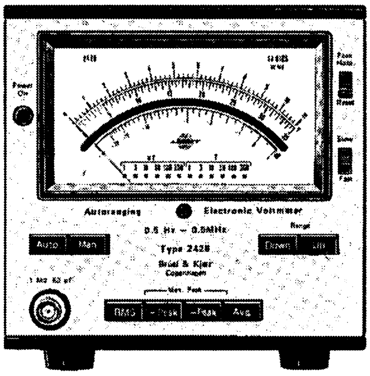
2426

Instruction Manual



Autoranging Electronic Voltmeter Type 2426

A mains operated precision instrument measuring RMS, Average, + Peak, − Peak, or Max. Peak (with Hold in the Peak modes) voltage levels from 100 μV to 350 V in the 0,5 Hz to 500 kHz range. Range selection may be made automatically or manually. Provision is also made for external range control or readout by a BCD signal, and connection of external meter time constants.

BRÜEL & KJÆR

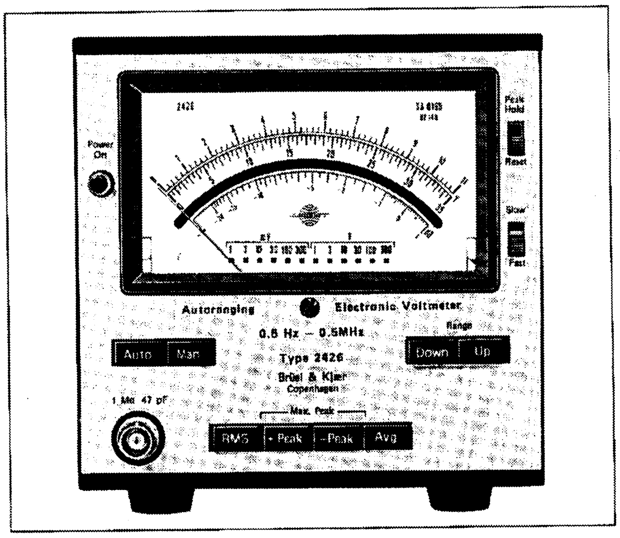
AUTORANGING ELECTRONIC VOLTMETER
TYPE 2426

November 1973

CONTENTS

Autoranging Electronic Voltmeter

FEATURES:
- True RMS, Average and Peak indication
- Linear frequency range from 0.5 Hz to 500 kHz
- Sensitivities from 1 mV to 300 V (full scale defl.)
- Automatic selection of correct range
- Calibrated amplification 60 dB
- AC and DC outputs
- BCD output with range information
- BCD input for external range selection
- Hold function for Peak measurement
- Provision for variable meter time constant
- Two built-in meter time constants
- Interchangeable meter scales



USES:
- Voltage measurement of + Peak, −Peak, Max. Peak, true RMS and Average values
- Calibrated amplifier
- General purpose EVM
- VU measurements

The Autoranging Electronic Voltmeter Type 2426 is a small size, general purpose voltmeter for indication of + Peak, −Peak, Max. Peak, true RMS and Average value of signals which makes it well suited for measurements on signals with complex waveforms. A Peak Hold function is included for measurement on impulse signals.

The operation of the instrument is extremely fast and easy as it is only necessary to select the mode of operation. In the "Auto" mode the instrument selects the correct range according to the input signal automatically. The selected range is indicated on the meter of the instrument as well as information hereof being available at a socket at the rear of the instrument in the form of an 8-4-2-1 BCD signal. In the "Manual" mode the range may be selected manually by push buttons "Down-Up" or it may be controlled remotely by a BCD signal.

The amplification of the instrument is calibrated and adjustable in 10 dB steps which makes it suitable for use in various set-ups where a calibrated amplifier is needed. For this purpose linear AC and DC outputs are available. The instrument is built into a cabinet of the B & K Modular Casette System enabling easy combination with other instruments and mounting in racks.

Description

As can be seen in Fig.1 the signal to be measured enters the 2426 at the input and passes through several attenuators and amplifiers which by appropriate combination of amplification and attenuation give the different sensitivity ranges. From the last amplifier the signal is led to the AC output and to the buffer amplifier and on to the rectifier circuit directly as well as via an inverter. This circuit has six operational modes which are selectable from the front panel. The modes are: "+ Peak", "−Peak", "Max. Peak", "Peak Hold", "RMS" and "Average".

The circuit provides correct RMS and Average values of signals with complex waveforms up to a crest factor of 5. The circuit features the possibility of varying the time constant by connecting external condensers which makes it well suited for measurement on narrow band random noise.

From the rectifier the signal is fed to the meter and the DC output terminal. Two meter dampings "Fast" and "Slow" can be selected. The "Fast" is in accordance with the standards for VU measurements and the "Slow" is intended for measurements on low frequency signals and signals with varying level.

The DC output signal is also fed to the autoranging section which consists of a mode selector circuit for the Man./Auto mode, a Down/Up range shift circuit, a comparator and logic circuit, a Down/Up counter which provides the BCD signal representing the chosen range for the BCD Data output socket, a Range indicator circuit which drives the range indicator lamps in the meter and a relay control circuit which in turn controls the attenuators to give the correct measuring range.

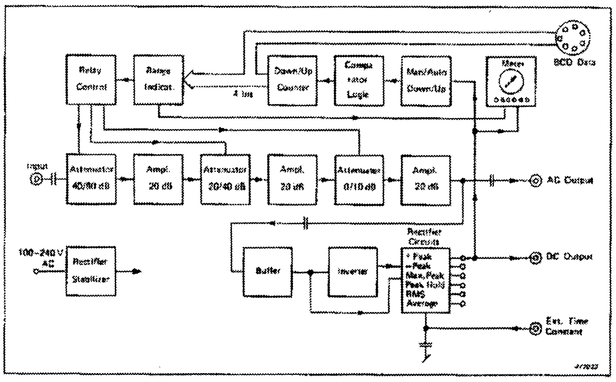


Fig. 1. Block Diagram of Type 2426

Specifications 2426

Voltage Range:
1 mV to 300 V full scale deflection

Scale Ranges:
0 to 3.5 V and 0 to 11 V.
In "Auto" mode the range shift occurs at approx. 2.5 V and 10 V. A certain "hysteresis" is built-in to secure stable reading in the shift areas

dB Range:
−80 dB to 50 dB; referred to 1 V

dBm Range:
−80 dBm to 52 dBm; referred to 0.775 V (1 mW in 600 Ω)

Input Impedance:
1 MΩ//47 pF (in all ranges)

Frequency Range:

	0.5 Hz – 2 Hz	2 Hz – 20 Hz	20 Hz – 0.2 MHz	0.2 MHz – 0.5
Fast	//////	//////	± 0.2 dB	± 0.5 dB
Slow	± 0.5 dB	± 0.2 dB		± 0.5 dB

Indication:
RMS: True reading of signals with crest factors up to 5
Averaging time,
fast: ≃ 270 ms
slow: ≃ 3 s
External condenser: 1 s per 2.5 μF

Peak: + Peak, −Peak, Max. Peak and Peak Hold Functions selectable on front panel

Time constants in Peak mode:

Fast	
Rise time constant	Discharge time constant
Reset < 50 μs Hold < 50 μs	2.7 s < 0.05 dB/s

Slow	
Reset < 500 μs Hold < 500 μs	30 s < 0.005 dB/s

External reset via socket on rear panel
External time constant and rise time via socket on rear panel

Average:
Fast (according to standards for VU measurements)
Slow

Rectifier Characteristics:
Dynamic range > 40 dB
Accuracy:
+ 10 dB to −20 dB: ± 0.5 dB.
−20 dB to −30 dB: ± 1 dB

Reset Function:
Manual by knob on front panel or automatic via socket on rear panel

Amplification:
60 dB to −50 dB in 10 dB steps

Attenuator Accuracy:
Better than 1%

Meter Scale Accuracy:
Better than 1% at full scale deflection

Signal Outputs:
AC:
1 V ± 2% for full scale deflection
Output impedance ≃ 100 Ω

DC:
1 V ± 2% for full scale deflection
Output impedance ≃ 10 Ω

BCD Data Socket:
Output: 8-4-2-1- BCD signal with range information
Input: BCD signal for external range control

Signal to noise ratio:
10 mV to 300 V > 60 dB
3 mV > 50 dB
1 mV > 40 dB

Power Supply:
AC:
100 V to 240 V, 50 to 400 Hz, 9 W

Dimensions (KK 00 24 cabinet):
Height: 132.6 mm (5.2 in)
Width: 139.5 mm (5.5 in)
Depth: 200.0 mm (7.9 in)

Weight:
2.3 kg (5.75 lbs)

Accessories Supplied:
Various fuses, lamps and power cord

Accessories Available:
Meter Scale for dBm measurements SA 0166
Meter Scale for VU measurements SA 0169

2. CONTROLS

2.1. FRONT PANEL

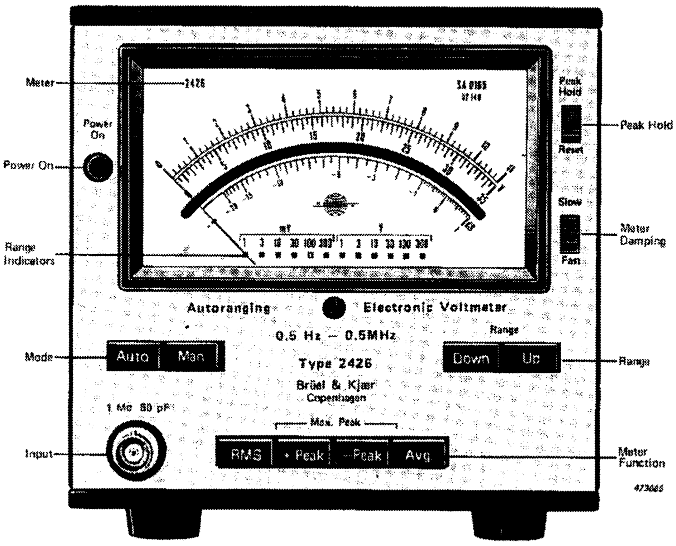


Fig.2.1. Front Panel of 2426

METER:

A moving coil meter with a mirrored back to prevent parallax errors. There are five interchangeable scales for the meter:

SA 0165. This scale is provided with the instrument. The two voltage scales are calibrated from 0 to 11 V (referred to as the 10 V scale) and 0 to 35 V (referred to as the 30 V scale). The dB scale is calibrated from —20 to + 1 dB.

The following optional scales are available on separate order:

SA 0033. Blank scale.

SA 0166. This scale is primarily used for dBV and dBm measurements. The dBV scale is calibrated from —20 to + 1 dBV (dB re 1 V) and the dBm scale from —20 to + 3 dBm (dB re 1 watt in 600 Ω). 0 dBV or dBm corresponds to the range shown by the RANGE INDICATOR. The two voltage scales on SA 0166 are calibrated from 0 to 11 V and 0 to 35 V.

SA 0169. This scale is for VU (volume unit) or percentage measurements (re 0 VU). The upper scale is calibrated from —20 to + 4 VU with 0 VU corresponding to the range shown by the RANGE INDICATOR. The lower scale is calibrated from 0 to 100%.

SA 0171. This scale is for dB measurements referenced to 1 μV. The dB scale is calibrated from 0 to + 21 dB with 0 dB corresponding to the range shown by the RANGE INDICATOR. The two voltage scales are calibrated from 0 to 11 V and 0 to 35 V.

RANGE INDICATORS:

The windows in all four meter scales are marked in appropriate units to permit direct readout of the range as shown by the RANGE INDICATOR neon lamps.

POWER ON:

Power is off with the switch "out" and on with the switch "in". Warm up time is approximately 3 seconds. The 300 V range is automatically selected when the power is turned on.

MODE:

Two mechanically interlocked push-button switches select either the automatic ("Auto.") or manual ("Man.") range selection mode.

In the "Auto." mode the instrument automatically sets its gain for a meter deflection between approximately 3 and 10 V on the 0 to 11 V scale.

In the "Man." mode, the instrument range must be selected manually by using the RANGE "Up" and "Down" switches.

RANGE:

Two momentary contact switches for changing the measuring range in steps of 10 dB when in the "Man." MODE. (These switches are inoperative in the "Auto." MODE). The range will change only once each time the "Up" or "Down" switch is depressed.

The "Up" switch increases the range in steps of 10 dB until the least sensitive range (300 V) is reached. The "Down" switch decreases the measuring range in steps of 10 dB until the most sensitive range (1 mV) is reached.

METER FUNCTION:

Four mechanically interlocked push-button switches select the signal characteristic to be measured. Five functions are possible with these switches:

"RMS" (Root Mean Square)
"+ Peak" (Positive peak value)
"—Peak" (Negative peak value)
"Avg." (Average)
"Max. Peak" (Maximum peak value, positive or negative. Selected by depressing "+ Peak" and "—Peak" simultaneously).

The averaging, rise and decay times of these functions are determined by the position of the METER DAMPING switch.

METER DAMPING:

This two position switch selects either the "Fast" or "Slow" meter damping with the following characteristics:

In the "RMS" mode the averaging time is 0,27 s for "Fast" and 3 s for "Slow".

In any of the Peak modes, "Fast" gives a rise time of < 50 μs and a decay time of 2,7 s. "Slow" gives a rise time of < 500 μs and a decay time of 30 s.

In the "Avg." mode, "Fast" gives a meter damping characteristic according to the ANSI Standard C 16.5-1961 for VU measurements.

The low frequency limit of the instrument is 20 Hz (± 0,2 dB) in "Fast" and 0,5 Hz (± 0,5 dB) in "Slow".

INPUT: A BNC input socket for application of the signal to be measured. The input impedance is 1 MΩ//60 pF. Accepts plug JP 0035 provided or standard BNC cables.

PEAK HOLD: This two position switch only functions in the "+ Peak", "—Peak", and "Max. Peak" METER FUNCTION modes:

"Peak Hold". The peak value of the signal is held by the meter. The decay rate is < 0,05 dB/s in the "Fast" METER DAMPING mode, and < 0,005 dB/s in the "Slow" mode.

"Reset". Gives a decay time constant of 2,7 s in the "Fast" METER DAMPING mode and 30 s in the "Slow" mode.

2.2. REAR PANEL

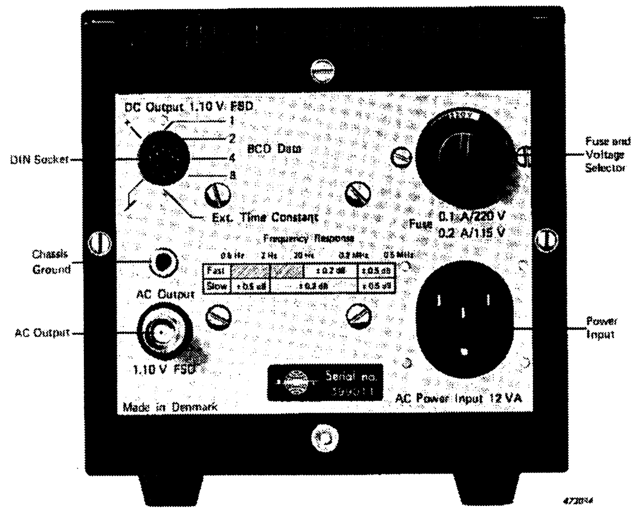


Fig. 2.2. Rear Panel of 2426

DIN SOCKET: This seven pin DIN socket accepts the DIN plug provided (B & K Type JP 0703). Serves the following functions:

1. DC output for connection to external monitoring equipment, Level Recorders, etc.
2. BCD output giving range information.
3. BCD input for external control of measuring range.
4. External Time Constant for selection of averaging times for RMS measurements and decay times for Peak measurements.
5. External meter reset in RMS and Peak modes.

The socket connection diagram is given in Fig.3.6.

AC OUTPUT: This BNC socket accepts the coaxial plug provided (B & K Type JP 0035). The output impedance is 100 Ω for connection to a minimum impedance of 2 kΩ//200 pF. Maximum output voltage is 5 V peak with 1,1 V RMS corresponding to full scale meter deflection.

FUSE AND VOLTAGE SELECTOR: Selects correct mains voltage. On delivery the central knob is fitted with a 100 mA fuse for 220 or 240 V operation. For 100, 115, 127 or 150 V operation a 200 mA fuse is also provided.

To remove the fuse, unscrew the black center knob and pull straight out. To change the mains voltage selector, remove the fuse, and then pull the black bush straight out. Replace the bush so its pin fits into the socket corresponding to the appropriate mains voltage.

POWER INPUT: The input power socket accepts power cable AN 0010. The connections to this socket and color code of the cable are shown in Fig.2.3.

CHASSIS GROUND: Connection point for chassis ground.

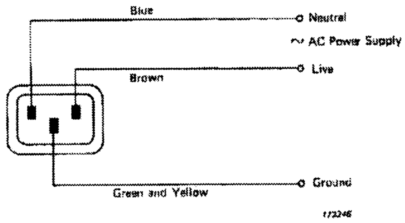


Fig.2.3. Power input socket

3. OPERATION

3.1. PRELIMINARY

3.1.1. Mounting

The 2426 may be used free standing (cabinet Type A) on its four rubber feet or the built-in metal stand may be used to raise the front of the instrument for better viewing. It may also be used in the B & K Rack Mounting Frame Type KK 0014 which can accommodate three instruments the size of the 2426 (such as Electronic Voltmeter 2425 or Phase Meter 2971).

3.1.2. Mains Voltage and Fuse Selection

Before use the 2426 should be checked that the proper fuse and mains voltage are selected. The 2426 is delivered fitted with a 100 mA fuse for 220 or 240 V operation. A 200 mA fuse is also provided which should be fitted for 100, 115, 127 or 150 V operation.

To change the fuse, unscrew the black central knob and pull it straight out. To select the mains voltage, pull the black voltage selector bush straight out (after first removing the fuse) and replace it so that the metal pin of the bush is opposite the appropriate voltage which appears in the window of the bush. Then replace the fuse.

The 2426 may be operated from any mains frequency between 50 and 400 Hz.

3.1.3. Meter Scale Installation

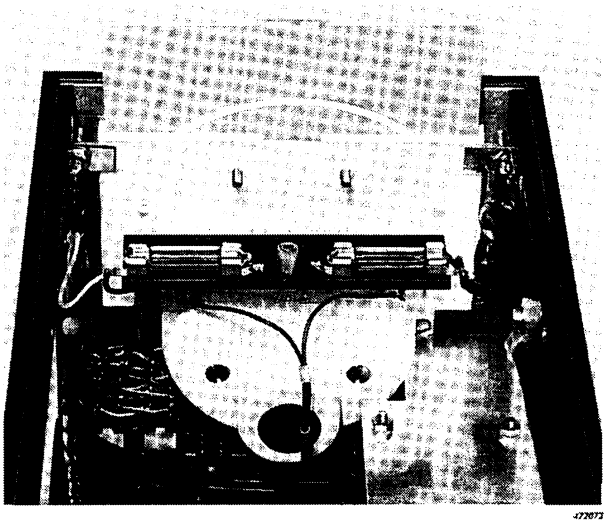


Fig.3.1. Meter scale installation

Select one of the meter scales listed in section 2.1. Disconnect the instrument from the mains supply and unscrew the fastening screw for the top panel on the rear of the case. Then unscrew the two thumb screws which hold the meter light block, slide the block back, and pull the meter scale straight up (Fig.3.1).

3.1.4. Meter Zero

With power to the instrument turned off, the meter may be mechanically zeroed using the screw directly below the meter scale.

3.1.5. Grounding Considerations

To assure proper grounding of a multiple instrument system free from ground loops:

1. Connect the signal grounds of all instruments together (automatically done through the screens of the input and output signal cables).

2. Connect both the signal ground to the chassis, and the chassis to the mains ground of one instrument only, preferably the one nearest the measurement point.

3. Make necessary adjustments such that the chassis ground of each of the other instruments is connected to one and only one of the following: 1) mains ground 2) signal ground 3) chassis ground of another instrument which must eventually be connected to mains ground.

The 2426 is delivered with the signal and chassis grounds connected by the wire shown in Fig.3.2. This connection may be broken if necessary to give the proper grounding configuration as outlined above.

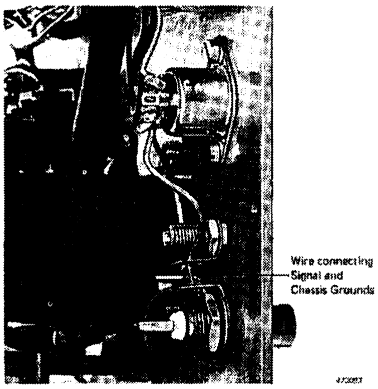


Fig.3.2. Wire connecting signal and chassis ground as seen with the right side panel removed

3.1.6. Internal/External Range Control

The measuring range selection of the 2426 may be controlled either internally or externally. To select internal (local) or external (remote) range control, disconnect the mains

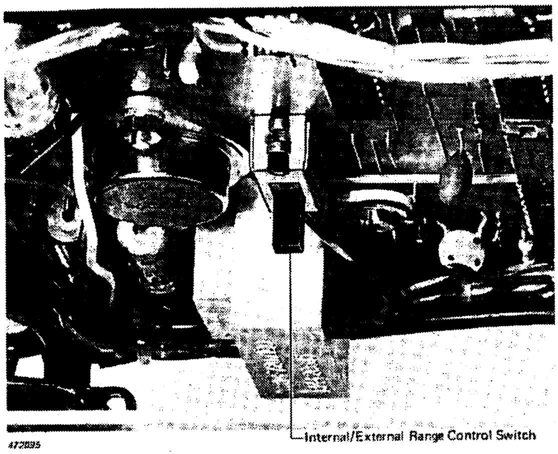


Fig. 3.3. Internal/External range control switch

cable, remove the left side panel (as viewed from the front), and activate the two position switch located underneath the circuit board under the top panel (Fig. 3.3). When the switch is to the right (as viewed from the front of the instrument) range selection is internally controlled (as delivered). When the switch is to the left, range selection is externally controlled through the DIN socket on the rear panel (see Section 3.5).

3.2. MEASUREMENT TERMS

3.2.1. RMS

The RMS (root mean square) value of a signal is usually measured and is especially important because it is directly proportional to the power dissipated in linear systems. Mathematically it is defined as

$$V_{RMS} = \sqrt{\frac{1}{T}\int_{t_1}^{t_2} |V(t)|^2 \, dt}_{\;T \to \infty}$$

where V_{RMS} is the RMS value of the signal V(t) averaged over a time $T = t_2 - t_1$.

To characterize the waveshape of the signal the crest factor (F_c) and form factor (F_f) are used:

$$F_c = \frac{V_{PEAK}}{V_{RMS}}$$

$$F_f = \frac{V_{RMS}}{V_{AVERAGE}}$$

The accuracy of the 2426 with signals of various crest factors is given in Section 4.5.4.

3.2.2. Average

Like RMS, the Average rectified value of a signal is also a time averaged value defined by:

$$V_{AVG} = \frac{1}{T}\int_{t_1}^{t_2} |V(t)| \; dt$$

where V_{AVG} is the average value of a full wave rectified signal V(t) averaged over a time $T = t_2 - t_1$.

For average measurements, the measuring instrument is limited by the Peak to Average ratio of the signal. These limits for the 2426 are given in Section 4.5.4.

3.2.3. Peak

The peak value of a signal is the maximum value of the signal that occurs within a given time. The 2426 measures either positive or negative peak values as shown in Fig.3.4.

The 2426 also measures the maximum peak value which is the highest of the positive and negative peak values. The maximum peak value must not be confused with the peak-to-peak value which is the sum of the positive and negative peak values as also shown in Fig.3.4.

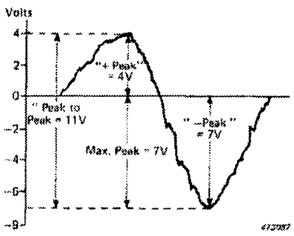


Fig.3.4. Various types of peak measurements

3.2.4. dBm

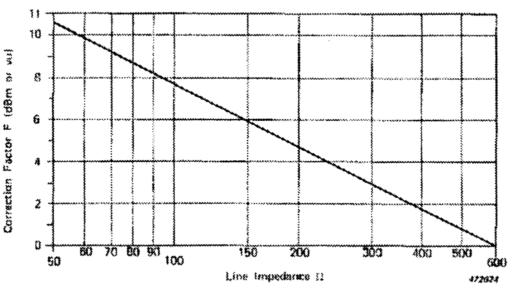


Fig.3.5. Correction factor for various line impedances for dBm measurements

The dBm is the dB ratio referenced to a power level of 1 mV in 600 Ω. This corresponds to a voltage of 0,775 V. If the line impedance is changed from 600 Ω a correction factor f must be added to the dBm reading:

$$10 \log_{10} \frac{600}{R}$$

where R is the magnitude of the line impedance. This relation is graphed in Figure 3.5. If this correction factor is not used when using the dBm scale on meter scale SA 0166, the values will then be dB re 0,775 V.

3.2.5. Volume

The term "volume" is used to characterize the dynamic amplitude of complex, non-periodic audio frequency signals such as those occuring in speech or music. In standard C 16.5-1961 of the American National Standard Institute (ANSI) the characteristics of a volume indicator are defined. When used in the "Fast" "Avg." mode with meter scale SA 0169, the 2426 conforms to this standard. Volume is read in volume units (VU) above or below a reference volume of 0 VU corresponding to 1 mV in 600 Ω (= 0,775 V).

The correct meter reading according to the ANSI standard is determined by "the greatest deflections occurring in a period of about one minute for program waves, or a shorter period (e.g. 5 to 10 seconds for message telephone speech waves, excluding not more than one or two occasional deflections of unusual amplitude".

3.3. AUTOMATIC OPERATION

(For the measurement of short duration, infrequently repeated signals, the "Man." mode is recommended).

1. Perform preliminary adjustments as necessary (Section 3.1).

2. Connect the signal to be measured. (If measuring across a balanced line it may be necessary to use Input Transformer TI 0001 in the 20 kΩ mode, see Chapter 6.).

3. Set controls:

MODE:	"Auto."
PEAK HOLD:	"Reset"
METER DAMPING:	"Fast" (to give faster autoranging than in "Slow")
METER FUNCTION:	As desired
POWER ON:	"On"

4. If the range continually shifts erratically, select the "Slow" METER DAMPING.

For "Peak" measurements go directly to step 9.

RMS and Average Measurements only

5. Wait for the meter to select and settle in the appropriate range. (Note: For certain types of signals, especially pulses with low repetition frequencies, it may not be possible to attain stable operation in the "Auto." mode).

6. Select "Fast" or "Slow" METER DAMPING. "Fast" should be used for signals with frequency components down to 20 Hz, "Slow" down to 0,5 Hz.

7. If large signal amplitude changes occur, the autoranging process is speeded up by selecting the "Fast" METER DAMPING.

8. Read the meter.

Peak Measurements Only

9. Wait for the 2426 to select and settle in the appropriate range.

10. Select "Fast" or "Slow" METER DAMPING.

11. Select "Peak Hold" for measuring and holding signals of very infrequent occurrence, or "Reset" for continuous or frequently repeated signals.

12. If the meter overdeflects, reset by setting PEAK HOLD to "Reset" and METER DAMPING to "Fast".

13. Read the meter.

3.4. MANUAL OPERATION

1. Perform preliminary adjustments as necessary (Section 3.1).

2. Connect the signal to be measured. (If measuring across a balanced line it may be necessary to use Input Transformer TI 0001 in the 20 kΩ mode, see Section 6.1).

3. Set controls:

MODE:	"Man."
PEAK HOLD:	"Reset"
METER DAMPING:	"Fast" (to permit faster range selection than in "Slow")
METER FUNCTION:	As desired
POWER ON:	"On"

4. If necessary, repeatedly press the "Down" (and/or "Up") RANGE switch until a satisfactory meter deflection is reached.

   For "Peak" measurements go directly to step 8.

RMS and Average Measurements Only

5. Select "Fast" or "Slow" METER DAMPING. "Fast" should be used for signals with frequency components down to 20 Hz, "Slow" down to 0,5 Hz.

6. If the meter overdeflects, momentarily select the "Auto" mode, or push the "Up" RANGE switch until an on-scale reading is reached.

7. Read the meter.

Peak Measurements Only

8. Select "Fast" or "Slow" METER DAMPING.

9. Select "Peak Hold" for measuring and holding signals of very infrequent occurrence, or "Reset" for continuous or frequently repeated signals.

10. If the meter overdeflects, momentarily set controls:

MODE:	"Auto"
PEAK HOLD:	"Reset"
METER DAMPING:	"Fast"

until a stable on-scale meter deflection is reached. Alternatively, manually uprange with PEAK HOLD in "Reset".

11. Read the meter.

For "Peak Hold" measurements, it should be remembered that once a peak has been captured, it will be held at that same meter deflection, regardless of any range changes, assuming that there is no longer an input signal of a higher amplitude present. Thus it is important to note the measuring range in which the measurement was made.

3.5. EXTERNAL RANGE CONTROL

The range setting of the 2426 may be controlled remotely by connection to the BCD input of the DIN socket on the rear panel. Multiplying the decimal value of the code by 10 gives the number of dB above the 1 mV range. The BCD code used for range selection is given in Table 3.1 with "0" corresponding to a short circuit and "1" to an open circuit. Thus no active electronics are required for remote range control, but a simple mechanical switch arrangement as shown in Fig.3.6 may be used. However, any active logic electronics operating on + 5 V DC may also be used.

	1	3	10	30	100	300
mV	0000	0001	0010	0011	0100	0101
V	0110	0111	1000	1001	1010	1011
Extra V			1100	1101	1110	1111

8 4 2 1 DIN socket designation
0 0 0 0 BCD code

073031

Table 3.1. BCD codes for range setting of the 2426

The procedure is as follows:

1. Set POWER "Off".

2. Select External range control as described in Section 3.1.6.

3. Connect the external range controlling device to the DIN socket on the rear panel of the 2426.

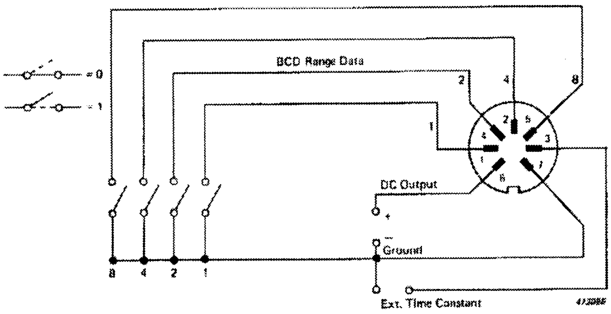


Fig.3.6. Connections to rear panel DIN socket

4. Connect AC or DC output to external equipment if desired.

5. Connect external time constants to the 2426 if desired (See Section 3.9).

6. Set MODE to "Man." (The "Auto." mode should not be selected when operating with external range control).

7. The remainder of the procedure is as outlined in Section 3.4, "Manual Operation", except that all range selection is controlled externally.

3.6. INTERNAL RANGE CONTROL WITH EXTERNAL READOUT

The 2426 may be used to give remote indication of range or to control other digital instruments. The BCD output is connected to the external readout device, to another digitally controlled instrument such as another 2426, or an external instrument which records the range information in synchronization with the analog output of the 2426.

1. Set POWER "Off".

2. Set Internal/External range control switch to internal (See Section 3.1.6).

3. Connect the BCD data output of the 2426 to external instrument. See Fig.3.6 and Table 3.1 for connection diagrams and range code.

4. Connect the AC or DC output of the 2426 to external recording or monitoring equipment if desired.

5. Operating procedure is as indicated in Section 3.3 and 3.4 for Automatic or Manual operation.

3.7. DC OUTPUT

The DC output from the rectifier circuits of the 2426 is available between pins 6 (positive) and 7 (ground) of the DIN socket of the rear panel (Fig.3.6).

The characteristics of the DC output are determined by the positions of the METER FUNCTION, PEAK HOLD, and METER DAMPING switches since these all select different rectifier/integrator characteristics as outlined in the Specifications. The output impedance is less than 10 Ω and 1,1 V DC corresponds to full scale deflection. Peak output voltage is 5 V.

The DC OUTPUT is suited for direct connection to the 2305 or 2307 Level Recorders or other monitoring equipment.

3.8. AC OUTPUT

The AC output of 1,1 V RMS corresponding to full scale meter deflection is available at the BNC socket on the rear panel of the instrument. The output impedance is 100 Ω and the maximum output voltage is 5 V peak into a load impedance of at least 2 kΩ.

Since the AC output is coupled through a 22 μF capacitor, its lower limiting frequency is determined by the loading of the socket. With a 42 kΩ load, for example, the frequency response due to loading will be —0,5 dB at 0,5 Hz and —3 dB at 0,18 Hz, and with a 14 kΩ load (which is in the range of input impedances of Level Recorders 2305 and 2307) the frequency response is —0,5 dB at 1,4 Hz and —3 dB at 0,5 dB. The normal response tolerances of the 2426 and succeeding instruments such as Level Recorders must then be added to these values to give the overall response tolerances. Thus for level recording below 2 Hz more linear response will be obtained if the DC OUTPUT of the 2426 is used.

3.9. EXTERNAL TIME CONSTANTS AND METER RESET

The "Ext. Time Constant" pin of the DIN socket on the rear panel of the 2426 may be used for (1) external selection of averaging times for RMS measurements, (2) external selection of decay times for Peak measurements, and (3) external meter reset. It should be noted that these connections affect only Peak and RMS measurements, and not Average.

3.9.1. External RMS Averaging Time

The averaging time of the RMS circuit will be increased by 1 second for every 2,5 μF capacitance connected across pin 3 (positive) and pin 7 (ground) of the DIN socket (Fig.3.6). Thus the total averaging time will be equal to the sum of the internal averaging time (0,27 s for "Fast", 3 s for "Slow" METER DAMPING) and the external averaging time (1 s per 2,5 μF). For example, for the "Slow" METER DAMPING, a 10 μF capacitor will increase the averaging time of the RMS circuit from 3 to 7 seconds.

3.9.2. External Peak Decay Time

The decay time of the "Peak" circuits of the 2426 may be changed by the connection of an external capacitor or resistor to pins 3 and 7 of the DIN socket (Fig.3.6).

The decay time will be increased by 10 seconds for every 2,5 μF capacitance connected. Thus the total decay time equals the sum of the internal decay time (2,7 s for "Fast", 30 s for "Slow" METER DAMPING) and the external decay time (10 s/2,5 μF). For example, for the "Slow" METER DAMPING, a 10 μF capacitor will increase the decay time from 30 to 70 seconds.

The decay time for peak measurements may also be decreased by connecting a resistor between pins 3 and 7 of the DIN socket. The decay time (τ) is then given by the formula:

$$\tau = \tau_i \quad \frac{R_e}{R_e + R_i}$$

where τ_i is the internal decay time constant of either 2,7 s ("Fast") or 30 s ("Slow"), R_i is equal to 3,9 MΩ and R_e is the value of the external resistance. This relationship is graphed in Fig.3.7 for the "Slow" METER DAMPING. It should be noted that accurate Peak measurements can only be guaranteed for decay time constants equal to or greater than 2,7 seconds.

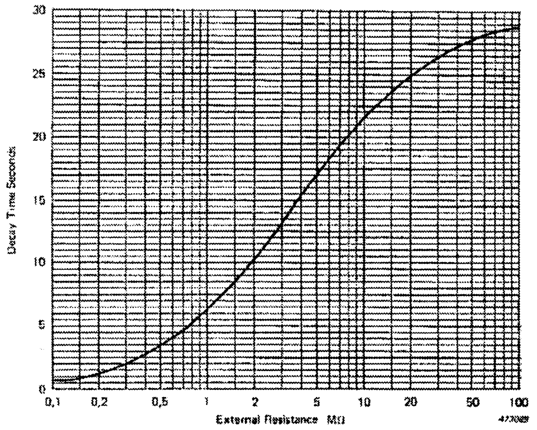


Fig.3.7. Peak decay times for various external resistances and with the "Slow" METER DAMPING

3.9.3. Remote Meter Reset

If the meter overdeflects in the Peak or RMS modes it may be reset by momentarily shorting pins 3 and 7 of the DIN socket. The reset time will be longest in the "Slow" mode, and shortest in the "Fast" METER DAMPING mode. If the instrument is in the "Auto." mode, resetting the meter externally will cause the instrument to downrange one range.

The external meter reset is different in function than the "Reset" position of the PEAK HOLD switch. The internal "Reset" of the PEAK HOLD switch functions only for the Peak modes and is slower than the external reset which functions in both the Peak and RMS modes.

The external meter reset may also be used when successive "Peak Hold" measurements are to be made. However, for this application if the signal is not continuous or steady in level, it is recommended to use the 2426 in the "Man." mode.

4. DESCRIPTION

In the description that follows, reference is made to the block diagram in Fig.4.1.

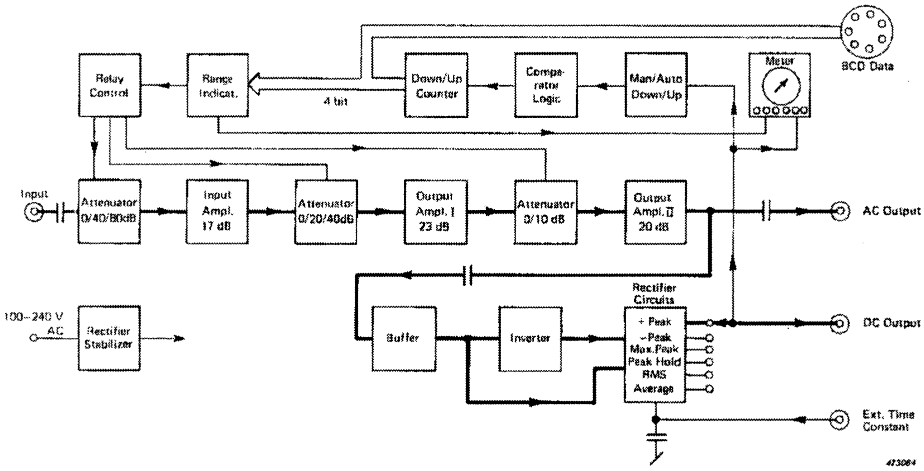


Fig.4.1. Block diagram of 2426

4.1. AC AMPLIFIER

4.1.1. Input Section

The input of the 2426 is via the front panel BNC connector. The signal is AC coupled through either a 68 nF or 2 μF capacitor selected by the METER DAMPING switch. In the "Fast" mode, the 68 nF capacitor is selected giving a low frequency response limit (± 0,2 dB) of 20 Hz. In the "Slow" mode, the 2 μF capacitor is selected giving a 0,5 Hz (± 0,5 dB) low frequency response limit. The input impedance in either mode and in all measuring ranges is a constant 1 MΩ paralled by 60 pF.

The signal is then fed to the relay controlled input attenuator which gives 0 dB attenuation in all mV ranges, 40 dB attenuation in the 1 V to 30 V ranges, and 80 dB attenuation in the 100 V and 300 V ranges.

The signal from the attenuator drives the diode protected input amplifier operating at 17 dB gain. These diodes protect the input amplifier up to 80 V RMS in the "mV" ranges. In the "V" ranges the maximum input voltages are determined by the input coupling networks. These limitations are 380 V RMS, 600 V Peak, and 250 V DC.

The input amplifier uses a differential field effect transistor circuit giving a high input impedance. This is then coupled to two emitter follower stages in cascade, giving a low output impedance. This circuit configuration also gives low DC offset and good temperature stability which is important since all the active stages of the AC amplifier are DC coupled.

4.1.2. Output Section

The output of the input amplifier drives the second set of relay controlled attenuators giving 0 dB attenuation in the 1 mV and 3 mV ranges, 20 dB attenuation in the 10 mV, 30 mV, 1 V, 3 V, 100 V and 300 V ranges, and 40 dB attenuation in the 100 mV, 300 mV, 10 V and 30 V ranges.

The signal from the attenuator drives an integrated circuit operational amplifier set for a gain of 23 dB. This amplifier connects to the second stage of the output amplifier through the final relay controlled attenuator giving alternately 0 and 10 dB attenuation, beginning with 0 dB in the 1 mV range. The second stage of the output amplifier is another integrated circuit operational amplifier with a fixed gain of 20 dB. It is coupled to the AC OUTPUT BNC connector on the rear panel through a 100 Ω resistor and 22 μF capacitor.

A circuit for the detection of DC overload is connected both to the output of the 23 dB and 20 dB amplifier stages. When overload occurs, this circuit triggers the upranging of the instrument until the overload is removed. In the manual mode, overloading gives meter overdeflection.

4.2. METER CIRCUITS

4.2.1. Input Section

The output of the AC amplifier also feeds a unity gain buffer amplifier through a coupling network selected by the METER DAMPING switch and giving the characteristics described in Section 4.1.1. The input of this amplifier is diode protected for voltages greater than approximately 14 V peak to peak. The buffer amplifier drives both the "positive" diode of the rectifier and the unity gain inverter amplifier (180° phase shift) which drives the "negative" diode of the rectifier. This full-wave rectifier consists of two active diodes which are connected to the appropriate meter circuit through the METER FUNCTION switches.

4.2.2. RMS Rectifier

The RMS rectifier squares the instantaneous voltage level of the signal, averages it over a given time, takes the square root, and presents the result to the meter.

In the 2426 this is accomplished using a circuit whose instantaneous transfer characteristic approximates a parabola and gives the desired squaring characteristic. Three active diodes successively switch three resistors into the circuit giving the desired parabolic transfer characteristic by a series of straight lines (Fig. 4.2). The squared output from the diodes charge the averaging capacitor which by feedback alters the bias on the diodes. This results in a linear output proportional to the RMS value of the signal and is equivalent to the square root extraction process.

The averaging times of the RMS circuit are selected by the meter damping switch or may be selected externally as described in Section 3.9.1. In the "Fast" mode the averaging time is 0,27 seconds and in the "Slow" mode, 3 seconds. When the METER DAMPING switch is changed from "Fast" to "Slow" the low frequency response limit of the instru-

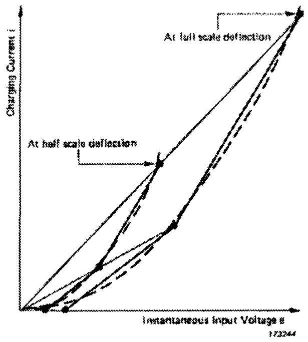


Fig. 4.2. Parabolic transfer characteristic of an RMS rectifier as approximated by a series of straight lines of various slopes

ment is changed from 20 Hz (± 0,2 dB) to 0,5 Hz (± 0,5 dB). The averaging times are chosen to give adequate averaging time for all frequencies above the lower limit, and in the "Slow" mode to be long enough to prevent the meter from following the waveform of the signal.

The RMS rectifier's crest factor specifications are given in Section 4.5.4. For further details on Brüel & Kjær RMS rectifiers and active diodes, the reader is referred to:

1. J. Austin Hansen: "RMS Rectifiers", B & K Technical Review 1972 No.2.
2. C. G. Wahrman: "A True RMS Instrument", B & K Technical Review 1958 No.3.
3. C. G. Wahrman: "Impulse Noise Measurement", B & K Technical Review 1969 No.1.

4.2.3. Peak Rectifier

The peak rectifier permits the measurement of positive, negative and maximum peak values.

The outputs of either (or both) the positive or negative diode of the full wave rectifier are fed to a current generator which charges a capacitor to the peak value of the signal. The rate at which the current generator can deliver current to the capacitor, and the size of the capacitor determine the rise time of the circuit, or how short a pulse may be measured. Since the value of the capacitor is changed by the METER DAMPING switch, the rise time (the time to change from 10% to 90% of the peak value) is < 50 μs in the "Fast" mode and < 500 μs in the "Slow"mode, for a voltage corresponding to full scale deflection. For lower voltages the rise time is proportionally higher.

The capacitor is discharged through a bleeder resistor also selected by the METER DAMPING switch. The capacitor will discharge less than 0,5 dB in 1/10 of the RC time constant. Hence the resistor is selected to give accurate peak measurements on signals down to the lower limiting frequency (LLF) selected by the METER DAMPING switch. The decay time (time to discharge to 37% of the initial value) is 2,7 seconds on the "Fast" mode (LLF of 20 Hz) and 30 seconds in the "Slow" mode (LLF of 0,5 Hz). Other decay times may be selected by the addition of an external resistor or capacitor as described in Section 3.9.2.

If it is desired to hold the peak value of the signal, the PEAK HOLD switch is activated thus breaking the discharge path of the capacitor. The decay rate then is less than 0,005 dB/s in the "Slow" mode and less than 0,05 dB/s in the "Fast" mode at 25°C.

4.2.4. Average Rectifier

The average rectifier gives the arithmetic average of the signal over a given time. The signal is rectified by the two active diodes of the full wave rectifier and then averaged over a time selected by the METER DAMPING switch. In the "Fast" mode, the characteristics are in accordance with the ANSI standard C 16.5-1961 for VU measurements.

4.2.5. Meter Amplifier and DC Output

The outputs of the RMS, Peak, or Average detectors are switched through the METER FUNCTION switches to drive the integrator amplifier and the integrating networks selected by the METER DAMPING switch. The output of the integrator is connected to the DC amplifier which drives the indicating meter, the DC OUTPUT, and the comparator in the autoranging circuit.

4.3. RANGING CIRCUITS

4.3.1. Comparator

In the automatic mode the output of the DC amplifier is fed to the comparator circuit. One section of the comparator determines when the input voltage exceeds approximately 1 V and triggers the upranging circuit one range, while the other section of the comparator triggers the downranging circuit one range if the input voltage is less than approximately 0,3 V. The switching levels of the comparator are set to give an overlap or hysteresis of the down and up range switching thresholds. This minimizes excessive range switching when measuring a slightly varying signal at one of the threshold levels.

When either the "Up" or "Down" comparator is triggered a single pulse is sent to the following circuitry commanding a range change of 10 dB. The comparator input voltage must then be brought back into range (between 0,3 and 1 V) to permit another comparison and range switching command. Hence, simultaneous with each comparator "Up" or "Down" command a relay connects a reset voltage of approximately 0,5 V to the input of the integrator and thus to the comparator through the DC amplifier. This voltage brings the comparator back into range, releases the reset relay, and again permits comparison of the input signal to see if it is in or out of range.

If overloading of the 23 dB or 20 dB AC amplifiers occurs another upranging system will be activated. The overload detector will turn off the field effect transistor (FET) which gates the input of the comparators. This causes the "Up" comparator to oscillate, issuing a rapid series of upranging commands. Once the overload disappears, the DC overload detector will turn the FET back on, thus stopping the upranging and once again feeding the input signal to the comparator.

In the manual mode the overload detector, reset relay, and DC amplifier output are disconnected from the input of the comparator. Instead, an "in range" voltage is fed to the comparator. Then pressing the "Up" or "Down" RANGE switches will remove the "in range" voltage and feed either a high or low voltage causing activation of the comparator "Up" or "Down" range commands. As in the automatic mode, only one ranging command is issued, and the comparator is reset by releasing the "Up" or "Down" switches, once again connecting the "in range" reset voltage to the comparator.

4.3.2. Up/Down Counter

The binary outputs of the comparator drive the Up/Down counter which converts the commands to a 4 bit BCD code (Table 3.1) used to drive the relay control circuit, the range indicator circuit, and give external range information through the rear panel DIN socket. The Up/Down counter is programmed so it will give an output code setting the instrument in the 300 V range whenever power is first applied.

When the Internal/External Range control switch is thrown to external (see Section 3.1.6) the power to the Up/Down counting integrated circuit is removed, thus disabling it and permitting direct external control of the relay control circuitry which sets the measuring range.

4.3.3. Relay Range Control

The output of the Up/Down counter (or an external input from the DIN socket) drives several logic gates which enable the triggering of the proper combinations of the attenuator relays. Although the Up/Down counter is programmed to only generate BCD codes from 0000 to 1011, other BCD codes may be inadvertently entered externally, and the results of these codes are also given in Table 3.1. It should be noted that if these "extra" codes are entered, the indication of the RANGE INDICATOR will be meaningless.

The input of the relay range control is designed to interpret an open circuit or 5 V DC as a binary "1", and a short circuit or 0 V DC as a binary "0".

4.3.4. Range Indicator

The output of the Up/Down counter also drives the range indicator which is an integrated circuit BCD to decimal converter and driver. The actual range indicators are small neon lamps mounted behind the meter scale.

4.4. POWER SUPPLY

The 2426 may be operated at mains voltages of 100, 115, 127, 150, 220 and 240 V AC at frequencies from 50 to 400 Hz. The power supply consists of a bi-polar 18 V regulated supply for powering the analog electronics, a + 5 V regulated supply for the digital electronics, and an 85 V supply for the neon range indicator lamps. The two meter scale lamps are connected in series directly across a separate 12 V transformer winding. Special care has been taken using suppression circuits to prevent the spurious activation of the digital electronics due to power line transients. In addition, all relays use diode transient suppression across the relay coil.

The power consumption of the 2426 is approximately 12 watts.

4.5. OPERATIONAL CHARACTERISTICS

4.5.1. Dynamic Range

The dynamic range of the AC amplifier of the 2426 referenced to maximum output voltage (5 V peak) is specified as better than 40 dB in the 1 mV range, 50 dB in the 3 mV range, and better than 60 dB in all other ranges. In practise the dynamic range alternates between a minimum of 60 dB beginning with the 10 mV range and 70 dB beginning with the 30 mV range as shown in Table 4.1. Also shown is the overall instrument gain in each range.

	mV						V					
Range	1	3	10	30	100	300	1	3	10	30	100	300
Gain (dB)	+60	+50	+40	+30	+20	+10	0	−10	−20	−30	−40	−50
Dynamic Range (dB)	40	50	60	70	60	70	60	70	60	70	60	70

Table 4.1. Gain and dynamic range of the 2426

The dynamic range of the DC output referenced to the maximum output of 5 V is better than 40 dB in all measurement ranges.

4.5.2. Frequency Characteristics

The frequency response of the AC amplifier of the 2426 is shown in Fig. 4.3. The low frequency response is limited by the coupling networks selected by the METER DAMPING switch. The high frequency response is given a rapid roll-off above 500 kHz by appropriate choice of feedback in the operational amplifiers used throughout the AC amplifier. The low frequency response limits are 0,5 Hz (± 0,5 dB) in the "Slow" mode and 20 Hz (± 0,2 dB) in the "Fast" mode.

The high frequency response limit is 500 kHz (± 0,5 dB). Thus the AC amplifier is capable of amplifying square waves without any appreciable rounding of the corners at frequencies up to 50 kHz.

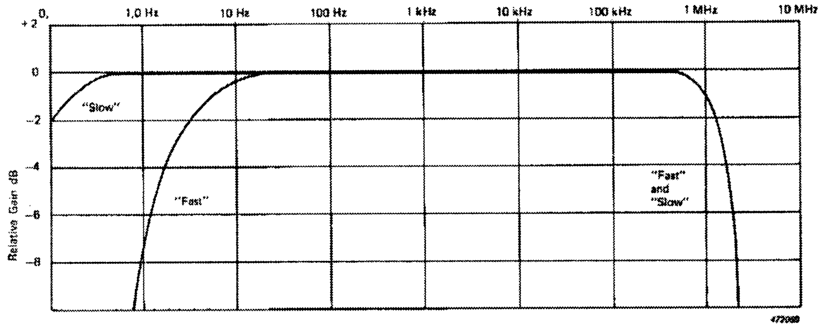


Fig. 4.3. Frequency response of the AC amplifier of the 2426

4.5.3. Phase Characteristics

The phase characteristics of the AC amplifier of the 2426 are shown in Fig. 4.4. As with the frequency response, the low frequency phase characteristics are determined by the position of the METER DAMPING switch.

The phase response of the 2426 will not affect the accuracy of the measurement of RMS signals of a sinusoidal or complex nature. Nor will Peak or Average measurements of sinusoidal signals be affected. However, for Peak and Average measurements of complex waveforms, errors may arise.

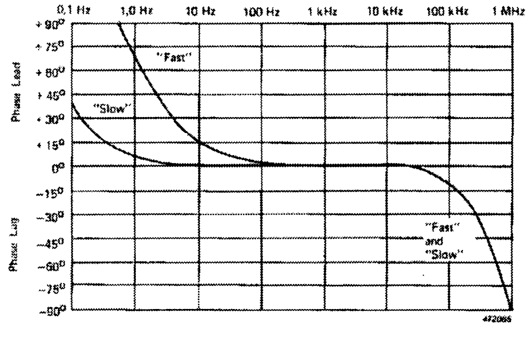


Fig. 4.4. Phase response of the AC amplifier of the 2426

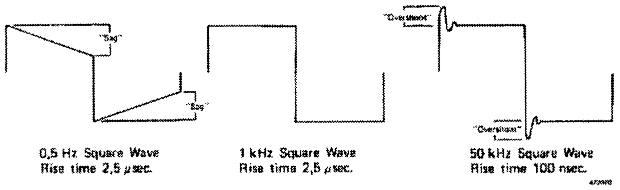


Fig. 4.5. Influence of phase response on square waves of various frequencies and rise times

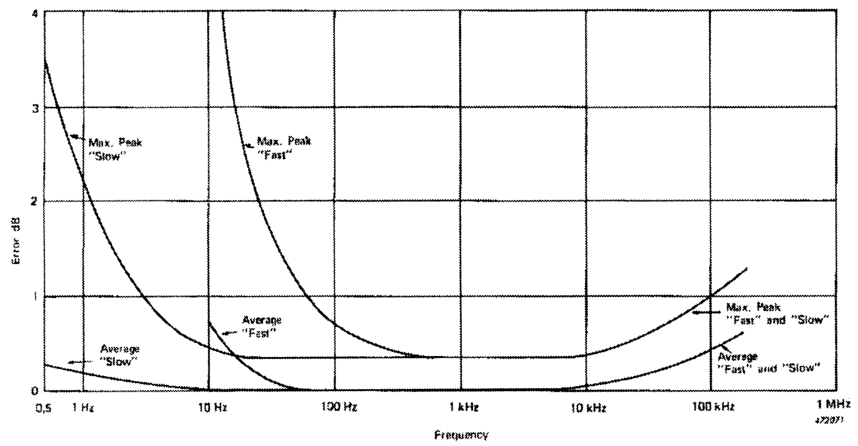


Fig. 4.6. Accuracy of Peak and Average indications of the 2426 for a square wave as compared to the RMS indication

The phase response of the amplifier affects the measurement accuracy of Peak and Average values of a square wave primarily at extremely low and high frequencies. This is illustrated in Fig.4.5. At low frequencies, a "sag" in the waveform occurs due to the phase of the low frequency components leading the fundamental. However, good square wave reproduction will occur at approximately 10 times the lower limiting frequency. Hence, essentially "sag-free" square waves will be reproduced above 5 Hz in the "Slow" mode and above 200 Hz in the "Fast" mode.

The high frequency phase characteristics become a factor when signals with a fast rise time are to be measured or amplified. If the rise time of the signal is less than 2,5 μs the amplifier will overshoot or "ring" as also shown in Fig.4.5. This overshoot will then change the peak value of the signal giving rise to a measurement error. This type of error is avoided with signal rise times greater than 2,5 μs.

The magnitude of the Peak and Average measurement errors as compared to the RMS indication is given in Fig.4.6.

4.5.4. Peak Voltage Capabilities

The 2426 is capable of the accurate measurement (± 0,5 dB) of the RMS values of signals with crest factors up to 5 at meter deflections of 1 dB below full scale deflection or lower. However, in the 300 V range, the maximum input voltage rating of the instrument restricts the crest factor capabilities of the instrument to some extent as shown in Fig.4.7.

Similarly for Average measurements, the Peak value of the signal is limited by the input and output voltage limitations of the instrument. The solid curve in Fig.4.8 gives the Peak/Avg. voltage limitations in all ranges except the 300 V range whose limitations are shown by the dashed curve.

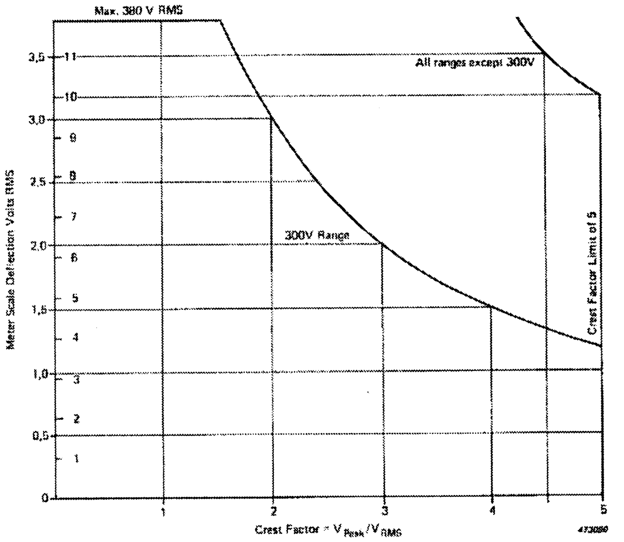


Fig.4.7. Crest factor limitations of the 2426 for RMS measurements

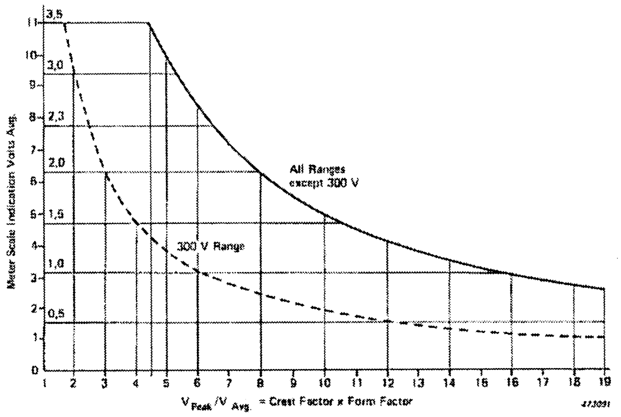


Fig.4.8. Peak to Average ratio limitations of the 2426 for Average Measurements

4.5.5. Ranging Speed

The rate at which the autoranging circuitry selects the desired range depends on a number of complex factors which do not yield a single specification or formula.

The basic ranging time limitation is the contact closure time of the relays used, which is 5 ms. Thus for every 10 dB of range shift, at least 5 ms is required since the 2426 always steps from one range to another through all intermediate ranges.

The upranging process is generally the fastest since it uses the faster overload upranging system described in Section 4.2.5 in addition to the slower comparator system. If the signal amplitude suddenly increases by a sufficient amplitude to overload the AC amplifier, the overload upranging system will rapidly uprange until the overload is removed. This, however, does not mean that the signal level is low enough to give an on-scale meter deflection. Once the overload is removed, the comparator is once again allowed to operate and uprange (or downrange) until an appropriate on-scale meter deflection is reached.

If no overload occurs, the upranging will be performed by the comparator circuit only and the rate of upranging will depend on the time constants of the METER FUNCTION selected.

The overload upranging system is the fastest since no time components of the meter circuitry preceed it. However, the speed of the comparator ranging system is directly related to the rise or averaging times for upranging, and the decay or averaging times for downranging. The upranging times of the comparator are approximately 0,1 to 0,5 seconds per range in the "Slow" mode and of the order of 5 to 10 ms per range in the "Fast" mode.

If the signal contains a high level transient this will probably cause the 2426 to "overshoot", that is, select too high a range. Thus to measure the signal after the transient, one must wait for the instrument to downrange, or select a METER FUNCTION which will speed the downranging process. Some approximate downranging times are given in Table 4.2. Note that these times are only approximate and may vary somewhat from instrument to instrument.

	+ Peak – Peak Max. Peak	Peak Hold	RMS	Avg.
Fast	0,9s	3 min.	0,11s	0,03s
Slow	17,0s	30 min.	1,20s	0,90s

073032

Table 4.2. Rate of downranging per range for various modes of the 2426

4.5.6. Meter Overdeflection

If the meter overdeflects in certain modes, it may be necessary to select another mode to rapidly reset the meter. This is due to the long time constants employed in these modes.

The maximum time for the meter to return on-scale after an overdeflection is approximately 50 s in the "Slow" Peak mode, 2 s in the "Fast" Peak mode, and 7 s in the "Slow" RMS and Average modes. For "Peak Hold", however, the return time is of the order of many minutes. In these cases, the meter resetting may be achieved by switching to the "Fast" METER DAMPING and also setting the PEAK HOLD switch to "Reset" if the hold function was used.

It should be noted that at times a meter overdeflection may occur when switching the METER DAMPING switch. This may be due to a high residual charge on one of the averaging capacitors from a previous overdeflection and can only be discharged by waiting for the meter to return on-scale in that position of the switch.

5. APPLICATIONS

5.1. USE WITH PHASE METER 2971

The uniform phase characteristics of the 2426 in all measuring ranges make it an ideal input to a phase meter such as Brüel & Kjær Type 2971. In addition, its autoranging feature automatically provides a voltage of the ideal amplitude required by the Phase Meter for its highest possible accuracy.

A typical phase measuring system is shown in Fig.5.1.

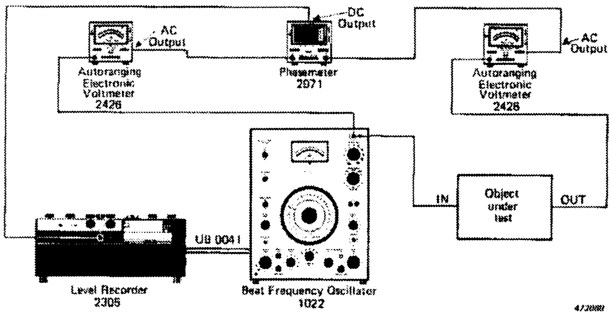


Fig.5.1. Use of the 2426 as input to Phase Meter Type 2971

Since the output of the 2426 s when in the "Auto." mode will lie between 0,3 and 1 V RMS the Phase Meter should be set in the "10 mV to 5 V" range for highest measurement accuracy.

The operating mode of the 2426 s depends on the noise content and level stability of the signal. If the signal is relatively noise free and stable, the "Fast" RMS mode may be used, but if the signal contains a sufficient amount of noise to cause excessive range switching, the "Slow" mode should be used.

Meter Damping	Slow		Fast				
Frequency	2 Hz	20 Hz	20 Hz	200 Hz	20 kHz	200 kHz	500 kHz
Average Phase Shift °	+2	0	+7	0	−2	−25	−63
Max. Deviation from Avg. °	0	0	±1	0	+0 −0	+4 −5	±14

073030

Table 5.1. The average phase shift of a group of sixteen 2426's and the maximum deviation from that average

If possible, the phase characteristics of the two 2426s used as inputs to the phase Meter should be matched. Table 5.1 shows the average phase deviations of 16 instruments plus the maximum deviations found within this group of 2426s. It can be seen from this table that the phase responses of the 2426s are closely enough matched for most purposes. If greater accuracy is required, especially at high frequencies, two 2426s may be calibrated against each other by feeding the same signal directly into both 2426s and comparing the relative phase response of the instruments on the Phase Meter.

5.2. INPUT MONITOR FOR DIGITAL EVENT RECORDER 7502

The "Peak Hold" mode of the 2426 may be used to facilitate the setting of the input signal level for the Digital Event Recorder Type 7502.

For easily repeated signals both the "+ Peak" and "—Peak" values of the signal should be measured in the "Peak Hold" mode. From these values, the optimum settings of the INPUT ATTENUATOR and OFF-SET of the 7502 may be determined. For instance, for a "+ Peak" value of 12 V and a "—Peak" value of 8 V the INPUT ATTENUATOR should be set for 6 dB and the OFF-SET of the 7502 for —1 V to accommodate the signal within the limits of ± 5 V.

If the signal can only be repeated with difficulty the recording level must be set based on estimates and past experience. The 2426 may then be used to monitor the Peak values of the signal in playback and thus permit optimum adjustments for the next recording.

5.3. LEVEL RECORDING

The AC or DC output of the 2426 may be connected to the Level Recorder 2305 or 2307 and operated as described in the appropriate Level Recorder instruction manual. It is recommended that the 2426 be operated in the manual mode when used with a Level Recorder unless a supplemental method of recording the range information of the 2426 in synchronization with the analog output is used.

5.4. USE OF 2426 AS REMOTE CONTROLLED ATTENUATOR

The accurate gain and phase characteristics of the 2426 make it ideal for use as a remotely controlled attenuator or amplifier.

The Internal/External range control switch is set to "external" and a BCD control signal is connected to the rear panel DIN socket as described in Section 3.5. The gain of the amplifier for the various BCD codes is then found by use of Tables 3.1 and 4.1.

6. ACCESSORIES

6.1. INPUT TRANSFORMER TI 0001

For voltage or VU measurements with the 2426 on balanced lines, or balanced amplifiers, it is necessary to use the Input Transformer TI 0001 which is available from B & K on separate order.

The transformer (Fig.6.1) provides a balanced input to the 2426 which is symmetrical with respect to ground. Using the INPUT IMP. switch of the transformer, an input impedance of 20 kΩ or 600 Ω can be selected. A third position of the switch enables the midpoint of the balanced inputs to be connected to the transformer's casing.

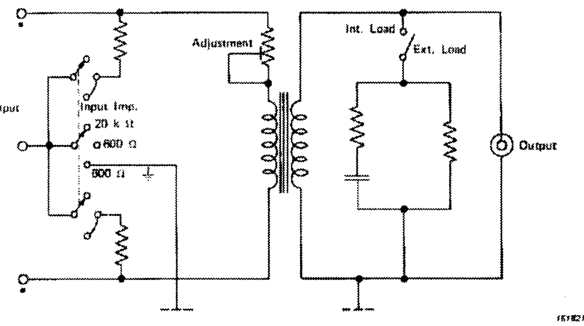


Fig.6.1. Input Transformer Type TI 0001

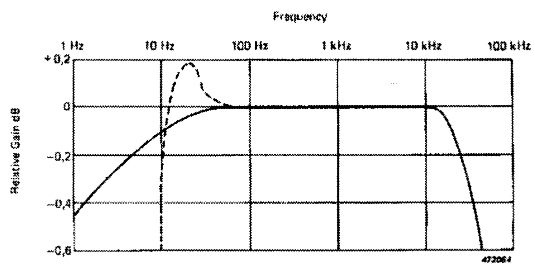


Fig.6.2. Frequency characteristics of Input Transformer TI 0001. The dashed curve gives low frequency response with a 1 μF capacitor connected in series with each of the balanced inputs

To ensure correct loading of the transformer's secondary when its output is connected to the INPUT of the 2426 the transformer is provided with a 25 kΩ load which may be selected using its INT. LOAD switch.

The frequency and phase characteristics of the transformer are shown in Figs. 6.2 and 6.3, while the maximum input voltage ratings for different signal frequencies are shown in Fig. 6.4. If signals containing a DC component are to be measured then a 1 μF capacitor should be connected in series with each of the transformer's balanced inputs for DC blocking purposes.

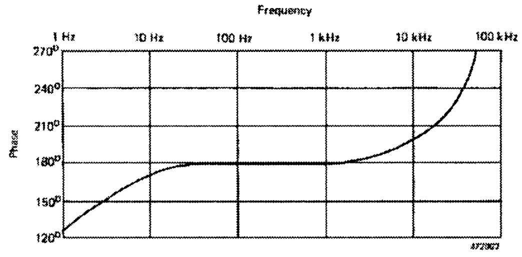


Fig. 6.3. Phase characteristics of Input Transformer TI 0001

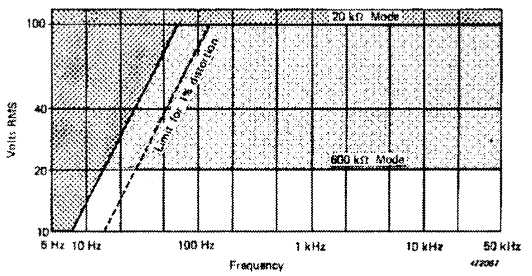


Fig. 6.4. Maximum input voltage ratings of Input Transformer TI 0001