longer than 60 seconds then the discharge process will be aborted. It is recommend that you safely discharge the capacitor manually and try analysis again.
Display shows `Warning! V=132V Safely discharge`	If the voltage across the capacitor is greater than 50V then the ***Atlas ESR*** will not attempt to discharge the capacitor, please safely discharge the capacitor manually.
Display shows `Self Test Fail Code 2`	It is possible that a hardware failure has occurred, please contact Peak Electronic Design Limited for assistance.
Display shows `In-Circuit/Leaky` even though it's a new capacitor and out-of-circuit.	The ***Atlas ESR*** will display "In-Circuit/Leaky" if the charge curve is non-linear by more than 10%. Some capacitors (even new ones) can exhibit a non-linear charge characteristic and means that the capacitance cannot be reliably measured. "Exercising" the capacitor can help, so try to measure it again a few times.

Appendix B - Technical Specifications

All values are at 25°C unless otherwise specified.

Parameter	Min	Typ	Max	Note
Peak test current into S/C		±20mA	±22mA	
Peak test voltage, full scale ESR		±40mV	±44mV	
Peak test voltage across O/C		±2.5V	±3.0V	
Capacitance measurement range	1µF		22000µF	
Capacitance accuracy	±4% ±0.2µF			
Capacitance measurement current	1.8mA	2mA	2.2mA	
ESR measurement range	0Ω		20Ω / 40Ω	2
ESR resolution for ESR < 2Ω	0.01Ω		0.02Ω	
ESR resolution for ESR > 2Ω	0.1Ω		0.2Ω	
ESR accuracy for ESR < 2Ω	±2% ±0.02Ω			
ESR accuracy for ESR > 2Ω	±2% ±0.2Ω			
ESR measurement current	0.8mA		22mA	
ESR test frequency	96kHz	100kHz	104kHz	
Abuse voltage (for C < 10µF)			±275V	3
Abuse voltage (for C > 10µF)			±50V	3
Auto-Discharge voltage limit			±50V	
Battery type (12V edition)	L1028, 23A, V23A, GP23A or MN21 12V Alkaline (28mm long x 10mm diameter)			
Battery type (AAA edition)	AAA Alkaline, NiMh or Lithium-Iron-Disulphide			
Inactivity power-down period	60 seconds			
Dimensions (excluding test leads)	103 x 70 x 20 mm			
Operating temperature range	10°C		40°C	1

Notes

1. Subject to acceptable LCD visibility.
2. Model ESR70 is capable of measuring up to 40Ω.
3. Maximum abuse voltage rated limitation of internal protection electronics. Probes, leads and unit are not certified for high voltage use.

Appendix C – Statutory Information

Peak Warranty

If for any reason you are not completely satisfied with the ***Peak Atlas ESR*** within 14 days of purchase you may return the unit to your distributor. You will receive a refund covering the full purchase price if the unit is returned in perfect condition.

The warranty is valid for 24 months from date of purchase. This warranty covers the cost of repair or replacement due to defects in materials and/or manufacturing faults.

The warranty does not cover malfunction or defects caused by:

a) Operation outside the scope of the user guide.
b) Unauthorised access or modification of the unit (except for battery replacement).
c) Accidental physical damage or abuse.
d) Normal wear and tear.

The customer's statutory rights are not affected by any of the above.
All claims must be accompanied by a proof of purchase.

WEEE (Waste of Electrical and Electronic Equipment), Recycling of Electrical and Electronic Products

In 2006 the European Union introduced regulations (WEEE) for the collection and recycling of all waste electrical and electronic equipment. It is no longer permissible to simply throw away electrical and electronic equipment. Instead, these products must enter the recycling process. Each individual EU member state has implemented the WEEE regulations into national law in slightly different ways. Please follow your national law when you want to dispose of any electrical or electronic products. **More details can be obtained from your national WEEE recycling agency.**