



# Human Vibration Measurement with the VM100 Vibration Analyzer

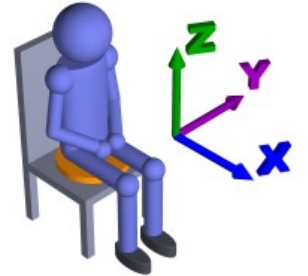
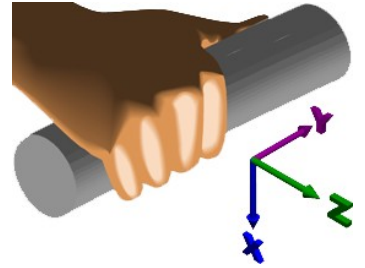


The VM100 Vibration Analyzer measures



- Hand-Arm Vibration (ISO 5349)

- Whole-Body Vibration (ISO 2631)



## Hand-Arm Vibration

Health and Safety at the Workplace

Vibration may cause damage to bones, joints, muscles and circulatory problems

Product evaluation (e.g. 2002/44/EC)



White Finger Syndrom

- Typical sources of hand-arm vibration:  
Hand-held power tools in manufacturing
- percussive metal-working tools
  - grinders and other rotary tools
  - impact wrenches etc.



Quarrying, mining and construction

- rock-drills
  - stone-hammers
  - pick-hammers
  - vibro-compactors
- etc.



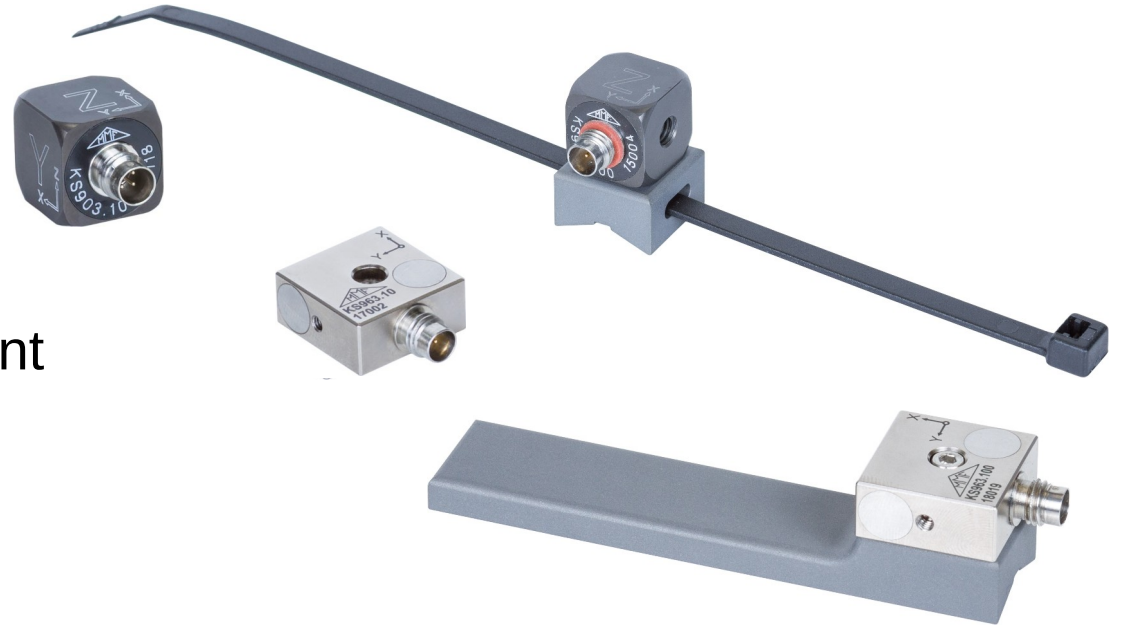
## Agriculture and forestry

- chain saws
  - brush saws
  - lawn mowers
- etc.



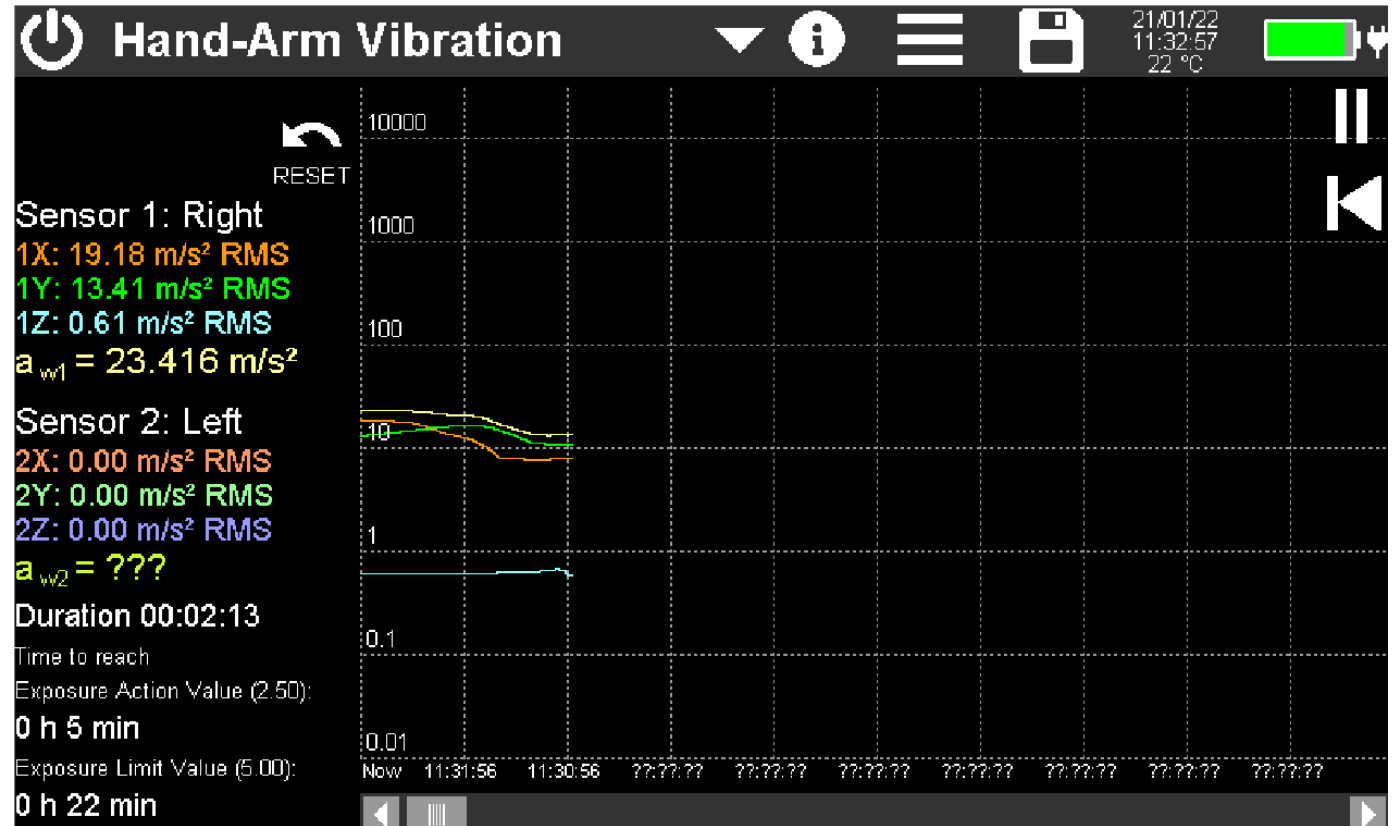
## Sensors for Hand-Arm Vibration

- triaxial
- small and light
- 10 mV/g sensitivity
- accessories for handle attachment





Hand-Arm  
Measurement  
with the VM100





## Whole-Body Vibration

Application of whole-body vibration measurement

- Health and Safety
- Product evaluation (e.g. 2002/44/EC)
- Comfort in vehicles and buildings



Potential **health risk** for operators of:

- Construction machinery e.g. loaders, excavators, bulldozers, rollers
- Mine and quarry equipment
- Forklift trucks
- Armored fighting vehicles, e.g. tanks  
etc.



## Health evaluation (Hand-Arm and Whole-Body):

Daily Vibration Exposure  $A(8)$

$$A(8) = a_{hv} \sqrt{\frac{T_e}{T_0}}$$

$a_{hv}$  measured weighted acceleration (RMS)  
 $T_e$  total exposure time per work day  
 $T_0$  8 hours (work shift)



## Comfort Evaluation in Vehicles (Whole-Body)

- measurements at seat surface, backrest and foot platform
- specific frequency weighting filters



## Sensors for Whole-Body Vibration

- triaxial
- pad for placement under a seated person
- 100 mV/g sensitivity





## Whole-Body Measurement with the VM100

**Whole-Body Mode**

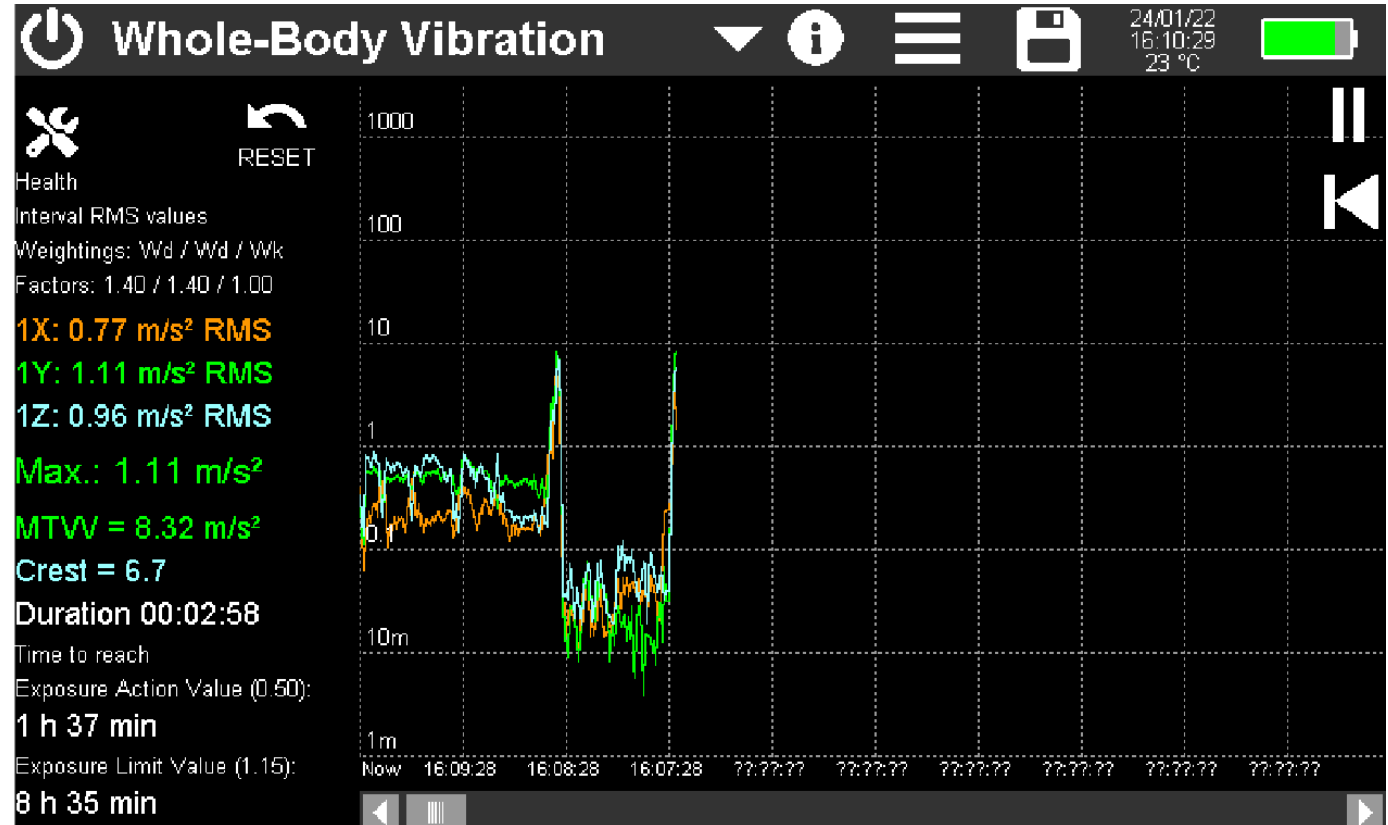
Health

Interval RMS values

Interval RMS values

Vibration dose (VDV)

✓



## Whole-Body Comfort Measurement

with 3 triaxial sensors (GB/T 4970-2009)

Simultaneous measurement at

1. Seat
2. Backrest
3. Feet

when driving along a specified test track





## Measuring Method of GB/T 4970-2009

3 total vibration values of the weighted RMS accelerations

X/Y/Z are calculated:

$$a_{vi} = \sqrt{k_x^2 a_{wx}^2 + k_y^2 a_{wy}^2 + k_z^2 a_{wz}^2} \quad k: \text{weighting factors}$$

A total sum of the 3 values is calculated:

$$a_v = \sqrt{(a_{v1}^2 + a_{v2}^2 + a_{v3}^2)}$$

ICS 43.040.50  
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中华人民共和国国家标准

GB/T 4970—2009  
代替 GB/T 5902—1996、GB/T 4970—1995

汽车平顺性试验方法

Method of running test—Automotive ride comfort

(ISO 2631-1, 1997, Mechanical vibration and shock—  
Evaluation of human exposure to whole-body vibration—  
Part 1: General requirements, NEQ)

2009-10-30 发布

2010-07-01 实施

中华人民共和国国家质量监督检验检疫总局  
中国国家标准化管理委员会 发布



## Measuring Method of GB/T 4970-2009






| <i>Measuring Point</i>     | <i>Direction</i> | <i>Weighting Factor (k)</i> | <i>Weighting Filter</i> |
|----------------------------|------------------|-----------------------------|-------------------------|
| Seat surface               | X                | 1.00                        | Wd                      |
|                            | Y                | 1.00                        | Wd                      |
|                            | Z                | 1.00                        | Wk                      |
| Seat backrest<br>* swapped | X*               | 0.40                        | Wd                      |
|                            | Y                | 0.50                        | Wd                      |
|                            | Z*               | 0.80                        | Wc                      |
| Foot platform              | X                | 0.25                        | Wk                      |
|                            | Y                | 0.25                        | Wk                      |
|                            | Z                | 0.40                        | Wk                      |



## Measuring Method of GB/T 4970-2009

| <i>Overall weighted RMS <math>a_v</math> (m/s<sup>2</sup>)</i> | <i>Human feeling</i> |
|--|----------------------|
| <0.315   | Not uncomfortable    |
| 0.315 to 0.63  | Little uncomfortable |
| 0.5 to 1   | More uncomfortable   |
| 0.8 to 1.6   | Uncomfortable        |
| 1.25 to 2.5  | More uncomfortable   |
| >2   | Very uncomfortable   |

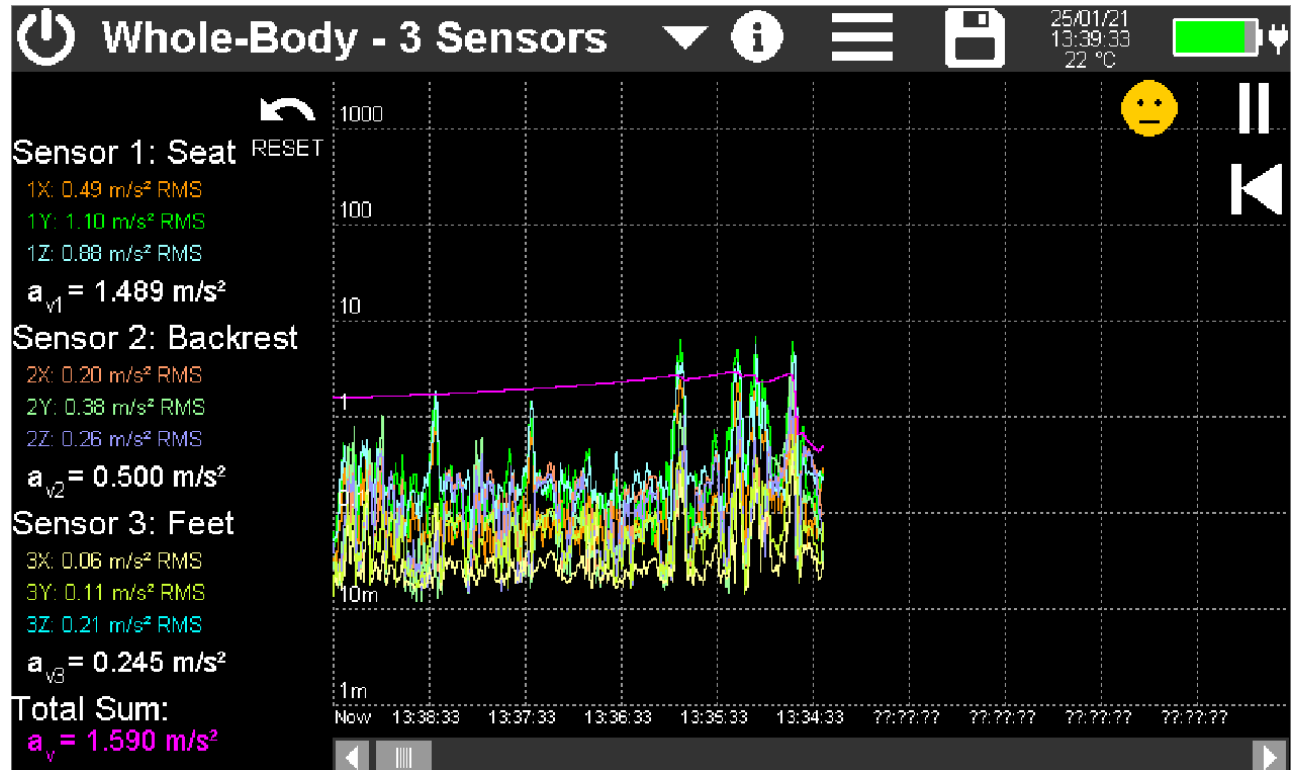
**Limit values for smileys**

|   |   |                                   |
|---|---|-----------------------------------|
|  | < | <input type="text" value="0.31"/> |
|  | < | <input type="text" value="0.63"/> |
|  | < | <input type="text" value="1.00"/> |
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✓



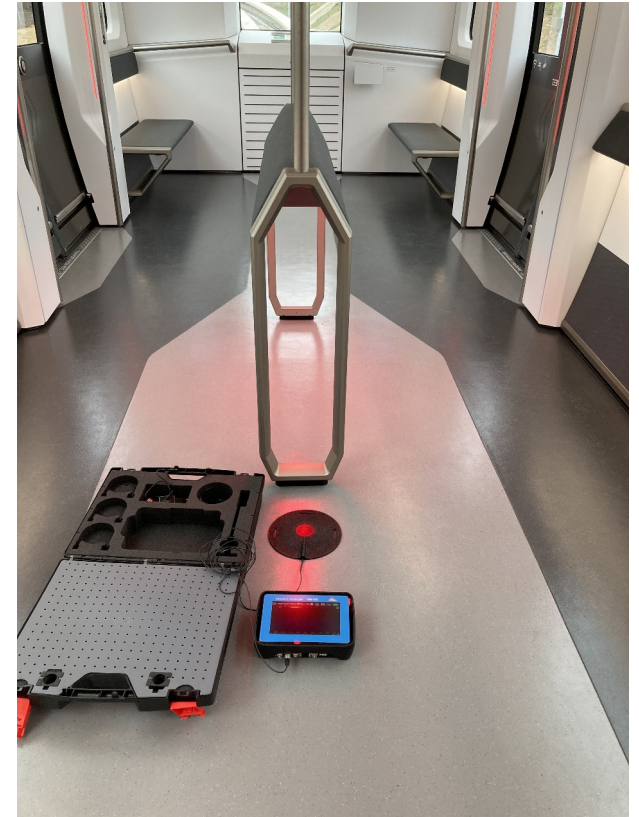
GB/T 4970-2009  
Measurement  
with the VM100A





## Ride Comfort in Rail Vehicles

Maglev Transportation system TSB



## Ship Vibration (ISO 20283-5)

- habitability on passenger and merchant ships
- applicable for all rooms where persons may stay

KS823B

