Digital Voltmeter

type 2432

FEATURES:

- IEEE 488/IEC 625–1 digital interface
- AC measurements in mV, V, dBV, dBμV, dBm, or dB relative to a user-selected reference voltage
- True RMS and Peak response from 2 Hz to 500 kHz
- AC ranges from 1,999 mV full-scale to 199,9 V, DC ranges from ±19,99 mV full scale to ±199,9 V
- Automatic range selection with manual override
- DC Output proportional to AC log, AC lin. or DC measurements for Level Recorders, FM Tape Recorders etc.
- Built-in voltage reference for self-calibration
- Range of Special Functions extends measurement capabilities
- Analogue circuits optically isolated from digital circuits for improved signal-to-noise ratio

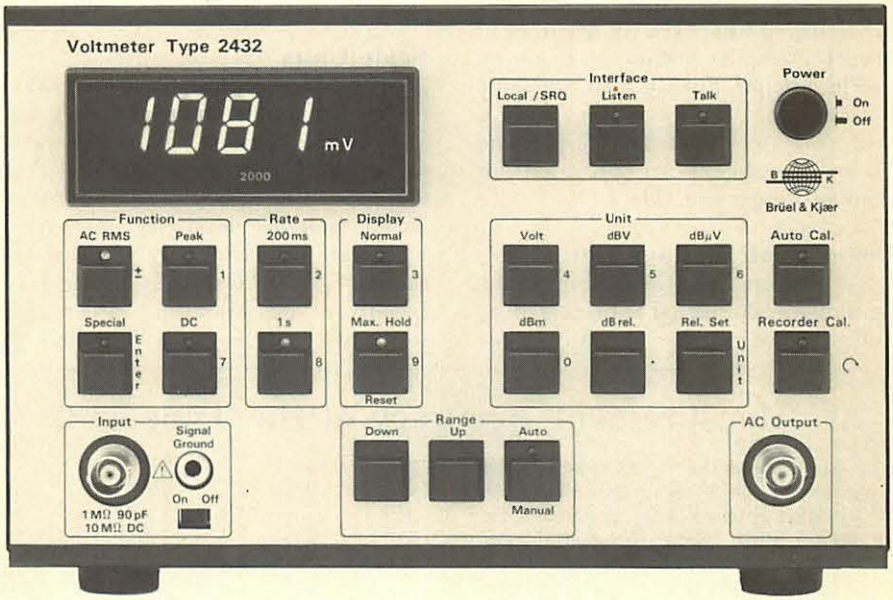
USES:

- Multi-function Voltmeter
- IEEE 488/IEC 625–1 bus-based test and measurement systems
- Electro-acoustic and electronic testing and measurement
- Frequency response analysis systems
- Calibrated AC amplifier with line level output for tape recorders and other measuring instruments
- Special measurement requirements–data logging, go/no-go testing etc.

The Type 2432 Voltmeter is a versatile and easy-to-use instrument with simple keystroke selection of a wide range of standard and special functions. Frequency response is linear from 2 Hz to 500 kHz, and logarithmic voltage detection circuitry gives high-resolution measurement throughout a wide dynamic range. Auto-calibration against a high-stability internal reference voltage ensures consistently high accuracy.

The low (screen) side of the 2432's input can be disconnected from ground, breaking noise-generating ground loops in the signal path and improving measurement accuracy.

The IEEE/IEC interface gives full remote control of the 2432 and allows external processing and recording of measurements. Integrated and automated test and measurement systems can be assembled using the 2432 with other bus-compatible instruments.



The Type 2432 Voltmeter is designed both for stand-alone use with straight-forward front panel control and for system use with its IEEE 488/IEC 625–1 interface. It measures true RMS and Max. Peak voltage of AC signals from 2 Hz to 500 kHz. AC measurements can be scaled linearly (V or mV), or in decibels relative to 1 V, 1 μV, 0,775 V (for dBm) or to a user-selected reference voltage. DC measurements are displayed in volts or millivolts with indication of positive or negative polarity. The automatic range selection is provided with manual override.

A range of Special Functions add facilities for analogue processing of the input signal, digital data processing, and storage and recall of measurement samples. Operating parameters for the Special Functions are entered using the front-panel pushkeys.

All switch settings, Special Functions and IEEE interface parameters are stored in a continuous memory when the 2432 is switched off, keeping it ready for instant use. When power is re-applied, the 2432 is automatically reset to the condition it was in immediately before being switched off. The continuous memory is powered by long life Ni-Cd cells which are automatically recharged while the instrument is operating.

Input Amplifier

Ground Loop Elimination

To eliminate ground loops from the input to the 2432, the screen (low side) of the input socket can be disconnected from the internal signal ground. The common-mode voltage rejection between the screen and signal ground is better than 50 dB, with a common-mode voltage range of ±0,1 V (limited by an internal safety link).

Analogue/Digital Isolation

The signal ground line can be isolated from the digital-chassis ground line to prevent ground loops in bus-connected measurement systems. In normal use a rear panel link connects the signal ground line to the digital-chassis ground. To eliminate ground loop problems this link can be removed, giving a common-mode voltage rejection between chassis and signal ground of 120 dB.

Auto-Ranging

The 2432's auto-ranging facility automatically switches the AC amplifier range to ensure that the output signal is between 0,1 V and 1 V RMS, or from 5% to 50% of full-scale. This is the region where the AC accuracy of the 2432 is at its maximum, as shown in Fig. 1 below. For DC measurements auto-ranging occurs at full-scale input and 9% of full-scale. "Up" and "Down" pushkeys are provided for manual Range selection.

Logarithmic Voltage Detector

To measure AC RMS voltages, the amplified input signal is processed by a logarithmic rectifier with a dynamic range of 46 dB, followed by an integrator circuit. Peak measurements are made by feeding the log-rectified signal to an analogue peak hold circuit. At the end of the measurement period (set by the Rate pushkeys) the integrator output is converted to digital form and the integrator is reset. After processing in the digital circuits (for display scaling, Special Functions etc.) the measurement is output on the display, the DC Output and the interface bus. This process results in a true RMS output for most commonly encountered AC signals including complex waveforms.

Display

The 2432's 3½-digit display is easily read even in high ambient light and has a wide viewing angle. Apart from indicating the measurement, the display also gives the gain setting of the Input amplifier in terms of the full-scale voltage, the Units in which the display is scaled, and over- or under-range signals in the amplifier. When the 2432 is being controlled via the IEEE/IEC interface, "Rem" is indicated in the bottom right of the display.

Scale Units

AC RMS and Peak measurements can be displayed with linear scaling, in volts or millivolts, or logarithmic scaling in decibels relative to 1 V, 1 μV, 0,775 V (1 mW in 600 Ω) or a user-selected reference level. DC measurements are displayed only with linear scaling. The DC Output is also scaled linearly or logarithmically according to the selected display scale units.

Display Modes

Two display modes are provided. In "Normal" mode the display is updated with the new voltage at the end of each measuring period. With "Max. Hold" selected the maximum voltage measured is displayed continuously and the display is updated only when a new maximum is measured.

Rate

The Rate pushkeys select the rate at which the display is updated — one or five times a second — and hence the period over which the detected voltage is integrated, 1 s or 200 ms. The low-frequency response of the amplifier is also affected by the Rate setting, as illustrated in Fig. 1.

Auto Calibration

A built-in high accuracy reference voltage source allows the measurement function in use — AC RMS, Peak or DC — to be calibrated at any time by pressing the Auto Cal. pushkey on the front-panel. More versatile control of calibration is provided by the Special Functions or under IEEE/IEC bus control.

AC & DC Outputs

AC Output

The AC Output sockets on the front and rear panels provide a calibrated, line-level output of AC input signals for external measuring and recording equipment. The output level is typically 0,1 V to 1 V RMS when the amplifier is auto-ranging; full-scale output is 2 V RMS.

AC Measurement Accuracy of the Type 2432

Fig. 1 shows the typical frequency response of the 200 mV range of the AC amplifier in terms of %-error versus frequency. With "Rate" (integration period) set to 1 s the amplifier has an extended low-frequency response, within ±0,25% down to 25 Hz and within +0,25%, –6% at 2 Hz.

The diagram shows the frequency response for input levels within the auto-range region of the amplifier — i.e., from 5% to 50% of the full-scale voltage (10 mV to 100 mV RMS in the 200 mV range). The auto-range feature ensures that the amplifier is always operating in this region by switching to the next gain range when the signal level is outside these limits. The frequency response for signal levels outside the auto-range region is detailed in the Specifications section of the Product Data.

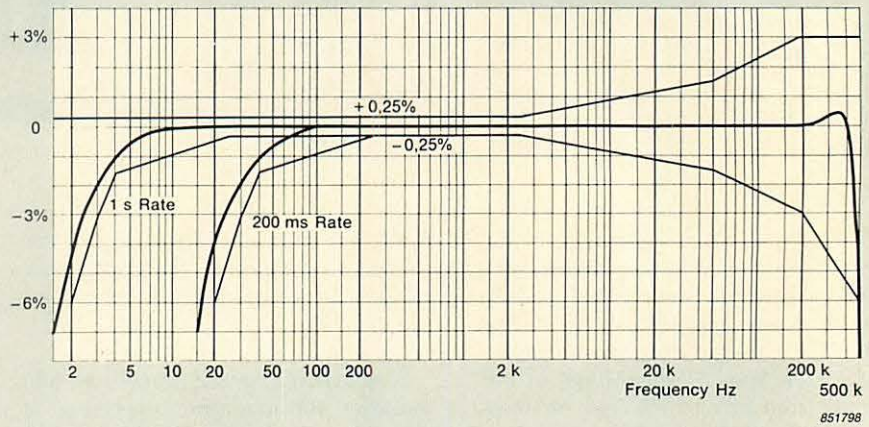


Fig. 1. Typical frequency response of the Voltmeter (AC measurements) for signals within the auto-range region (5% to 50% of full-scale). The light lines show the maximum errors occuring in the 200 mV range; the frequency response in all other ranges is within ±0,25% of that in the 200 mV range

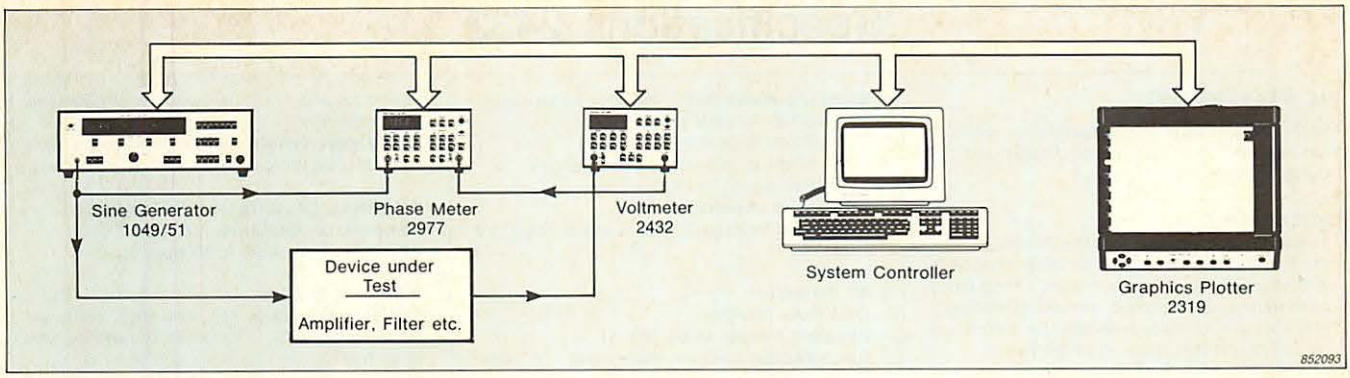


Fig. 2. The 2432 in a typical IEEE interface bus sytem, measuring gain and phase characteristics of an amplifier or similar circuit. Results can be presented on the System Controller's screen or as hard copy on the Type 2319 Graphics Plotter

DC Output

The digitally generated DC Output is derived from the displayed AC RMS, Peak or DC measurement and is scaled according to the displayed Unit — volts or decibels. The full-scale DC Output for AC linear measurements is 10 V. With decibel scaling selected, the DC Output range is 0,4 V to 9,6 V at 200 mV/dB. Selecting High Resolution dB rel. measurement gives an output of 0,6 V to 9,4 V at 400 mV/dB.

When the 2432 is measuring DC voltage the DC Output is centred at +5 V; 0 V output corresponds to negative full-scale and 10 V output corresponds to positive full-scale.

Interface Bus (IEEE)

The 2432's IEEE–488 standard interface has full Talker (T 5) and Listener (L 3) capability for remote control of all instrument functions, including the Special Functions, and remote recording of measurements and status information. "Talk" and "Listen" pushkeys allow data transfers in systems operating without a System Controller. The "Local/SRQ" pushkey re-asserts front-panel control after remote operation; when the 2432 is under Local control it generates a bus "SRQ" (Service Request).

A typical interface-bus-based measurement system is illustrated in Fig. 2, where the 2432 is illustrated in conjunction with the Type 2977 Phase Meter and the Type 1049 or 1051 Signal Generator. Measurement results can be stored and presented in a variety of ways; here, the Type 2319 Graphics Plotter is shown as an example of a suitable output device.

Bus Address

The interface bus address is set using one of the Special Functions. As with all other instrument settings, the address will be retained in the continuous memory when the 2432 is switched off.

Special Functions

The Special Functions of the Type 2432 add a range of operational and data-processing facilities, making it an exceptionally powerful and versatile instrument. Special Functions can be selected using the numbered pushkeys on the front panel or via the IEEE interface. A Quick Reference Guide with brief details of the Special Functions and their parameters is supplied with the 2432.

The following are some of the Special Functions included in the 2432:

Exponential Averaging. An exponential (time-weighted) average with a time constant equal to twice the front-panel Rate setting can be selected, instead of the normal linear integration.

Block Average. The display is updated after a user-selected number of measurements (up to 1999) have been recorded to indicate the mean value of the sample block.

Running Average. A "walking window" function, averaging the current measurement with up to 49 previous measurements and displaying the result after each measurement. Window length is user-selected.

Go/No-go Indication. With upper and lower limits entered, threshold crossing is indicated by the Over-/Underrange arrows on the display and by a logic signal (TTL compatible) at the rear-panel Ext. Trigger socket.

High-Resolution Decibel Display. Measurements in dB rel. can be displayed with 0,01 dB resolution, within a range of ±11 dB.

Data Storage and Recall. Up to 1024 measurements are stored, with preset variable delay between measurements. Recall facilities allow selection of Next or Previous, First or Last, Maximum or Minimum measurement; display of mean value of measurements, continuous sequential display of record.

Auto-Calibration. The 2432 is fully calibrated against its built-in high stability voltage reference in approximately 8 s.

The Special Function format is also used to set parameters associated with the IEEE/IEC Interface.

External Trigger

The rear-panel External Trigger input is TTL compatible. It is used with a number of Special Functions to start individual measurements or measurement sequences in response to an external stimulus. The Ext. Trigger socket includes +5 V and Chassis (Digital Ground) connections. The same 8-pin DIN socket also incorporates the following connections:

Threshold. A TTL-compatible output triggered by threshold crossings occuring when the Go/No-go Special Function is selected.

Detector out. HI (signal) and **LO** (signal ground). Output of the Log. Voltage Detector; when Exponential Averaging (Special Function) is selected, the Detector output voltage is a DC level instantaneously proportional to the RMS input with an averaging time-constant equal to twice the Rate switch setting. The output voltage range is ±4,6 V with a scale of 200 mV/dB (400 mV/dB in the High Resolution mode). It is not corrected for errors during Auto-Calibration of the voltmeter.

Specifications 2432

AC MEASUREMENT:

RMS or Peak voltage measurements with linear or logarithmic scaling of display and DC output, and linear AC output

ACCURACY:
The figures given apply to the 200 mV range; the frequency response in all other ranges is within ±0,25% of these values. Frequency bandwidths are quoted for measurements made at the 1 s Rate with the low frequency cut-off at 200 ms given in parentheses
5% to 50% of full scale:
Max. errors as a percentage of the indicated measurement
±0,25%, 25 Hz (250 Hz) to 2,5 kHz
±1,5%, 4 Hz (40 Hz) to 50 kHz
±3%, 3 Hz (30 Hz) to 200 kHz
(Add 3,2% to the above figures for Peak measurements)
+3%, –6%, 2 Hz (20 Hz) to 500 kHz
(+12%, –15% for Peak measurements)
Accuracy figures are relative to the internal calibration reference, and are valid after auto-calibration and in a stable environment ($\Delta T < 1K$)

Typical accuracy above 50% of full scale:
±2,5%, 4 Hz (40 Hz) to 50 kHz
±5%, 3 Hz (30 Hz) to 200 kHz
±7%, 2 Hz (20 Hz) to 500 kHz
Typical accuracy, 1% to 5% of full scale:
±3,5%, 4 Hz (40 Hz) to 50 kHz
±5%, 3 Hz (30 Hz) to 4 Hz (40 Hz)
±7%, 2 Hz (20 Hz) to 3 Hz (30 Hz)
±6%, 50 kHz to 200 kHz
±12%, 200 kHz to 500 kHz

Voltage Measurement Ranges: six ranges, 1,999 mV to 199,9 V full-scale in steps of 20 dB (10:1 ratio) ± 0,25%
Resolution, Voltage Measurements: better than 0,25% of range

Decibel measurement ranges:
dBV: relative to 1 V, –94,0 dB to +46,0 dB
dBμV: relative to 1 μV, +26,0 dB to +166,0 dB
dBm: relative to 0,775 V (1 mW in 600 Ω), –91,8 dB to +48,2 dB
dB rel.: relative to a user selected reference voltage
Resolution, dB measurements: 0,1 dB — may be increased to 0,01 dB using the High Resolution Special Function with dB rel.

Noise: less than 20 μV RMS, 80 μV peak, at max. gain with input short-circuited

AC Amplifier:
Input Impedance: 1 MΩ//90 pF
Max. Input Voltage: 350 V (DC + peak AC); 250 V DC or 220 V AC RMS 50/60 Hz
At higher frequencies, $V_{max}=10^7/f(Hz)$
Signal Ground/Input Socket Screen Separation:
Impedance: 4 kΩ//1 μF
Common Mode Voltage Rejection: >50 dB at 50/60 Hz
Common Mode Range: ±0,1 V (DC + peak AC; diode-clamped)
Signal Ground/Chassis Separation:
Common Mode Voltage Rejection: >120 dB at 50/60 Hz
Common Mode Range: ±42 V (to comply with IEC 348)
Gain: +60 dB in 2 mV range to –40 dB in 200 V range, six ranges in steps of 20 dB ±0,02 dB
Signal-to-Noise Ratio, 300 kHz bandwidth:
>60 dB in 2 mV range
>75 dB in 20 mV range
>80 dB in 200 mV to 200 V ranges
(peak signal to RMS noise)
AC Output Impedance: 50 Ω
AC Output Voltage: 2 V ±1% at full-scale, 5 V peak (max.)

AC Detector:
True RMS detector
Dynamic Range: 46 dB (200:1)
Crest Factor: (measurement error <0,5 dB)
8 dB (2,5:1) at full-scale
14 dB (5:1) at full-scale –6 dB
30 dB (32:1) at full-scale –26 dB
Linear Integration: integration times 10 ms, 200 ms, 1 s
Exponential Averaging: effective averaging times 20 ms, 400 ms, 2 s (2 × "linear" integration time)
Peak Detector: captures max. peak (positive or negative) in 10 ms, 200 ms or 1 s period
Response Rate: 5 dB/μs
Droop (Leakage) Rate: <0,1 dB/s at 25°C

DC MEASUREMENT:

Five voltage ranges from 19,99 mV to 199,9 V full-scale

ACCURACY:
20 V, 200 V Ranges: ± (0,05% of reading + 0,1% of range)
200 mV, 2000 mV Ranges: ± 0,1% of range
20 mV Range: ± 0,4% of range (±80 μV)
Max. Error, DC to 14 Hz: –0,5 dB (–6%) with source resistance ≤1 kΩ
Accuracy figures are relative to the internal calibration reference, and are valid after auto-calibration and in a stable environment ($\Delta T < 1K$)
Resolution: better than 0,1% of range

DC Amplifier:
Input Resistance: 10 MΩ ±1%
Signal Ground/Input Socket Screen Separation:
Impedance & Common Mode Range: As for AC Amplifier
Common Mode Voltage Rejection: CM signals within the CM voltage range have no influence on DC measurements
Signal Ground/Chassis Separation:
CM Range & Rejection: As for AC Amplifier
Normal Mode Rejection: >30 dB at 50(60) Hz ±0,5%

DC OUTPUT:
Digital-to-analog conversion of displayed measurement; linear response with DC or AC volt display, log. response with AC dB display. Updated at the same rate as the display
DC Output Impedance: 50 Ω
Output Voltage:
AC, linear: 0 V to +10 V (full-scale)
AC, log: +0,4 V to +9,6 V at 200 mV/dB
High Resolution dB rel. +0,6 V to +9,4 V, 400 mV/dB
DC: 0 V (negative full-scale) to +10 V (positive full-scale), centred at +5 V
Resolution: 10 mV

AUTO-RANGING:
AC Trigger Levels: Switches to next gain range at 5 dB below full-scale (voltage indication 1122) and 27 dB below full-scale (voltage indication 89)
DC Trigger Levels: Switches to next range when display indicates 180 or 1999 (full-scale)

INTERNAL CALIBRATION REFERENCE:
Temperature Stability: ±50ppm/°C
Absolute Accuracy: ±500ppm at 25°C

IEEE INTERFACE:
Conforms with IEEE Std. 488–1978, compatible with IEC 625–1. Provides remote control of all front-panel functions and Special Functions except Signal Ground and Power switches. Output of measurement data and status information
Functions Implemented:
Talker — T 5
Listener — L 3
Remote/Local — RL 1
Device Trigger — DT 1
Device Clear — DC 1
Service Request — SR 1
Address: Set to 22 (decimal) on delivery; can be altered using Special Function

ENVIRONMENTAL LIMITS:
Operating Temperature: +5°C to +40°C (41°F to 114°F)
Storage Temperature: –25°C to +70°C (–13°F to +158°F)
Humidity: 90% RH non-condensing at 40°C

EXTERNAL MAGNETIC FIELD:
80 A/m, 50 Hz external magnetic field will typically introduce less than 30 μV AC RMS noise (2 mV range, short-circuit Input)

ELECTROMAGNETIC INTERFERENCE:
Complies with US FCC requirements for Class B computing devices

POWER SUPPLY:
100; 115; 127; 200; 220; 240 V AC 50-60 Hz, 25 VA — Complies with Safety Class II of IEC Publication 348

DIMENSIONS:
Metal cabinet, excluding connectors and feet
Height: 133 mm (5,3 ins)
Width: 210 mm (8,3 ins)
Depth: 200 mm (7,9 ins)

WEIGHT:
3,7 kg (8,2 lb)

ACCESSORIES INCLUDED:

Mains Cable	AN 0020
4 mm Plug (2)	JB 0002
BNC Plugs (2)	JP 0035
8-pin DIN plug	JP 0808
IEEE–488 connector kit	UA 0814
Fuses T160 mA (2)	VF 0051
Fuses T316 mA (3)	VF 0042
Quick Reference guide (Special Functions)	QH 0022

ACCESSORIES AVAILABLE:

BNC–BNC Cable	AO 0087
IEEE 488 Interface Cable (2 m)	AO 0265
25-pin IEC 625–1 to IEEE 488 Interface Cable (2 m)	AO 0264
Adaptor to convert IEEE 488 instrument to 25-pin IEC 625–1	AO 0195