

instructions for

ADDENDUM (MICRO-18)

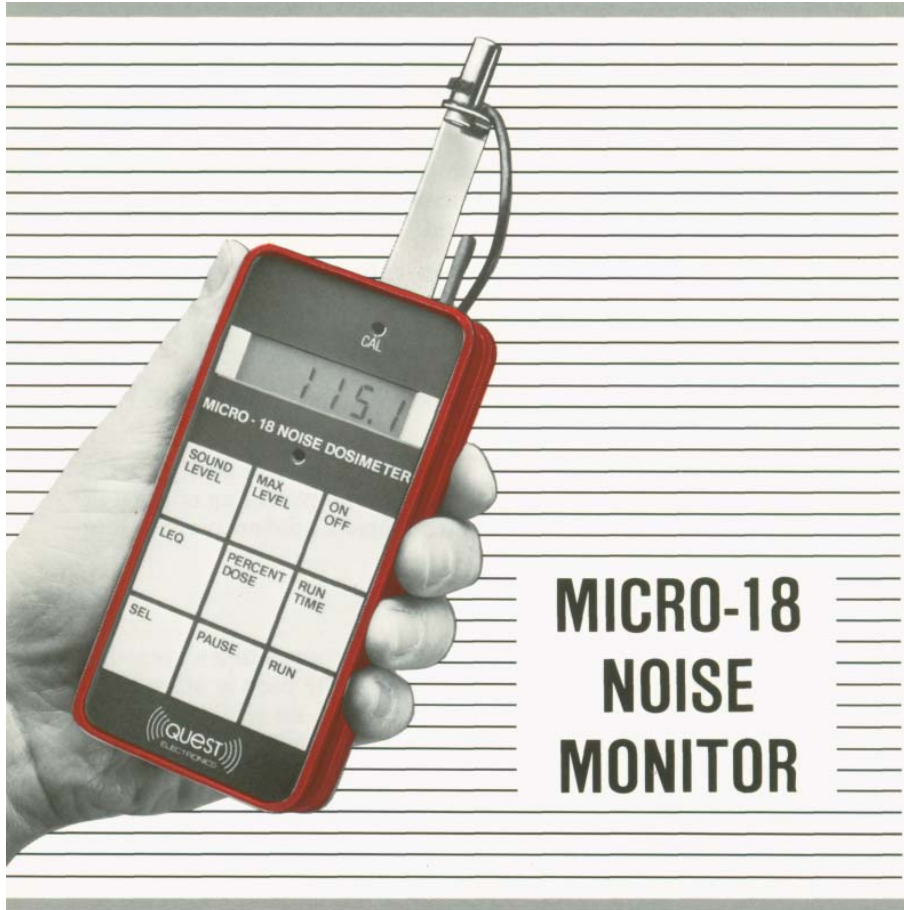
The following new features have been added to the Micro-15/14/ 18.

- 1.) The convenience of a latching Sound Level Key means hands free updating of the display with the current sound level. Simply press any other key to deactivate this function.
- 2.) To speed operation and assure single touch response, the keyboard is now scanned by the microprocessor 16 times per second rather than the previous once per second.
- 3.) The ease of calibration has been enhanced by the use of an algorithm for small magnitude changes. The algorithm had been averaging over a one second period. The new algorithm averages small magnitude changes over a 63 msec, period.
- 4.) The overload time threshold has been changed from 115 dB Peak to 115 dB RMS.
- 5.) The code for switch settings is displayed automatically on the LCD startup. This serves to confirm the proper set up of the unit and is a quick opportunity to assure tampering did not occur during the last operation.

CODE:

The Micro 18 code is normally 1 of 8 codes representing all possible switch setting of the 3 internal switches. If the code is other than these 8 codes, the unit has been modified and an addition should be found in the manual. (Consult a Micro-15 manual or factory if the code sheet can not be found).

	8 HOUR CRITERION	
CODE	LEVEL	THRESHOLD
8277	85 dB	NONE
8677	85 dB	70 dB
8A77	85 dB	75 dB
8E77	85 dB	80 dB
C277	90 dB	NONE
C677	90 dB	70 dB
CA77	90 dB	75 dB
CE77	90 dB	80 dB



MICRO-18 NOISE MONITOR



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INTRODUCTION

The Quest MICRO-18 Noise Dosimeter (Figure 1) is a multifunction sound analyzing instrument in a convenient hand-held package. It provides information as basic as any dosimeter and may also be used as a sound level meter, an integrating sound level meter, and maximum level meter.

This manual begins with brief simplified operating instructions and expands into a complete analysis explanation. The user is advised to review the manual in its entirety to assure proper use of the MICRO-18. However the simplified instructions will provide basic instructions.

SIMPLIFIED OPERATING INSTRUCTIONS

This section is intended as a brief introduction to the MICRO-18. See the appropriate section in the manual for a more detailed description of various functions.

To operate the controls, loosen the single screw on front of unit and remove front cover.



Figure 1. MICRO-18 Noise Dosimeter

Turning the MICRO-18 On

Press ON/OFF key. The MICRO-18 should display "18:8.8.8" for 3 seconds and then display "-----". If this sequence does not occur, check battery.

Changing Battery

Loosen two screws on back of unit and change battery. Use a 9-volt alkaline battery.

Calibration

Insert microphone in a 58-839 calibrator adaptor and place adaptor in calibrator. Turn on calibrator and press SOUND LEVEL on the MICRO-18. The display should read between 109.5 and 110.5 dB. If necessary, adjust CAL screw while pressing SOUND LEVEL to bring reading within these limits.

Pause and Run

When the MICRO-18 is turned on, or is reset, or the battery is changed, or the pause key is pressed, the unit is automatically in the pause mode. In the pause mode, only SOUND LEVEL is active. All other functions may be read but they are not accumulating new data. Press RUN to start or continue accumulating data.

Reading Data

Pressing any key except ON/OFF will cause data to be displayed. The key must be held down for 1 second before it is read. If the key is held down, the data will be updated each second. When the key is released, the last displayed data will remain on the display. If the data can not be calculated (as an example, LEQ can not be calculated if the MICRO-18 has never been in the run mode), then "-----" will be displayed.

Displayed Data

- SOUND LEVEL The current sound level in decibels.
- MAX LEVEL The maximum level with a slow time constant.
- LEQ The average integrated sound level, without a threshold, integrated during run time and expressed in decibels.
- SEL The sound exposure level of the total integrated noise averaged over one second expressed in decibels.

- PERCENT DOSE The accumulated noise dose expressed as a percent for all noise above the threshold.
- RUN TIME The time the unit has been in the run mode and accumulating data. The time will be in minutes and seconds for the first hour; hours, minutes, and 1/10 of a minute from 1 to 20 hours; and hours and minutes after 20 hours.

ON/OFF Mode

To put the MICRO-18 in the off mode, hold the ON/OFF key for five seconds until the display shows "18:8.8.8". When the key is released, the display will be blank.

Data is retained for several weeks when the unit is off.

Press ON/OFF to turn the MICRO-18 back on. No data is lost when the unit is off.

Very low power is drawn from the battery when the unit is off. If it is not going to be used for a few weeks, remove the battery.

Reset Mode

To reset the MICRO-18, hold down both the ON/OFF and the PAUSE keys for five seconds. When the display shows "-----" or ": 0", the unit is reset.

The five-second delay is to prevent accidentally turning the unit off or resetting it.

GENERAL DESCRIPTION

The microprocessor based Quest MICRO-18 Noise Dosimeter simultaneously monitors seven different noise functions. It can be used as a personal noise dosimeter, an area monitor, and as a noise survey instrument.

The MICRO-18 measures the following seven functions:

- Sound level
- Maximum sound level
- Average integrated sound level
- Sound exposure level
- Percent dose
- Run time
- Pause time

The MICRO-18 can be programmed by internal switches to the following parameters:

Criterion levels of 85 or 90 dB for eight hours.
Threshold levels of None, 70, 75, or 80 dB.

The switches are set at the factory to an 85 dB criterion level and to no threshold unless otherwise specified. See SWITCH SETTINGS.

The readings can be taken at any time without destroying or resetting the data. Even turning the unit off will not destroy the internal memory. A water- and dust-resistant cover protect the unit from the elements as well as tampering.

The unit is small enough to be placed in a shirt pocket or on a belt with the microphone clipped to the shirt collar or on the shoulder. The microphone can be attached to a bracket for use as a sound level meter. Or the unit can be mounted on a tripod for area surveys.

The MICRO-18 is powered by a single 9-volt transistor battery with an 80-hour battery life. A low battery indication is displayed eight hours before the end of life of an alkaline battery.

SPECIFICATIONS

Standards: ANSI S1.4-1983 type 2
ANSI S1.25-1978 type 2
IEC 651 type 2 (sound level reads slow response level once each second).
IEC 804 type 2
ISO R1999

Detector: True RMS; 63 dB pulse range and crest factor.

Range: 50-146 dB. (Percent dose and average level from threshold to 146 dB.)

Frequency Weighting: "A" (see Figure 4).

Thresholds: None, 70, 75, or 80 dB. (Consult factory for other settings.)

Exchange Rates: 3 dB. (Consult factory for other settings.)

Criterion Levels: 85 or 90 dB. (Consult factory for other settings.)

Readout: 4-digit liquid crystal display.
Dose: .01 to 19999%.
Time: hours, minutes, and seconds.
Sound level: 0.1 dB.
Integrated sound level: 0.01 dB.

Microphone: 8 mm, omnidirectional PZT ceramic with collar clip and 36-inch cable.

Battery: Single 9-volt alkaline; 80-hour battery life.

Battery Indicator: Shows at least 8-hour battery life is available.

Calibration: External calibrator.

Temperature: -10 to +50°C operating; -40 to +60°C storage (battery removed).

Humidity: 0 to 95% R.H.

Magnetic Field Effects: Negligible below 4000 A/M (50 oersteds) at 50 to 60 Hz.

Size: 2.5 x 5.1 x 1.3 inches (64 x 130 x 33 mm).

Weight: 11 ounces (315 grams) including battery and coverplate.

Construction: CMOS microprocessor in rugged aluminum housing with tamper-, water-, and dust-resistant security cover.

SWITCH SETTINGS

There are three switches inside the battery compartment under the flap. The switches are used to select criterion levels and threshold (see Figure 2).

NOTE

If the switches are missing, the unit has been factory-set for the required criterion level and threshold.

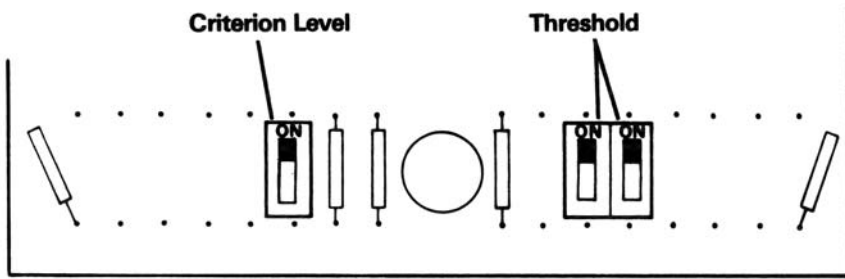


Figure 2. Switch Settings

The criterion level is set with the single switch at the left. On sets 85 dB. Off sets 90 dB.

The threshold is set with the dual switches at the right.

With both of the dual switches on, there is no threshold.

With the left dual switch off and the right on, the threshold is 70 dB.

With the right dual switch on and the left off, the threshold is 75 dB.

With both of the dual switches off, the threshold is 80 dB.

As an example, all three switches are on, the unit is set to an 85 dB for 8-hour criterion level with no threshold.

Consult the factory if other criterion levels, exchange rates, or thresholds are required. Available settings are as follows:

Criterion level: 70, 84, 85, or 90 dB.

Exchange rate: 3, 4, 5, or 6 dB

Threshold: None, 70, 75, 80, or 85 dB.

PRINCIPLES OF OPERATION

General

The MICRO-18 Noise Dosimeter uses an 8-mm omnidirectional ceramic microphone buffered by a high impedance FET input stage. The electronics utilizes low power circuitry for long battery life, maximum stability, and high reliability over a wide range of environmental conditions. A block diagram of the MICRO-18 is shown in Figure 3.

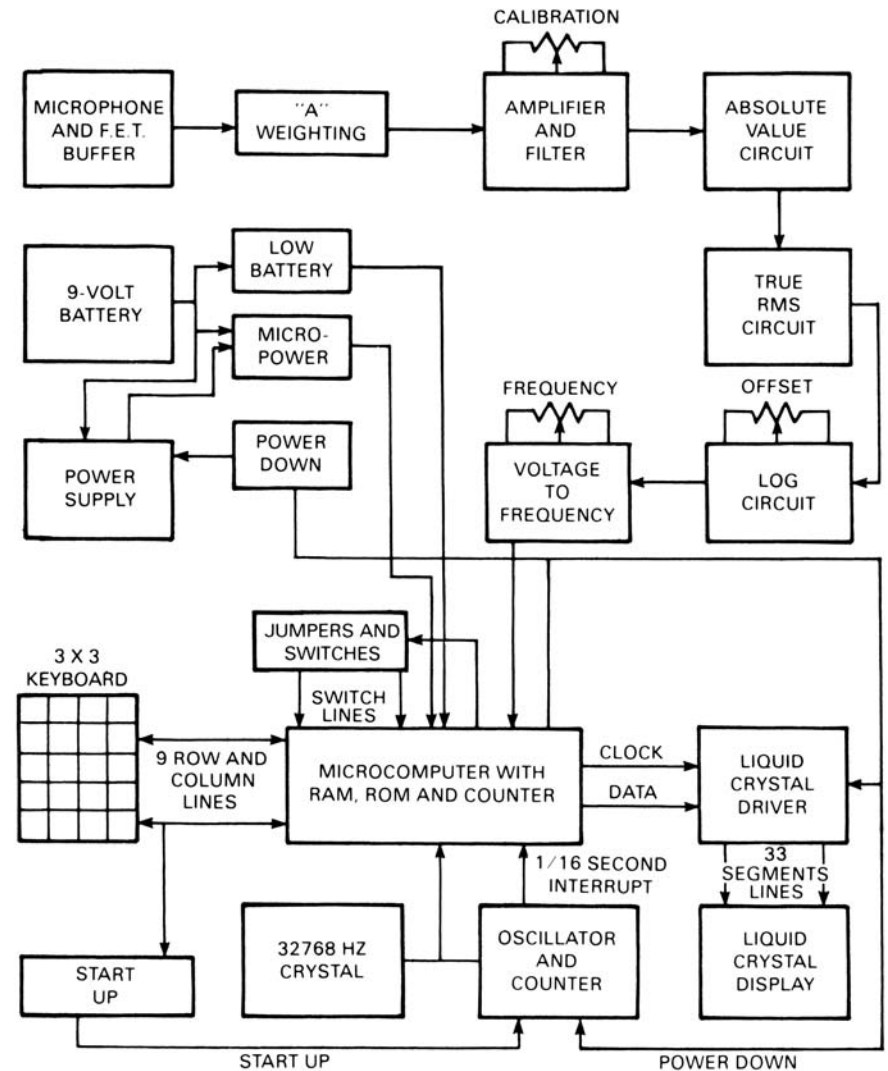


Figure 3. Block Diagram, MICRO-18 Noise Dosimeter

Weighting Characteristics

The MICRO-18 has an "A" weighting characteristic as shown in Figure 4. The "A" weighting provides a response similar to the human ear.

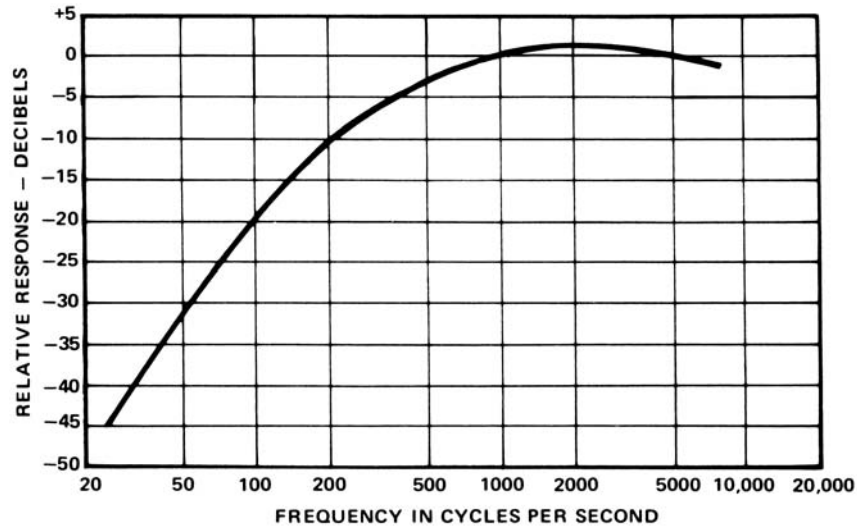


Figure 4. Frequency Response Characteristic for A Weighting

Microphone Characteristics

The microphone used on the MICRO-18 Dosimeter is a Model 1845 ceramic microphone. An integral FET amplifier and a controlled acoustical construction provide the transduction sensitivity level, frequency range, and frequency response required by type 2 instruments. Overall diameter is 8 mm. Typical sensitivity is 70 dB below 1 volt per microbar measured at 1 kHz. Figure 5 is a diagram of a typical microphone response.

Internal Electrical Noise

The internal electrical noise of the MICRO-18 is equivalent to an acoustical level of approximately 40 dB. This is 10 dB below the minimum sound level and has little effect on the readings.

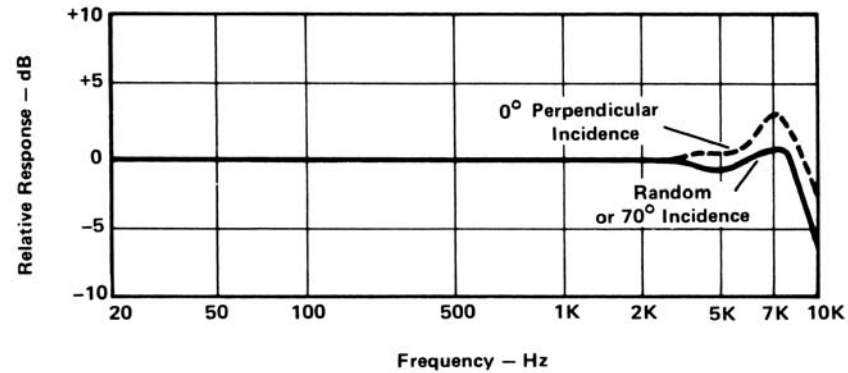


Figure 5. Model 1845 Microphone Response — Perpendicular and Random Incidence

Microcomputer Modes

The MICRO-18 is controlled by an MC146805 CMOS Microcomputer. The MC146805 in addition to being a general purpose microprocessor has 32 input/output lines, 112 bytes of RAM, 2106 bytes of ROM, a counter, an interrupt, a low power wait state, and a very low power stop state. The MICRO-18 operates in one of the following six modes.

Reset Mode

The MICRO-18 enters the reset mode when the unit is reset or a battery is installed. In this mode power is applied to the unit, all previous data is cleared, the counter is cleared, the pause register is set, four dashes are placed on the display, and the unit enters the wait mode.

Wait Mode

The microcomputer waits for an interrupt to occur. During the wait mode it continues to gather data from the voltage to frequency converter. Otherwise the microcomputer is in a low power state. When the 1/16 second interrupt occurs, the unit enters the pause or run mode depending on the pause register.

Pause Mode

In this mode the SLOW time constant sound level is computed and the pause time is counted. Every second the keyboard is checked to see if any key is pressed. If a key is pressed the computer enters the compute mode. Otherwise it returns to the wait mode.

Run Mode

This is the same as the pause mode except the data necessary to compute Maximum Level, LEQ, SEL, Percent Dose, and Run Time is accumulated.

Compute Mode

If a key has been pressed in the pause or run modes the MICRO-18 will compute and display the desired function. If the key is held down it will recompute it one second later using the data accumulated during that second. If the data will not compute (as an example, Lavg will not compute if the sound level never exceeds the threshold level) the display will show four dashes.

When computing is completed, the processor returns to the wait mode.

Stop Mode

If the ON/OFF key has been depressed for five seconds, the MICRO-18 enters the stop mode. In the stop mode the processor stops accumulating but does not erase data. Power is removed from the analog circuitry and the display circuitry. The 32,768 Hz oscillator is stopped as is the processor oscillator. Only a few microamps of current are drawn from the battery to maintain the microcomputer memory and to power the ON/OFF key.

When the ON/OFF key is then pressed the computer returns to where it was before it was turned off except it will be in the pause mode.

Formulas and Definitions

The MICRO-18 uses the following formulas to calculate the accumulated data:

$$DOSE = \frac{100}{TC} \left[\int_0^{RTIME} 2^{(LS-CRIT)/3.01} dt \right]$$

$$LEQ = 3.01 \left[LOG_2 \int_0^{RTIME} 2^{L/3.01} dt - LOG_2 (RTIME) \right]$$

$$SEL = 3.01 \left[LOG_2 \int_0^{RTIME} 2^{L/3.01} dt \right]$$

Where:

- LS = Sound level in dB with SLOW time constant if the sound level is greater than the threshold level and is -∞ if the level is less than the threshold level.
- L3 = Sound level without SLOW time constant.
- TC = Criterion time in seconds or 28800 seconds.
- RTIME = Run time in seconds.
- CRIT = Criterion level in dB.

Key Functions

- SOUND LEVEL The sound level, in decibels, at the end of each second, with slow (1 second) time constant. SOUND LEVEL is the only function active during pause time.
- MAXIMUM LEVEL The maximum sound level, in decibels, with slow time constant.
- LEQ The integrated average sound pressure level without a threshold. It is measured in decibels.
- SEL The total sound exposure level in decibels integrated over one second.

- PERCENT DOSE The dose measured as a percent of the allowable 8-hour dose of all the noise greater than the threshold.
- RUN TIME Length of time the unit has been in run mode.

Controls

- ON/OFF When pressed for five seconds, unit turns off and the display becomes blank. When unit is off, pressing the key will turn it back on in the pause mode. Memory is not erased when unit is turned off. When off, the battery drain is very low.
- PAUSE Stop accumulating data. Only sound level is active. When key is pressed, pause time is displayed.
- RUN Starts or continues accumulating data. Display shows run time.
- RESET Pressing both PAUSE and ON/OFF for five seconds will cause the unit to reset. After the unit has reset, a "0" will be displayed and the unit will be in the pause mode.

TESTING AND CALIBRATION

Battery Test

Press SOUND LEVEL and check the display for a single decimal point (example 72.9). If additional colons and decimal points appear (example :7:29), the battery is low and requires replacement. If the decimal points and colons are reversed after a day of use but had been normal at the start of the day, the readings are still good.

Battery Replacement

Loosen the two screws on the back of the unit and remove the back. Remove the battery from the cavity and carefully unclip the battery. Replace with a new battery. Take care to observe the polarity of battery and do not reverse the terminals. For best results use a 9-volt alkaline battery. Replace the battery in the compartment and check the display. If it displays four dashes replace the back cover. If not, check the connections on the battery. The MICRO-18 is now operating in the pause mode.

NOTE

When the unit is off, the battery still powers the memory. If the unit is not going to be used for a few days, remove the battery.

Calibration and Maintenance

The MICRO-18 should maintain its accurate calibration for many months of use. However, to insure consistently accurate operation it is recommended that the unit be sent to a reliable calibration facility once a year for a complete checkout and calibration.

The MICRO-18 should be checked each day before it is used. It is recommended that one of the Quest calibrators, such as the CA-12B, CA-15B, CA-22, or the CA-32 Sound Level Calibrators be used with the proper 8-mm microphone adaptor.

Daily Calibration

1. Turn MICRO-18 on, press SOUND LEVEL, and check to see if only one decimal point is on the display. If two colons and a decimal point are on, the battery is low and should be changed.

2. Turn on the calibrator and check the battery indicator. Replace the battery if required. If the calibrator has multiple frequencies or levels, set it to 1000 Hz and 110 dB. Listen to see if the calibrator is producing a tone.

3. Remove the windscreen from the microphone. Carefully insert the microphone in the coupler and place the coupler in the calibrator.

Make sure the microphone is inserted all the way in the coupler and the coupler rests flush on the inner rim of the calibrator. Turn the calibrator on and hold down the SOUND LEVEL key on the MICRO-18. The MICRO-18 should display between 109.5 and 110.5 dB.

Atmospheric pressure has virtually no effect on the MICRO-18. However, calibrator sound levels are affected by altitude; and if the MICRO-18 is calibrated at high altitudes, corrections must be made. For the Quest CA-12B calibrator the correction is -.1 dB for each 2000 feet above sea level. For example, at 6000 feet the MICRO-18 should be calibrated to 109.7 dB.

4. If the reading is off slightly, insert a small screwdriver in the hole above CAL and slowly turn the adjustment screw while pressing the SOUND LEVEL key until the display reads 110.0 dB.

5. The MICRO-18 is now calibrated and ready for use.

6. If a calibrator is used at any frequency other than 1000 Hz, then the proper correction for that frequency weighting must be made (see Figure 4).

OPERATING PROCEDURE

1. If display is blank, press ON/OFF to turn unit on.

2. Clear the MICRO-18 memory by pressing and holding down both the ON/OFF key and the PAUSE key for five seconds until the display shows a single zero and a single colon.

3. If two decimal points and a colon are displayed, replace the battery and continue.

4. Check the calibration of the unit (see Calibration and Maintenance).

5. Attach the microphone to the collar of the operator (see Effects of Operator Presence).

6. Press the RUN key.

7. Install the security cover and attach the unit to the operator's belt or pocket.

8. At the end of the workday, remove the security cover and press PAUSE.

9. Remove the unit from the operator.

10. Press each function key and record the results.

11. Press the ON/OFF key until the display becomes blank. If the unit is not going to be used for several days, remove the battery.

Effects of Operator Presence

Any object or surface can act as a reflector or absorber of sound. An operator or person wearing the dosimeter is also a reflector or absorber of sound and affects the microphone performance. The MICRO-18 is designed to read correctly with the microphone in a random incidence sound field without the presence of reflecting objects.

The recommended placement of the microphone for personal noise monitoring is on the shirt collar, high on the shoulder, and away from the neck as far as practical (see Figure 6). If the noise is directional it is generally the best practice to place the microphone near the ear which receives the most noise exposure.



Figure 6. Recommended Placement of Microphone

If the MICRO-18 is to be used as a hand-held instrument the microphone should be mounted on the 58-863 microphone bracket (see Figure 7). It may be either clipped to the bracket or the clip removed and the microphone screwed to the bracket. The bracket is then attached to the belt clip on the back of the instrument. If desired the complete unit can be mounted on a tripod (see Figure 8). The microphone should be pointed upward forming approximately a 70-degree angle with the noise source. It should not be pointed at the noise source.



Figure 7. Microphone Mounted on 58-863 Bracket



Figure 8. MICRO-18 Mounted on Tripod

Use with Windscreen

To prevent wind from blowing across the microphone and causing erroneous measurements, the Model WS-5 windscreen should be used (see Figure 6). It is recommended that the windscreen be used at all times. In addition to wind protection it helps support the microphone in an upright position and protects it from dust, oil, and humidity. The windscreen is made of reticulated polyurethane foam. The acoustical attenuation is small and can generally be neglected. Attenuation is approximately 0.5 dB at 8 KHz, 0.25 dB at 4 KHz, and 0 at frequencies below 2.5 KHz.

INTERPRETING RESULTS

Estimating TWA from LEQ

A short term sample can be used to estimate a worker's 8-hour Time Weighted Average. After 8 hours a worker's TWA would be equal to the LEQ. If the work day is other than 8 hours, the TWA can be calculated by adding a correction factor to the representative LEQ reading.

As an example, if a worker has an LEQ of 85.50 dB after a 10-minute sample, and the sample is representative of the noise throughout the workday, and the workday at that position is 7:15 then from Table 1 in the 3.01 exchange rate column find -.42 dB and subtract it from 85.50 to compute a TWA of 85.08 dB.

Accuracy of Readings

There is a tendency to overestimate the accuracy of digital readings. In the MICRO-18, some values such as LEQ are computed to 0.01 dB. The absolute accuracy of the reading is not 0.01 dB. (See specifications for accuracy and tolerances.) However, the resolution of 0.01 dB is useful in determining the sample time required for a short-term sample. As an example, if LEQ reading is increasing .03 dB every second then additional sample time may be required. If the reading remains stable within a few 0.01 dB's then the sample time may be long enough.

Hints and Good Practices

The MICRO-18 is in the pause mode when it is turned on, is reset, the pause key is pressed or after the battery is replaced. Wait until the SOUND LEVEL has stabilized before entering the run mode.

Always remember to press RUN.

Table 1. Corrections for Computing TWA from LEQ. Values in this Table were computed from the formula:

$$\text{Correction} = \text{ER} \times \text{Log}_2 \frac{\text{Workday}}{8}$$

WORK-DAY HR:MIN	EXCHANGE RATES			
	3.01dB	4dB	5dB	6.02dB
0:30	-12.04	-16	-20	-24.08
1:00	-9.03	-12	-15	-18.06
1:30	-7.26	-9.66	-12.07	-14.53
2:00	-6.02	-8	-10	-12.04
2:30	-5.05	-6.71	-8.39	-10.1
3:00	-4.25	-5.66	-7.07	-8.51
3:30	-3.59	-4.77	-5.96	-7.18
4:00	-3.01	-4	-5	-6.02
4:15	-2.74	-3.65	-4.56	-5.49
4:30	-2.49	-3.32	-4.15	-4.99
4:45	-2.26	-3	-3.76	-4.52
5:00	-2.04	-2.71	-3.39	-4.08
5:15	-1.82	-2.43	-3.03	-3.65
5:30	-1.62	-2.16	-2.7	-3.25
5:45	-1.43	-1.9	-2.38	-2.86
6:00	-1.24	-1.66	-2.07	-2.49
6:15	-1.07	-1.42	-1.78	-2.14
6:30	-.9	-1.19	-1.49	-1.8
6:45	-.73	-.98	-1.22	-1.47
7:00	-.57	-.77	-.96	-1.15
7:15	-.42	-.56	-.71	-.85
7:30	-.28	-.37	-.46	-.56
7:45	-.13	-.18	-.22	-.27
8:00	0	0	0	0
8:15	.13	.17	.22	.26
8:30	.26	.34	.43	.52
8:45	.38	.51	.64	.77
9:00	.51	.67	.84	1.02
9:15	.63	.83	1.04	1.26
9:30	.74	.99	1.23	1.49
9:45	.85	1.14	1.42	1.71
10:00	.96	1.28	1.6	1.93
10:15	1.07	1.43	1.78	2.15
10:30	1.18	1.56	1.96	2.36
10:45	1.28	1.7	2.13	2.56
11:00	1.38	1.83	2.29	2.76
11:15	1.48	1.96	2.45	2.96
11:30	1.57	2.09	2.61	3.15
11:45	1.66	2.21	2.77	3.33
12:00	1.76	2.33	2.92	3.52
12:30	1.93	2.57	3.21	3.87
13:00	2.1	2.8	3.5	4.21
13:30	2.27	3.01	3.77	4.54
14:00	2.43	3.22	4.03	4.86
14:30	2.58	3.43	4.28	5.16
15:00	2.73	3.62	4.53	5.46
15:30	2.87	3.81	4.77	5.74
16:00	3.01	4	5	6.02

Considerations of Measurement and Accuracy

An integrating meter such as the MICRO-18 Noise Dosimeter can integrate all continuous, intermittent, and impulsive sound levels within the range of the instrument. This avoids many of the potential errors created by attempting to read and interpolate sound level meters in fluctuating sound fields. However, it is important to use correctly and to understand the limits of any instrument to achieve its maximum accuracy.

Microphone location generally has the greatest effect on the accuracy of any noise measuring instrument. The correct placement of the MICRO-18 microphone has been discussed under "Effects of Operator Presence".

Threshold discontinuity can cause notable differences in readings on various meters if the noise level is near the unit's threshold. Since the instrument assumes that noise even slightly below the threshold is absolutely quiet, that noise level is not accumulated into the results while a noise level just slightly higher is accumulated. This is most noticeable in the readings of dose if the threshold is the same as the criterion level.

Peak noise levels greater than the range of the instrument are "clipped" and act as if they were at the maximum level of 146 dB.

Crest factor is an almost meaningless term for instruments with crest factors in excess of 30 dB. The MICRO-18 is capable of measuring pulses as short as 1 millisecond, with a peak amplitude of 143 dB and a background level of 80 dB. This is a pulse range of 63 dB. The crest factor would depend on how often this pulse occurred but could be greater than 60 dB.

ACCESSORIES

Model WS-5 Windscreen

Refer to page 16 for instructions on using the MICRO-18 microphone.

Service Policy

The Quest product you have purchased is one of the finest acoustic instruments available. It is backed by our full one year warranty which seeks complete customer satisfaction. This is your assurance that you can expect prompt courteous service for your equipment from the entire Quest service organization.

Should your Quest equipment need to be returned for repair or recalibration, please contact the Service Department at (800)245-0779 (USA) or Fax (262)567-4047 for a Return Authorization Number. The RA number is valid for 30 days, and must be shown on the shipping label and purchase order/cover letter. If you are unable to return instruments in that time call for a new RA number. Send it prepaid and properly packed in the original shipping carton directly to Quest Technologies, 1060 Corporate Center Drive, Oconomowoc, WI 53066 U.S.A.

Repair or replacement work done under warranty will be performed free of charge, and the instrument will be returned to you prepaid. Your copy or a photocopy of the Quest Registration Card will serve as proof of warranty should the factory require this information.

If for any reason you should find it necessary to contact the factory regarding service or shipping damage, please direct your calls or letters to the attention of the Service Manager, Quest Technologies, (262) 567-9157 or (800) 245-0779. Office hours are from 7 AM to 6 PM (Central Standard Time) Monday through Friday.

For service or recalibration outside the U.S.A., please contact your local Quest Dealer or fax Quest U.S.A. at (262)567-4047.