CPC field-specific training G01R

Measuring electric variables
Measuring magnetic variables
Agenda

- Neighbouring fields
  - What is classified in G01R
  - Main Groups in G01R
  - Groups and examples in G01R 1-13
  - Groups and examples in G01R 15-29 (Measuring)
  - Groups and examples in G01R31 (Testing)
  - Groups and examples in G01R33 (Magnetic)
  - Example in G01R35 (Calibrating)
Neighbouring Fields

B Transporting

G Physics

H Electricity

G05 Controlling, Regulating

G01 Measuring Testing

G06 Computing

G01D Sensors

G01R Measuring Electric/Magnetic Variables

G01N Determining Material Properties
Agenda

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| ✓ | Measuring all kinds of electric or magnetic variables directly or by derivation from other electric or magnetic variables |
| ✓ | Measuring all kinds of electric or magnetic properties of materials |
| ✓ | Indicating presence or sign of current or voltage |
| ✓ | Testing electric or magnetic devices, apparatus or networks, or measuring their characteristics |
| ✓ | NMR, EPR or other spin-effect apparatus, not specially adapted for a particular application |
| ✓ | Equipment for generating signals to be used for carrying out such tests and measurements (test signal / pattern generators) |
What does G01R NOT cover

- Measuring physical variables of any kind by conversion into electric variables
- Measuring diffusion of ions in an electric field, e.g. electrophoresis, electro-osmosis (G01N)
- Investigating non-electric or non-magnetic properties of materials by using electric or magnetic methods (G01N)
- Indicating correct tuning of resonant circuits (H03J3/12)
- Monitoring electronic pulse counters (H03K21/40)
- Monitoring operation of communication systems (H04)
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## Main Groups in G01R

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>G01R 1, 3</td>
<td>Constructional details, manufacture of testing and measuring instruments</td>
</tr>
<tr>
<td>G01R 5, 7</td>
<td>Converting voltage or current into a mechanical displacement</td>
</tr>
<tr>
<td>R01R9</td>
<td>Instruments employing mechanical resonance</td>
</tr>
<tr>
<td>G01R11</td>
<td>Electromechanical arrangements for measuring electric energy</td>
</tr>
<tr>
<td>G01R13</td>
<td>Displaying electric variables</td>
</tr>
<tr>
<td>G01R 15-29</td>
<td>Measuring electric variables</td>
</tr>
<tr>
<td>G01R31</td>
<td>Testing electric properties</td>
</tr>
<tr>
<td>G01R33</td>
<td>Measuring magnetic variables</td>
</tr>
<tr>
<td>G01R35</td>
<td>Testing or calibrating apparatus in G01R1-G01R33</td>
</tr>
</tbody>
</table>
Agenda

- Neighbouring fields
- What is classified in G01R
- Main Groups in G01R
- **Groups and examples in G01R 1-13**
  - Groups and examples in G01R 15-29 (Measuring)
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  - Example in G01R35 (Calibrating)
Groups and examples in G01R 1-13

**G01R1: Construction details**

- Housings
- Sockets (for test purposes)
- Measuring probes, probe needles
- Pointers, scales
- Arrangements with multiple probes
- Screening arrangements against electric or magnetic fields
Groups and examples in G01R 1-13

G01R1 Example

Probe Card

G01R1/06711: Probe needles
G01R1/0731: Intermediate card through which the probes pass
G01R31/2889: Interfaces between probe and tester

101 balls on wafer
102 wafer
120 circuit board
140 probe head
142 metal housing
144 pins
Groups and Examples in G01R 1-13
G01R5, G01R7: Converting current or voltage to **mechanical** displacement

Stepping motor for a meter (G01R7/06 + H02K)
Groups and examples in G01R 1-13

G01R11: Electromechanical arrangements for measuring time integral of power or current

- Conventional electricity meters
- Coils, armatures, bearings, counters
- Arrangements for avoiding or indicating fraudulent use
- Dynamo-electric motor meters

Electrical energy meter (G01R11/04)
Groups and examples in G01R 1-13
G01R13: Displaying electric variables or waveforms

- Oscilloscopes: triggering, sampling, software therefor etc.
- Representing measured value (e.g. in numerical form)

**Trigger Circuit**
(G01R13/0254)

**Displaying V / I / R**
(G01R1 + G01R13)
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Groups and examples in G01R 15-29 (Measuring)

G01R 15, 17, 19, 21-23, 25, 27, 29:
Measuring electric variables

<table>
<thead>
<tr>
<th>Code</th>
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<tbody>
<tr>
<td>G01R15</td>
<td>Devices used for the measurement (e.g. galvanomagnetic, electro-optical etc.)</td>
</tr>
<tr>
<td>G01R17</td>
<td>Comparison with a reference value (e.g. measuring bridge arrangements)</td>
</tr>
<tr>
<td>G01R19</td>
<td>Measuring currents or voltages</td>
</tr>
<tr>
<td>G01R21</td>
<td>Measuring electric power</td>
</tr>
<tr>
<td>G01R22</td>
<td>Measuring time integral of electric power (e.g. by electricity meters)</td>
</tr>
<tr>
<td>G01R23</td>
<td>Measuring frequency and frequency spectra</td>
</tr>
<tr>
<td>G01R25</td>
<td>Measuring phase angle between voltages and currents</td>
</tr>
<tr>
<td>G01R27</td>
<td>Measuring resistance, reactance, impedance</td>
</tr>
<tr>
<td>G01R29</td>
<td>Measuring other electric quantities</td>
</tr>
</tbody>
</table>
Groups and examples in G01R 15-29 (Measuring)

**G01R29: Measuring other electric quantities**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>G01R29/02</td>
<td>Measuring characteristics of individual pulses</td>
</tr>
<tr>
<td>G01R29/06</td>
<td>Measuring depth of modulation</td>
</tr>
<tr>
<td>G01R29/08</td>
<td>Measuring electromagnetic field characteristics</td>
</tr>
<tr>
<td>G01R29/10</td>
<td>Radiation diagram of aerials, antenna testing</td>
</tr>
<tr>
<td>G01R29/12</td>
<td>Measuring electrostatic fields</td>
</tr>
<tr>
<td>G01R29/22</td>
<td>Measuring piezo-electric properties</td>
</tr>
<tr>
<td>G01R29/26</td>
<td>Measuring noise figure, signal to noise ratio</td>
</tr>
</tbody>
</table>
Groups and examples in G01R 15-29 (Measuring)
Examples G01R 15-29: Measuring electric variables

Hall Effect current sensor
G01R15/202
Groups and examples in G01R 15-29 (Measuring)
Examples G01R 15-29: Measuring electric variables

Measuring frequency by converting it into a train of pulses G01R23/10
Groups and examples in G01R 15-29 (Measuring)
Examples G01R 15-29: Measuring electric variables

Detecting lightning activity G01R29/0842
Groups and examples in G01R 15-29 (Measuring)
G01R29/10: Antenna testing
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- **Groups and examples in G01R31 (Testing)**
- Groups and examples in G01R33 (Magnetic)
- Example in G01R35 (Calibrating)
| ✓ | Testing cables / conductors, locating electric faults |
| ✓ | Environmental, stress or reliability tests, e.g. burn-in |
| ✓ | Testing dielectric strength or breakdown voltage |
| ✓ | Testing individual semiconductor devices (transistor, diode, LED) |
| ✓ | Testing of electronic circuits, Wafers, PCBs |
| ✓ | Automated Test Systems (ATE) |
| ✓ | Integrated circuit testing, e.g. in-circuit test |
| ✓ | Testing of digital circuits (e.g. function, timing) |
| ✓ | Test signal or pattern generators, generating test patterns |
| ✓ | Testing electrical condition of batteries (e.g. capacity or charge) |
| ✓ | Testing of circuit interrupters, switches, electric machines |
Groups and examples in G01R31 (Testing)

What does G01R31 NOT cover

- Testing of A/D converters
- Testing displays
- Diagnostic testing of television systems
- Testing of engines, vehicles, aircraft systems
- Testing of computers, processors, microcontrollers
- Checking memories
- Computer-aided design, simulation
- Servicing or maintenance of battery cells
- Transmission systems for measured values
Groups and examples in G01R31 (Testing)

Examples G01R31

Monitoring effectiveness of insulation: partial discharge detection using acoustic measurements (G01R31/1209)
Groups and examples in G01R31 (Testing)

Examples G01R31

Evaluating MOSFET device (G01R31/2621)

START

FIG. 4

OBTAIN \( I_{ds} - V_g \) CHARACTERISTICS

\(~ S1 ~\)

SET CARRIER MOBILITY \( \mu \) AND GATE INSULATING FILM CAPACITY \( C_g \)

\(~ S2 ~\)

MEASURE VARIATION OF SOURCE-DRAIN CURRENT \( I_{sd} \)
FOR CONSTANT SOURCE-DRAIN VOLTAGE \( V_{sd} \)

\(~ S3 ~\)

MULTIPLY MEASURED VARIATION OF SOURCE-DRAIN CURRENT \( I_{sd} \)
BY INVERSE OF RATIO OF ON-TIME PERIOD TO ESTIMATE VARIATION OF SOURCE-DRAIN CURRENT \( I_{sd} \), WHEN ONLY ON VOLTAGE IS CONTINUOUSLY APPLIED

\(~ S4 ~\)

CONVERT ESTIMATED VARIATION OF SOURCE-DRAIN CURRENT \( I_{sd} \) INTO AMOUNT OF VARIATION \( \Delta V_t \) OF THRESHOLD VOLTAGE \( V_t \)

\(~ S5 ~\)

END
Groups and examples in G01R31 (Testing)
Examples G01R31

Automated test system (ATE) G01R31/2834

117 pogo tower
121 interconnect board
123 probe head
125 probe pins
127 wafer
129 chuck
Groups and examples in G01R31 (Testing)

Examples G01R31

Test program executor G01R31/319 (Tester hardware)
Groups and examples in G01R31 (Testing)

Examples G01R31

Scan chain G01R31/318533

FIG. 3
Groups and examples in G01R31 (Testing)
Examples G01R31

Battery monitoring G01R31/36
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Groups and examples in G01R33 (Magnetic)

G01R33: Measuring magnetic variables

- Magnetic sensors
- Flux concentrators, flux guides
- Housings e.g. against stray fields
- Measuring direction or magnitude of magnetic fields or flux
- Hall effect devices
- Magnetoresistive devices
- Measuring magnetic properties of solids or fluids
- Measuring super-conductive properties
Groups and examples in G01R33 (Magnetic)

**G01R33 examples**

Semiconductor substrate (1) having Hall elements (2) G01R33/07

1. Substrate
2. Hall elements
3. Protective film
10. Flux converging plate
11. Conductive layer
20. Resist
Groups and examples in G01R33 (Magnetic)

G01R33 examples

Measuring angular position
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Example in G01R35 (Calibrating)

G01R35: Testing or calibrating apparatus in G01R1-G01R33

Tester for electric energy meter
Thank you for your attention!