The 3166 CLAMP ON POWER HiTESTER provides clamp measurement of power lines from single-phase to three-phase four-wire circuits all in a single unit. In addition to the basic measurements including voltage, current, power, power factor, and integrated values, it is also capable of measuring demand, important for power management, and harmonics (option). Data can be transferred to a computer using the RS-232C interface or optional 3.5-inch floppy disk drive. Data can be saved as text files for easy handling and analysis.

Ideal for factory power supply maintenance, Model 3166 will be invaluable for improving where it is desired to improve energy-saving efficiency.
Compact Clamp on Power

Support for different power circuits
A single unit supports measurement of power lines from single-phase to three-phase four-wire circuits.

Wide range of measurement functions
The following can be measured simultaneously: voltage, current, active/reactive/apparent power, integrated power value, power factor, and frequency.

Demand measurement
Using the demand measurement mode, daily, weekly, and monthly reports can be generated.

Lead/lag discrimination for power factor
Indications of power factor and reactive power are signed to indicate leading or lagging.

Separate integration of opposite polarities
For integrated measurements, separate indications of opposite polarities are available: active power consumption/regeneration/sum, reactive power lag/lead/total, and so forth.

Support for measurement using personal computer
Efficient measurement, management, and analysis on a personal computer is possible when using the optional floppy disk drive unit and the standard RS-232C interface.

Compact unit: B5 book size, weighing 1.6 kg
The compact design makes this unit easy to carry, and ideal for operation in cramped surroundings.

Detection function to prevent wrong connections
The connection check screen recognizes disconnected wires, detects the phase, and can distinguish clamp sensors connected backwards, thus reducing measurement errors.

Support for reactive power measurement method
For the measurement of reactive power, there is a choice of reactive power measurement by a reactive power meter or by the active power calculation method based on the voltage, current, and active power.

High-speed D/A output
When the optional D/A output is installed, four channels of high-speed analog outputs are available.

Harmonics analysis for 3-phase lines
Harmonic components in the line being measured and their fluctuations can be monitored by using the optional harmonics analysis software.


**Meter Packed with Functions**

---

### Simple settings

All settings are carried out in conversational style, using the cursor keys and function keys.

#### Setting screen for demand measurement

<table>
<thead>
<tr>
<th>Mode</th>
<th>20.000A</th>
<th>50.000A</th>
<th>100.00A</th>
<th>200.00A</th>
<th>500.00A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a2W</td>
<td>3.0000kW</td>
<td>7.5000kW</td>
<td>15.000kW</td>
<td>30.000kW</td>
<td>75.000kW</td>
</tr>
<tr>
<td>1a3W</td>
<td>6.0000kW</td>
<td>15.000kW</td>
<td>30.000kW</td>
<td>60.000kW</td>
<td>150.000kW</td>
</tr>
<tr>
<td>3a3W</td>
<td>6.0000kW</td>
<td>15.000kW</td>
<td>30.000kW</td>
<td>60.000kW</td>
<td>150.000kW</td>
</tr>
<tr>
<td>3a4W</td>
<td>9.0000kW</td>
<td>22.500kW</td>
<td>45.000kW</td>
<td>90.000kW</td>
<td>225.000kW</td>
</tr>
<tr>
<td>1a2W</td>
<td>6.0000kW</td>
<td>15.000kW</td>
<td>30.000kW</td>
<td>60.000kW</td>
<td>150.000kW</td>
</tr>
<tr>
<td>1a3W</td>
<td>12.000kW</td>
<td>30.000kW</td>
<td>60.000kW</td>
<td>120.000kW</td>
<td>300.000kW</td>
</tr>
<tr>
<td>3a3W</td>
<td>12.000kW</td>
<td>30.000kW</td>
<td>60.000kW</td>
<td>120.000kW</td>
<td>300.000kW</td>
</tr>
<tr>
<td>3a4W</td>
<td>18.000kW</td>
<td>45.000kW</td>
<td>90.000kW</td>
<td>180.000kW</td>
<td>450.000kW</td>
</tr>
<tr>
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<td>12.000kW</td>
<td>30.000kW</td>
<td>60.000kW</td>
<td>120.000kW</td>
<td>300.000kW</td>
</tr>
<tr>
<td>1a3W</td>
<td>24.000kW</td>
<td>60.000kW</td>
<td>120.000kW</td>
<td>240.000kW</td>
<td>600.000kW</td>
</tr>
<tr>
<td>3a3W</td>
<td>24.000kW</td>
<td>60.000kW</td>
<td>120.000kW</td>
<td>240.000kW</td>
<td>600.000kW</td>
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<tr>
<td>3a4W</td>
<td>36.000kW</td>
<td>90.000kW</td>
<td>180.000kW</td>
<td>360.000kW</td>
<td>900.000kW</td>
</tr>
</tbody>
</table>

---

### Table of ranges

Ranges indicated in the shaded areas apply to Model 9298.

Note 1: The range table shows the full-scale indications for each measurement range.

Note 2: Measurement ranges for apparent power and reactive power have the units shown in the table (W) replaced by VA or var.

Note 3: An input of 0.4% or less of the measurement range produces an indication of zero.

Note 4: The display of measurement values is possible up to 130% of the measurement range, except for the 600 V range, where the limit is 100%.

Note 5: Model 9298 is designed to meet CAT III 300V safety standards for grounding voltage. For safety reasons, do not attempt to measure circuits containing voltage beyond this level.
Measurement screen gives clear indication of power use status

Instantaneous value display screen
Measurement is carried out continuously (if there are no waveform defects) by calculation on samples each equivalent to two AC cycles. The instantaneous value display follows the display update rate, and this data is displayed intermittently.

Min/Max value display screen
Minimum and maximum values are found from the cumulative set of samples obtained so far. This aids positive identification of transient waveform features such as power spikes.

First integration value display screen
This shows the active / reactive / apparent power consumption, and average values within a time interval.

Second integration value display screen
This shows details of the power values, including the consumption / regeneration / sum (lag/lead/total) power values.

Speedy power measurement and data processing with a personal computer
The data can be transferred to a personal computer, either via the RS-232C interface or by copying the data onto a 3.5-inch floppy disk, using the optional 9595 FDD UNIT. This approach can be expanded to make it possible to measure, tabulate and analyze data on energy conservation measures.
9556 HARMONIC ANALYSIS SOFTWARE, 9619-01 HARMONIC DATA ANALYSIS UTILITY

Analyze Harmonics Through a Power Line!

■ Analyze harmonics from all angles

This screen can display voltage and current waveforms that were sampled at 256 points per cycle.

Time series
This screen displays changes over time for up to four specified analysis items, from the beginning of time series measurement. This display clearly shows the fluctuating state of harmonics.

Bar graph
This screen can display the bargraph for the 1st through 40th harmonics, the total sum up to the 40th harmonic, and the total harmonic distortion.

Vector
This screen can display the vectors for the 1st through 40th harmonics, the total sum up to the 40th harmonic. This screen allows the user to understand the inflow and outflow of the harmonic waves of each order, and is useful for determining specific sources of harmonics.

■ 9556 Specifications (option)

9556 is designed to be installed and used in the 3166, with the optional 9595 FDD UNIT connected.

- Media: One 3.5-inch 2HD floppy disk (The 9595 FDD UNIT is required in order to be able to install the software.)
- Measurement range: Basic wave frequencies 45Hz to 66Hz, and 360Hz to 440Hz
- Measurement method: PLL synchronization
- Number of orders analyzed: Up to 40th harmonic (when base wave is 45Hz to 66Hz)
- Window width: 1 cycle (when base wave is 45Hz to 66Hz)
- Window type: Rectangular
- Amount of data analyzed: 256 points
- Accuracy:
  - Harmonic levels: at 50/60Hz:
    - 1st to 20th harmonic: ±0.5%rdg. ±0.2% fs, 21st to 40th ±0.9%rdg. ±0.3% fs
    - At 400Hz:
      - 1st to 4th harmonic: ±0.5%rdg. ±0.3% fs, 5th to 13th ±0.9%rdg. ±0.3% fs.
      - Add on the accuracy of the clamp-on sensor (current/power)
  - Harmonic wave power phase angle: at 50/60Hz: 1st to 3rd harmonic ±2˚, 4th through 40th harmonic ±0.3˚ (x+1˚),
    - At 400Hz: 1st to 13th harmonic ±2.0˚ (x+1˚)
  - Harmonic voltage/current level must both be at least 1% of the range; in the case of current/power, the accuracy of the clamp-on sensor is also added on. (k=order of harmonic wave)
  - Normal measurement: ±0.3%rdg. ± value in spec. for the 3166
  - Level of each order of harmonic, content of each order of harmonic, and phase angle of each order of harmonic for voltage / current/power
  - Total up to 40th (or 13th, at 400Hz) harmonic for voltage/current/power
  - Total harmonic distortion for voltage/current (THD-F and THD-R)
  - Normal measurement of voltage/current/active, reactive, or apparent power/power factor/base frequency
- Analysis items:
  - Approx. 6 seconds (for a 3-phase, 4-wire line)
  - A maximum of four of the analysis items can be selected.
  - 5 /10 /15 /30 /60 minutes / 2 hours/3 /4 /6 /8 /12 hours
  - Four of the analysis items can be selected (requires 9594 D/A output)
- Other functions:

■ 9619-01 Specifications (option)

9619-01 is computer software for analyzing and printing harmonic data that has been measured by the 9556 and saved on a 3.5-inch floppy disk.

- Supply Media: Two 3.5-inch 2HD floppy disks
- Operating: IBM PC/AT or compatible
- Environment: Windows95 (higher than SP1)/Windows98
- Data Display: Waveform/List/Graph/Time Series
- Included Functions: Cursor measurement/Enlargement by time series / Printing

- The optional 9595 FDD UNIT is required in order to be able to install the 9556.

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- The optional 9595 FDD UNIT is required in order to be able to install the 9556.
The Analytical Power to Resolve Problems

- Power factor and integration measurement values shown signed
  For site diagnosis, lead/lag power factor indications can be shown, and both individual and integrated consumption/regeneration power figures show the selling/buying relationship with the power company.

- Reactive power method can also be used for calculation
  For reactive power calculation, in addition to the existing calculation method, it is also possible to select the reactive power calculation method, whereby even an unbalanced load can be measured accurately.

**Calculation expression (for single-phase two-wire)**

- Voltage \( U = \sqrt{\frac{1}{M^2} \frac{1}{L_s} (I_s^2) \cdot s} \)
- Current \( I = \sqrt{\frac{1}{M^2} \frac{1}{L_s} (I_s^2) \cdot s} \)
- Active power \( P = \frac{1}{M^2} \frac{1}{L_s} (U_s \times I_s) \)

* For integrated values, in the demand measurement mode the output response time is approximately 1 second.

- High-speed D/A output for every two AC cycles (option, Specify at time order)
  When the optional 9594 D/A OUT is connected, any four of voltage, current, active power, reactive power, apparent power, power factor, frequency, and integrated power can be selected, and output as 5 V DC f.s. signals. In the normal measurement mode, the response is rapid, every two AC cycles, so that in combination with a HIOKI MEMORY HiCORDER for example, transient fluctuations can be recorded.

Example of D/A output

- Current waveform
- 3166 Current D/A output
- 3166 Power D/A output

Example of motor starting waveforms

ISO 14001 international environmental standard

- What is ISO 14001?
  Based on international environmental conventions, the International Organization for Standardization (ISO) established this standard for environmental management, promulgating ISO 14001, "Environmental Management System" and ISO 14011, "Environmental Monitoring Procedures" in September 1996. Facing the twenty-first century, industry must review its relation to the earth's resources.

- Principal international conventions
  - Ozone layer protection ... Montreal Protocol
  - Global warming ... Framework Convention on Climate Change
  - Acid rain ... Sofia Protocol
  - Oceanic pollution ... OPRC and other conventions
  - Shipment of hazardous waste across national frontiers ... Basel Convention
  - Biodiversity ... Convention on Biological Diversity

- Why are energy-saving measures required?
  One of the current number of environmental treaties is the Framework Convention on Climate Change, which establishes a legal basis for optimization of thermal and electrical energy. Therefore, in order to obtain ISO 14001 approval, industry must take energy-saving measures, and there will be concern over the method of managing this.

- Clamp on power meters essential for energy-saving measures
  A company’s power management requires an easy method of determining the pattern of energy use, and it is moreover important that measurements can be taken anywhere. A clamp-on meter allows measurements while lines are live, and in any location, thus being an essential item. The 3166 is of course a clamp-on unit, and also has a wide range of functions for efficient processing of a large quantity of collected data. It will thus be invaluable for attaining ISO 14001 compliance.

**Leading power factor \( - (\cos \theta_1) \)**

**Lagging power factor \( + (\cos \theta_2) \)**

Can be used to improve installation efficiency, by for example deriving the capacitance of a leading phase capacitor.

When using the reactive power calculation method

\[
\text{Reactive power } Q = \frac{1}{M^2} \frac{1}{L_s} (U_s \times I_s (s + \frac{M}{4}))
\]

The calculation for active power is made directly from the instantaneous values of voltage and current.

When not using the reactive power calculation method

\[
\text{Reactive power } SI Q = \sqrt{S^2 - P^2}
\]

The apparent power is found from the voltage and current values, and then the reactive power is derived.

\[
\text{Apparent power } S = U \times I
\]
### Basic specification

**Measurement line:** Single-phase two-wire, single-phase three-wire, three-phase three-wire, three-phase four-wire

**Measurement item:** Voltage, current, active power, reactive power, apparent power, integrated value, power factor, frequency

**Measurement range:** Voltage, current, and active power ranges according to the range table on page 2

**Measurement method:** Digital sampling method, phase-locked loop (PLL) synchronization, or 50/60/400 Hz fixed clock

**Input method:** Voltage Insulated input(s), Current Insulated input(s) using clamp-on sensor

**Effective input range:**
- 10% to 110% of range (only up to 100% for 600 V range, 2.5% or more for the 20 A range, however)

**Display indication range:**
- 0.4% to 130% of range (below 0.4% shown as zero)

**Rectification method:** RMS (true effective values)

**Sampling rate:** Approx. once per second (except when using floppy disk or RS-232C interface)

**Input impedance:** Voltage: 1.3 MΩ±10%. Current: 0.88±10% (50/60 Hz)

**Max permitted voltage:** Voltage: 600 V AC rms, 850 V peak value

**Max permitted current:** Current: 1 A AC rms, 1.42 A peak value

**Max in-phase voltage:** 600 V AC rms, 50/60 Hz

**Crest factor:** Voltage: 2 or less (f.s. input, except 1.41 or less in 600 V range), Current: 3 or less (f.s. input, except 2.84 or less in 500 A range)

**[Integrated value measurement]**

**Measurement range:**
- Active power ±0.000 Wh to ±999999 MWh
- Apparent power 0.000 VAh to 999999 MVAh
- Reactive power ±0.000 Wh to ±999999 MWh

**Timer setting range:** 10 seconds to 1000 hours (settable in 10-second steps)

**[Power factor measurement]**

**Measurement range:** ±1.000 (lead) to 0.000 to 1.000 (lag)

**[Frequency measurement]**

**Measurement range:** 40.00 to 500.00 Hz

**Input range:** 10% to 110% of range (except for 100% for 600 V range)

**Measurement source:** Voltage U1 or U1 (same as PLL synchronization)

**D/A output:** 9594 D/A OUT (option) required

**Configuration:** 12-bit D/A converter (sign + 11 bits) four channels

**Output item:** Any four from: voltage, current, active power, reactive power, apparent power, power factor, frequency, active power amount (consumption, regeneration, sum)

**Output voltage:** DC ±5 V (f.s. for ±0.5 output approx. ±6.6 V)

### Measurement accuracy

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Current</th>
<th>Active power</th>
</tr>
</thead>
<tbody>
<tr>
<td>±0.1% rdg.±0.2% f.s.</td>
<td>±0.1% rdg.±0.2% f.s.±clamp accuracy</td>
<td>±0.1% rdg.±0.2% f.s.±clamp accuracy</td>
</tr>
</tbody>
</table>

**Apparent power accuracy:** From all measurement values, ±1 dtg. for calculation

**Reactive power accuracy:** When using the reactive power measurement method

**Integration accuracy:** For each of active power, reactive power, and apparent power, measurement accuracy ±1 dtg.

**Power factor accuracy:** From all measurement values, ±1 dtg. for calculation

**Frequency characteristics:** With fundamental frequency 45 Hz to 66 Hz, up to 50th harmonic, ±3% f.s. ± measurement accuracy

**In-phase voltage influence:** Within ±0.2% f.s. (600 V rms, 50/60 Hz, between shorted voltage input terminals and case)

**External magnetic field influence:** Within ±1.5% f.s. (in magnetic field 400 A/m snm, 50/60 Hz)

**Power factor influence:** ±1.0% rdg. (45 Hz to 66 Hz, power factor = 0.5, using active power measurement)

**Real-time accuracy:** ±0.25 ppm ±1 second (at 25°C)

### General Specification

**Location for use:** Indoors, altitude up to 2000 m

**Operating temperature and humidity ranges:** 0°C to 40°C, 80% rh or less, no condensation

**Insulation resistance:** At least 100 MΩ at 500 V DC

**Withstand voltage:** 5.55 kV AC Voltage input connectors - casing, 3.25 kV AC Voltage input connectors - current input connectors, output connectors, external interface connectors, casing

**Power supply:** 100 to 240 V AC ±10% 50/60 Hz

**Power supply maximum rated power:** 33 VA max.

**Dimensions and mass:** Approx. 246W × 176D mm; approx. 1.6 kg (including 9594 D/A OUT)

**Supplied accessories:** 9438 VOLTAGE CABLE (1 set), (including 9595 FDD UNIT (option) required), Save/load function for settings, save function for measurement values, measurement value output function (direct connection to printer), floppy disk formatting function (MS-DOS format, file renaming and deletion function)

**Applicable standards:**
- (Voltage measurement unit) Pollution degree 2 overvoltage categoryB
- Aircraft transients transient overvoltage 6000 V
- (Power supply) Pollution degree 2 overvoltage category II
- Power supply: 100 to 240 V AC ±10% 50/60 Hz
- (Power supply) Power consumption 1.2 A
- (Power supply) Power consumption 1.2 A
- (Power supply) Power consumption 1.2 A
- (Power supply) Power consumption 1.2 A
Measurement is not possible with the 3166 alone. Order the 9291 or 9298 CLAMP ON SENSOR required for measurement.

**Example combinations**
- Single-phase two-wire: 3166 + (9291 or 9298) X1
- Three-phase three-wire: 3166 + (9291 or 9298) X2
- Three-phase four-wire: 3166 + (9291 or 9298) X3

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**9442 PRINTER**

- **Printing method**: Thermal serial dot matrix
- **Paper width**: 112 mm
- **Printing speed**: 52.5cps
- **Power supply**: 9443 AC ADAPTER or supplied nickel-hydride battery (capable of printing about 3000 lines on full charge from 9443)

Dimensions and mass:
- 486 mm MAX. x 155 mm x 42 mm, approx. 740 g

When ordering the 9442 PRINTER, also order the 9444 CONNECTOR CABLE required for connection to the 3166 and 9443 AC ADAPTER.

**9444 CONNECTOR CABLE**

- **Cord length**: approx. 1.5 m

**9443 AC ADAPTER**

- **Cord length**: approx. 3 m

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**3166 CLAMP ON POWER HI-TESTER**

Measurement is not possible with the 3166 alone. Order the 9291 or 9298 CLAMP ON SENSOR required for measurement.

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**9595 FDD UNIT**

- **Supported media**: 3.5-inch 2HD (1.2/1.44 Mbyte)
- **Format**: MS-DOS
- **Power supply**: Supplied from 3166
- **Dimensions and mass**: Approx. 240 g (excluding cables and projections)
- **Data saved**: Settings and measurement data saved
- **Operating temperature and humidity ranges**: 5°C to 40°C, 80% rh or less, no condensation

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**9383 CARRYING CASE**

Holds the main unit and 9291 CLAMP ON SENSOR. Measurement is also possible while still in the carrying case, and screen indications can be checked. This case is handy for protection from dust and oil.

- **Material**: Soft vinyl "leather-style"
- **Dimensions**: Approx. 45W X 140H X 340D mm; approx. 2.3 kg

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**9619-01 HARMONIC DATA ANALYSIS UTILITY**

**9556 HARMONIC ANALYSIS SOFTWARE**

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**9383 CARRYING CASE**

- **Material**: Soft vinyl "leather-style"
- **Dimensions**: Approx. 45W X 140H X 340D mm; approx. 2.3 kg

---

**9440 CONNECTOR CABLE**

- **Cord length**: approx. 2 m
- **One end left cut**: approx. 1.5 m

**9441 CONNECTOR CABLE**

- **Cord length**: approx. 2 m
- **One end left cut**: approx. 1.5 m

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**3166 CLAMP ON POWER HI-TESTER**

**Option**

- **9291**: CLAMP ON SENSOR (500A AC)
- **9298**: CLAMP ON SENSOR (100A AC)
- **9554**: D/A OUT (Include 9441 CONNECTOR CABLE)
- **9595**: FDD UNIT
- **9556**: HARMONIC ANALYSIS SOFTWARE
- **9619-01**: HARMONIC DATA ANALYSIS UTILITY
- **9383**: CARRYING CASE
- **9440**: CONNECTOR CABLE (For External control)
- **9441**: CONNECTOR CABLE (For D/A output, supplied with 9594)
- **9442**: PRINTER
- **9443-01**: AC ADAPTER (For printer, Japan)
- **9443-02**: AC ADAPTER (For printer, EU)
- **9443-03**: AC ADAPTER (For printer, America)
- **9444**: CONNECTOR CABLE (For printer)
- **9290**: CLAMP ON ADAPTER (1500A AC)
- **1196**: RECORDING PAPER (For printer, 10 rolls)

*Not conformable with the CE marking.*