The current transducers from LEM are considered as a key element linking power and the control circuitry. For a majority of application within the power electronics field such as: variable speed drives, servo-control elements, uninterruptible power supplies and switch mode power supplies. Due to their precise and isolated current measurements, the transducers contribute to the improvement of efficiency, reliability and safety of equipment, but very often, they are blamed for high functional costs and the volume they occupy in systems, which are continuously subjected to constraints of size and weight limitations, and price reductions in the market. With the LAH series, LEM meets these requirements and proposes a series of transducers characterised by six benefits.

- Thanks to the concept for vertical mounting, it has been possible to reduce the volume and, in particular, the footprint which is now fair below 5 cm². In order to facilitate the development of a product range at the customer's, all LAH types use the same housing thus occupying the same surface.

- A complete current range: the multi-purpose primary circuit of the LAH 25-NP itself allows to obtain the three following turns ratios with a simple connection on the printed circuit board: Iₚₛ = 8 A, 12 A and 25 A. This allows, for each range, to benefit from the maximum accuracy which is always expressed as a function of Iₚₛ. Just like the LAH25-NP, the LAH 50-P and LAH 100-P are equipped with a three primary pins. Unlike the LAH-25-NP, the latter ones have a reinforced section and are internal interconnected, in order to facilitate the wiring and to ensure an optimum electrical connection between the primary circuit and the printed circuit board.

- The LAH transducers, based on the closed-loop principle, offer exceptional electrical characteristics. The characteristics obtained are remarkable: bandwidth from 0 to 200 kHz, response time at 90 % less than 500 ns and accuracy better than 0.25 % ¹ for the LAH 50-P, LAH 100-P and 0.3 % ¹ for the LAH 25-NP.

- The reduced dimensions of the LAH transducers observe the prescribed distances between the primary and the secondary circuits, thus meeting the requirements of the standard EN 50178.

- Due to the uniformity of the different versions, their multi-purpose and the mass production, LEM can offer the LAH series with a remarkable price/ performance ratio.

- An option on the LAH 25-NP and LAH 50-P ranges enables the measurement of differential current as well as the measurement of 3 phases with 2 transducers by means of a through hole aperture used for insertion of the second primary-circuit.

**Evolution of the conditions for current measurement**

The evolution of the requirements with regards to current measurements has been showing trends, which are mainly characterised by the standards, the evolution of the electronic power components, the permanent concern about improving the profitability of the proposed equipment, and the compactness of the measuring devices. So, the galvanic isolation is no longer only considered as an answer to a technological constraint, but also as an element of safety. Regarding the components, the new power switching devices used for electronic speed control, offer a reduction of the switching times and an increase of the operating voltages and currents. As far as profitability is concerned, the cost of ownership greatly depends on the efficiency curve of the equipment. If this equipment uses measured current values in its control circuits, then also the transducers contribute to the improvement.

When the latters use current measurements in its control circuits, their enhancement also comes through the transducers.

These recent innovations, and those to come, impose and will impose, on current measurements; the observance of the standard-related aspects, the high dynamic characteristics (response times and behaviour at high-amplitude current (di/dt) and voltage (dv/dt) changes) and a constant progress in accuracy and size reductions.

**Preference for a measuring system**

These conditions and trends give orientations as to the measuring methods to be used. The ideal is to combine experience and innovation at the same time. The experience must comprise both the theoretical and the technological aspects. The innovation must pursue two objectives, that of continuous improvements and that of technological progress. This approach allows to meet the actual requirements, but also to assure oneself of the level of evolution necessary for meeting the challenges of the future. The Hall effect transducer offers an extremely well-balanced solution to these needs. The principle is proven and the technological innovations are accompanied by the know-how of the engineers, thus allowing to offer transducers with regularly improved performances with a continuously increased price/performance ratio. Thanks to the measuring system offered by the transducer, the performances in dynamic operations are optimised once and for all.

Compared to a current measurement carried out with discrete elements, this relieves the design engineer of the difficult tasks related to EMC compatibility and of the development of the operating circuit scheme, which guarantees him the desired dynamic performance. Since the transducer is a precise element which does not cause

¹ without electrical and magnetic offset
any or few insertion losses, it actively participates in improving the efficiency of the equipment.

Closed-loop operating principle

The proven closed-loop operating principle, used by LEM when building its first current transducer more than 30 years ago, has served as a base for designing the LAH series. Since that time, this principle has been used with success for isolated measurements of currents and voltages.

Every conductor carrying a current $I_p$ (Fig. 1) generates a magnetic field, which is concentrated in a magnetic circuit. This field can be measured in an air gap by using a Hall element. The latter has the property of converting the magnetic flux into a voltage, when it is supplied with a constant current $I_C$.

When applying the closed-loop principle, the Hall voltage is only used for balancing the primary and the secondary flux. The additional secondary coil, for example with 2,000 turns, carries a current $I_s$ which equals $1/2000$ of the primary current, in order to exactly compensate for the field of the primary conductor. The total flux then equals zero.

The compensation circuit accepts DC and AC currents up to the limit frequency of the electronics. Above that value, the current transducer works as a normal transformer with a primary and a secondary winding. This allows electrically isolated measurements of currents up to several hundred kHz.

The LAH series

The LAH series from LEM have been developed to offer a solution to the constraints of space, price, performance and weight. Their application areas are extremely varied: variable speed drives, servo-control elements, uninterruptible power supplies and switch mode power supplies.

Table 1 gives an overview of the main characteristics of the series LAH transducers.

Table 1: The technical data are given for a supply voltage of ±15V (±5%)

<table>
<thead>
<tr>
<th>Technical data</th>
<th>LAH 25-NP</th>
<th>LAH 50-P</th>
<th>LAH 100-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective primary current $I_{PN}$</td>
<td>8/12/25 A</td>
<td>50 A</td>
<td>100 A</td>
</tr>
<tr>
<td>Measuring range at 85 °C</td>
<td>18/27/55 A</td>
<td>110 A</td>
<td>140 A</td>
</tr>
<tr>
<td>at 70 °C</td>
<td>-</td>
<td>-</td>
<td>160 A</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.3 %</td>
<td>0.25 %</td>
<td>0.25 %</td>
</tr>
<tr>
<td>Supply voltage ±5 %</td>
<td>±12 V ... ±15 V</td>
<td>±0.1 mA</td>
<td>±0.1 mA</td>
</tr>
<tr>
<td>Temperat. drift -25 °C...+85 °C</td>
<td>±0.1 mA</td>
<td>±0.1 mA</td>
<td>±0.1 mA</td>
</tr>
<tr>
<td>Response time</td>
<td>&lt; 500 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bandwidth (-1dB)</td>
<td>0...200 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test voltage, 50/60 Hz, 1 min</td>
<td>5 kV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>EN50178</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface on the printed circuit board</td>
<td>460 mm²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exact reproduction of the waveform at the transducer output

The protection of fast power switching devices such as IGBT’s requires a very fast detection of overcurrents. At a current slope of 100 A/µs, there is practically (Fig. 2) no delay to be seen with regards to the primary current.

Behaviour at dv/dt noise

Each electrical component with a galvanic isolation between the primary and the secondary circuit has a capacitive coupling between the isolated potentials. At high switching frequencies, this leads to undesired EMI influences (EMI = Electro-Magnetic Interference). On the secondary side, i.e. at the output of the component, an interfering signal appears. The figures 3 et 4 show the behaviour at a voltage change of 1 and 6 kV/µs for an applied voltage of 1000V. Note the very short duration of the disturbance of less than 200 ns which can be easily filtered. This is very important for the use with digital regulating circuits using pulse width modulation (PWM). In this case, a small filter is sufficient for the attenuation, in order not to limit the dynamic characteristics.
the transducer only occupies 460 mm$^2$ on the printed circuit board, and its height is just 21 mm. Despite its compactness, the triple primary circuit is fully protected, and the distance obtained between the primary and secondary connections is 12 mm.

**Primary circuits**

The original constructive solution with three transversal U-shaped primary terminals offers technical advantages, which allow to reduce the development time and the number of transducers in stock. With the LAH 25-NP, you have three transducers in one; an 8 A nominal, a 12 A nominal and a 25 A nominal current type. It is important to note that in the three connection variants, the LAH 25-NP offers performances of a very high level and which are completely identical. Due to the amplitude of the measured currents and to the mounting on a printed circuit board, the LAH 50-P and LAH 100-P are equipped with a triple primary circuit which has a reinforced section and interconnected terminals.

**Connection variants of the LAH 25-NP**

In **variant 1**, the three primary circuits connected in parallel form one winding. The turns ratio is thus 1:1000. This allows to measure currents up to 55 A peak with a nominal current of 25 A.

In **variant 2**, two primary circuits connected in parallel are wired in series with the last primary circuit, thus forming two windings. The turns ratio is thus 2:1000. This allows to measure currents up to 27 A peak with a nominal current of 12 A.

In **variant 3**, the series-connected primary circuits form three windings. The turns ratio is thus 3:1000. This allows to measure currents up to 18 A peak with a nominal current of 8 A.

**Wide frequency bandwidth**

The excellent coupling characteristics between the primary circuit and the compensation coil are also reflected in the bandwidth. The LAH wide frequency range reaches a level which is rarely obtained with traditional Hall effect transducers.

**Reduced mounting surface**

With the LAH series, whether for measuring a current of 8 A or 100 A,
Applications and set-up

Measuring differential currents
LAH 25-NP and LAH 50-P are available in special versions with a through-hole (3.2 mm\(\phi\)) which allows to measure differential currents. In this configuration, the magnetic fields generated by the currents circulating in the primary circuit and through the hole add or subtract dependant upon direction.

Fig. 9. Differential measurement

### Measuring three phases with two transducers

A particularly interesting application for adding up currents is the measurement of two phases per transducer as shown in figure 10.

Fig. 10. Two transducers, three phases

Except in case of an earth fault, the sum of the currents in the three phases of a motor always equals zero. This makes it possible to easily reconstruct the three phase currents \(I_u\), \(I_v\), \(I_w\) from the measurements taken by the two transducers ( \(I_x = I_u + I_v\) and \(I_y = I_v + I_w\), figure 11).

Fig. 11. Symmetrical mode

### Determination of the measuring resistor

The measuring voltage generated at the terminals of the measuring resistor depends on the amplitude of the primary current \(I_p\), the turns ratio of the transducer \(K_N\) and the measuring resistor \(R_M\). The nominal current \(I_{PN}\) determines the type of transducer and its turns ratio \(K_N\). The voltage measured at a given primary peak current \(I_p\) is thus determined by the choice of the resistor \(R_M\).

\[
R_M = \frac{V_M}{I_p \cdot K_N}
\]

With:
- \(V_M\) = Measuring voltage
- \(K_N\) = depending on the transducer and its wiring (see table 2)
- \(I_p\) = Max. peak current to be measured

The LAH transducers have been developed with the concern for offering a great flexibility in the choice of the measuring resistor, in order to allow the user to adjust the measuring voltage to its optimum level. Of course, there is a lower and an upper limit for the choice of the resistors. For the user, these limits result in a measuring voltage range, within which he can adjust the desired voltage with the aid of the resistor.

The upper limit depends on the minimum supply voltage of the transducer (more precisely, the minimum voltage available for the coil and the resistance of \(V_{M}\)), the resistance of the coil (and its temperature) and the peak current that one desires to measure.

Fig. 12. Short circuit between two phases

Fig. 13. Earth leakage in the V phase
\[ R_{\text{M (max)}} = \frac{V_{W}}{I_p \cdot K_N} - R_S \cdot T_A \]

With:
\[ V_{W} = 11.75 \text{ V (V}_{\text{C (min)}} - 2.5 \text{ V = 15 V) or with a supply voltage of 12 V} \pm 5 \%: V_{W} = 12 \cdot 0.95 - 2.5 = 8.9 \text{ V}. \]
\[ R_S \cdot T_A = \text{coil resistance at the} \text{ temperature } T_A \text{ (see table 2)} \]
\[ *2,5 \text{ V (voltage } V_{CE \text{ (min)}} \text{).} \]

The lower limit depends on parameters some of which are intrinsic to the transducer, and others to the application. It is important to keep in mind that the nominal current of the customer’s application is the parameter which has the greatest influence on the value of \( R_{\text{M (min)}} \) and consequently on the lower limit of the measuring voltage range.

\[ R_{\text{M (min)}} = \frac{V_{C (max)}}{I_{\text{P (max)}} \cdot T_A} \]

With:
\[ V_{C (max)} = 15.75 \text{ V at } 15 \text{ V} \pm 5 \% \text{ and } 12.6 \text{ V at } 12 \text{ V} \pm 5 \%
\[ I_{\text{P (max)}} \cdot T_A = \text{max. power of the transistors at the temperature } T_A \text{ (see table 2)} \]

### Calculations

1) For a nominal current of 24.2 \( A_{\text{RMS}} \), one chooses an LAH 25-NP with one winding in the primary circuit.

This implies \( K_N = 1/1000 \) (s. table 2).

2) For this transducer, at 70 °C:
\( R_S = 99 \Omega \), and \( P_{\text{tr (max)}} = 0.29 \text{ W} \) (see table 2)

3) Peak current to be measured during 3 seconds:
\[ 22 \cdot 1.7 \cdot \sqrt{2} = 52.89 \text{ A} \]

The amplitude and the duration are well below the specifications in the data sheet (55 A during 10 s). Depending on the application, these values can be exceeded (please contact LEM).

4) Calculation of \( R_{\text{M (max)}} \)
\[ R_{\text{M (max)}} = \frac{11.75}{99} = 123.16 \Omega \]

hence
\[ V_{M (max)} = 123.16 \cdot 52.89 \cdot \frac{1}{1000} = 6.51 \text{ V} \]

5) Calculation of \( R_{\text{M (min)}} \)
\[ R_{\text{M (min)}} = \frac{15.75}{24.2 \cdot 1000} = 0.29 \frac{56,6 \Omega}{24.2 \cdot 1000} = 56,6 \Omega \]

hence
\[ V_{M (min)} = 56.6 \cdot 52.89 \cdot \frac{1}{1000} = 2.996 \text{ V} \]

6) Calculation of \( R_S \) for a measuring voltage of 4 V \( (V_M) \) at 52.89 A.
\[ R_S = \frac{4}{52.89 \cdot 1000} = 75.6 \text{ A} \]

7) Check that \( R_{\text{M (min)}} < R_S < R_{\text{M (max)}} \)
\[ 56.6 < 75.6 < 123.16 \]
8) With a 75 Ω resistor of the E24 series, one obtains an output voltage of 3.97 V at 52.89 A.

\[
V_M = 75 \times 52.89 \times \frac{1}{1000} = 3.97 \text{ V}
\]

**Reminders and advice**

It is possible that the desired measuring voltage is outside the calculated measuring voltage range (this could have been the case above). If the desired measuring voltage is below the lower limit of the calculated voltage range, one can:

- either realise \( R_M \) with the aid of two resistors forming a voltage divider,
- or slightly reduce the supply voltage of the transducer (reduction of the thermal losses in the amplifier), in order to be able to decrease the value of \( R_{M\text{max}} \), and consequently the value of the minimum measuring voltage,
- or try it with another current range of the LAH series. In the example above (at +85 °C), with an LAH 50-P instead of the LAH 25-NP, the lower limit of the measuring voltage range decreases by 3.18 V to 0 V.

If the desired measuring voltage is greater than the upper limit of the calculated measuring voltage range, one must:

- try it with another current range of the LAH series. In the example above (at +85 °C), with an LAH 50-P instead of the LAH 25-NP, the upper limit of the measuring voltage range increases to 6.25 V at 8 V.
- and, of course, check that one has neither underestimated the minimum value of the supply voltage of the transducer for the calculation of \( R_{M\text{max},V} \), nor over-estimated the ambient temperature for the value of \( R_s \) (coil resistance)

**Standards**

During the design of the LAH series, the regulations of the EN 50 178 standard have been taken into consideration. All transducers offer a safe insulation up to a voltage of 600 V in symmetrical networks. This value is valid for mains-circuits with pollution degree 2 and overvoltage category III.

All materials are UL-listed (UL = Underwriter’s Laboratories). The marking with the CE mark testifies the conformity with the European EMC Directive 89/336/EEC and the Low Voltage Directive 72/23/EEC.
**ELECTRICAL DATA**

<table>
<thead>
<tr>
<th>I_{PN}</th>
<th>Primary, permanent DC or rms current</th>
<th>UNITS</th>
<th>LAH 25-NP</th>
<th>LAH 50-P</th>
<th>LAH 100-P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At</td>
<td>25</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

| I_{P}  | Primary current measuring range (10s) max | ± At  | 0 to 55   | 0 to 110 | 0 to 160 |

<table>
<thead>
<tr>
<th>R_{M}</th>
<th>Measuring resistor with ± 15V (±5%)</th>
<th>Min</th>
<th>Max</th>
<th>Min</th>
<th>Max</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T_{A} = 70°C at I_{PN} [± At]</td>
<td>Ω</td>
<td>67</td>
<td>371</td>
<td>0</td>
<td>335</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>at I_{PN} [± At] (note 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T_{A} = 85°C at I_{PN} [± At]</td>
<td>Ω</td>
<td>70</td>
<td>366</td>
<td>0</td>
<td>327</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>at I_{PN} [± At] (note 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| I_{SN} | Secondary nominal DC or rms current | mA    | 25        | 50       |

| K_{V}  | Conversion ratio                    |       | 1-2-3/1000 | 1/2000   |

| V_{c}  | Supply voltage (± 5%)               | V     | ±12...15   |

| I_{c}  | Current consumption                 | mA    | 10 + I_{S} |

| V_{c}  | rms voltage for AC isolation test   | V     | ±5        |

| V_{c}  | rms rated voltage (see note 2)      | V     | 5         |

**ACCURACY - DYNAMIC PERFORMANCES DATA**

<table>
<thead>
<tr>
<th>X</th>
<th>Accuracy at I_{PN}, T_{A} = 25°C (see note 3) %</th>
<th>I_{PN}</th>
<th>0.3</th>
<th>0.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>ε</td>
<td>Linearity</td>
<td>%I_{PN}</td>
<td>&lt;0.2</td>
<td>&lt;0.15</td>
</tr>
<tr>
<td>I_{O}</td>
<td>Zero offset current at T_{A} = 25°C max</td>
<td>mA</td>
<td>±0.15</td>
<td>±0.15</td>
</tr>
</tbody>
</table>

| I_{OR} | Residual current at zero I_{O} after an overload of 5xI_{PN} | mA | ±0.20 | ±0.25 |

| I_{TR} | Thermal drift of offset current I_{O} | 0...+70°C | ±0.10 | ±0.60 |

| I_{TR} | Thermal drift of offset current I_{O} | -25°C...+85°C | ±0.10 | ±0.70 |

<table>
<thead>
<tr>
<th>I_{R}</th>
<th>Reaction time at 10% pf I_{PN}</th>
<th>ns</th>
<th>&lt;200</th>
</tr>
</thead>
<tbody>
<tr>
<td>t_{d}</td>
<td>Response time at 90% of I_{PN} (with di/dt of 100 A/µs)</td>
<td>ns</td>
<td>&lt;500</td>
</tr>
<tr>
<td>di/dt</td>
<td>di/dt accurately followed</td>
<td>A/µs</td>
<td>&gt;200</td>
</tr>
<tr>
<td>f</td>
<td>Frequency bandwidth (-1dB)</td>
<td>kHz</td>
<td>DC-200</td>
</tr>
</tbody>
</table>

**GENERAL DATA**

<table>
<thead>
<tr>
<th>R_{S}</th>
<th>Secondary coil resistance</th>
<th>Ω</th>
<th>99</th>
<th>104</th>
<th>135</th>
<th>142</th>
<th>115</th>
<th>121</th>
</tr>
</thead>
<tbody>
<tr>
<td>m</td>
<td>Weight</td>
<td>g</td>
<td>20</td>
<td>22</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>T_{A}</th>
<th>Operating temperature °C</th>
<th></th>
<th>-25...+85</th>
</tr>
</thead>
<tbody>
<tr>
<td>T_{S}</td>
<td>Storage temperature °C</td>
<td></td>
<td>-40...+90</td>
</tr>
</tbody>
</table>

**PRIMARY BUSES CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Number of primary turns</th>
<th>Primary permanent DC or rms current I_{PN} [A]</th>
<th>Conversion ratio K_{N}</th>
<th>Output current at I_{PN} I_{SN} [mA]</th>
<th>Primary resistance max at I_{PN} and T_{A} 85°C R_{P} [mΩ]</th>
<th>Primary insertion inductance L_{I} [µH]</th>
<th>Recommended PCB connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAH 25-NP</td>
<td>1 25</td>
<td>1/1000</td>
<td>25</td>
<td>0.18</td>
<td>0.012</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 12</td>
<td>2/1000</td>
<td>24</td>
<td>0.81</td>
<td>0.054</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 8</td>
<td>3/1000</td>
<td>24</td>
<td>1.62</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td>LAH 50-P</td>
<td>1 50</td>
<td>1/2000</td>
<td>25</td>
<td>0.12</td>
<td>0.008</td>
<td></td>
</tr>
<tr>
<td>LAH 100-P</td>
<td>1 100</td>
<td>1/2000</td>
<td>50</td>
<td>0.08</td>
<td>0.007</td>
<td></td>
</tr>
</tbody>
</table>

Note 1: Sinusoidal 50 Hz
Note 2: Pollution class 2, cat. III
Note 3: Without I_{O} and I_{OR}

LEM reserves the right to carry out modifications on its transducers, in order to improve them, without previous notice.
Dimensions LAH 25-NP (in mm, 1 mm = 0.0394 inch)

Bottom view

Connection

Left view

Dimensions LAH 50-P, LAH 100-P (in mm, 1 mm = 0.0394 inch)

Bottom view

Connection

Left view

Secondary Terminals:
Terminal M : Measure
Terminal + : Supply Voltage +12...+15V
Terminal - : Supply Voltage -12...-15V
As far as patents or other rights of third parties are concerned, liability is only assumed for components per se, not for applications, processes and circuits implemented with components or assemblies. For more details see the available data sheets.

Terms of delivery and rights to change design or specifications are reserved.
5 Years Warranty
on LEM Transducers

LEM designs and manufactures high quality and high reliability products for its customers over the entire world.

Since 1972, we have delivered several million current and voltage transducers which are, for most of them, still in operation on traction vehicles, industrial motor drives, UPS systems and many other applications requiring high quality standards.

Our 5 years warranty applies on all LEM transducers delivered from the 1st. of January 1996 and is valid in addition to the legal warranty. The warranty granted on our Transducers is for a period of 5 years (60 months) from the date of their delivery.

During this period we shall replace or repair at our cost all defective parts (provided the defect is due to defective material or workmanship).

Further claims as well as claims for the compensation of damages, which do not occur on the delivered material itself, are not covered by this warranty.

All defects must be notified to us immediately and faulty material must be returned to the factory along with a description of the defect.

Warranty repairs and or replacements are carried out at our discretion. The customer bears the transport costs. An extension of the warranty period following repairs undertaken under warranty cannot be granted.

The warranty will be invalidated if the buyer has modified or repaired, or has had repaired by a third party the material without LEM's written consent.

The warranty does not cover any damage caused by incorrect conditions of use and cases of force majeure.

No responsibility will apply except legal requirements regarding product liability.

The warranty explicitly excludes all claims exceeding the above conditions.

LEM, Geneva, January 1, 2001
Business Area Components

Paul Van Iseghem
President of LEM Components