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# *ACCUTRON*

# *B-MOD*

**MINE AIRFLOW SENSOR**

**TECHNICAL  
INFORMATION**





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## **ACCUTRON B-MOD – SPECIFICATIONS**

### **Introduction**

The ACCUTRON B-MOD is a compact rugged ultrasonic airflow monitor system specially designed for mine environment.

The system consists of three units – a Control Unit and two transducer assemblies that are connected by a cable to the control unit.

In use, the two-transducer assemblies units are aligned across a tunnel section to intersect the airflow. Ultrasonic pulses travel across the tunnel between the two units. The transit times are measured accurately by the on-board microelectronics in the Control Unit, and this information is directly proportional to the airflow. The system is able to measure flow in excess of 1 000 000 CFM with a precision better than any conventional method used for measuring airflow. Because the system samples the airflow across the entire tunnel, instead of at one point (such as the case with Venturi Tubes), the errors caused by turbulence of the airflow are minimized.

The ACCUTRON B-MOD utilizes advanced microprocessor technology, and can easily be programmed on site via laptop computer to obtain the readings of airflow or air velocity in any units required. Direct readings of airflow in real time can be made via the LED display screen on the control unit and/or remotely using the 4-20mA output.

The main advantages are the ability to sample across the entire airflow distribution in the tunnel, resulting in an inherent average reading over the cross section of the tunnel. Other instruments, placed at specific points give the readings at only one point in the tunnel.





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## ACCUTRON B-MOD – SPECIFICATIONS / Electronic and Mechanical

Physical Size:	Control Unit	9.41 inch (L) x 11.62 inch (H) x 4.35 inch (D)
	Mounting Centers	6.0 inches (L) x 10.75
	Transducer Assembly	2.25 inch diameter x 7 inch (L)
Mounting:	Industrial CATV pan and tilt mount for transducer assemblies	
Display Readout:	Eight Digit Alphanumeric LED display (standard) <ul style="list-style-type: none"><li>▪ Simple display of airflow volume in any user specified units.</li><li>▪ The LED display can be turned on or off, by programming.</li></ul>	
Available Outputs:	Serial Links	RS-232 for programming
	Analog Output	4-20 mA instrumentation output
	Analog Output Modes	Normal: 4 mA = to 0 airflow 20 mA = to max airflow
		Split: 12 mA = to max airflow 4 mA = to max neg (-) airflow 20 mA = to max pos (+) airflow
	Full Scale	arbitrarily specifiable during programming
Connectors:	Aluminium Alloy military style	
Power Requirements:	110 Vac / 6 W	standard
	220 Vac / 6 W	optional
	12 Vdc / 6 W	standard

## MECHANICAL CONSTRUCTION

Control Unit:	Industrial style Polystyrene with clear door, gasketed to NEMA 12/13.
Transducer Ass'y:	ABS Plastic, completely sealed against moisture and contamination

## MEASUREMENTS RANGE

Moving average:	1 to 255 points (50pts recommended) to smooth out gusty airflows
Display Units:	KCFM, M <sup>3</sup> /s, M/S, fpm
Resolution:	better than 1%*
Accuracy:	better than 2.5%* (on the 100,000 cfm scale with 5M separation between units. For higher ranges, the accuracy is greater.



**LEGEND**

TB1	Line
TB2	Neutral
TB3	Ground
TB4	4-20 mA (+)
TB5	4-20 mA (-)

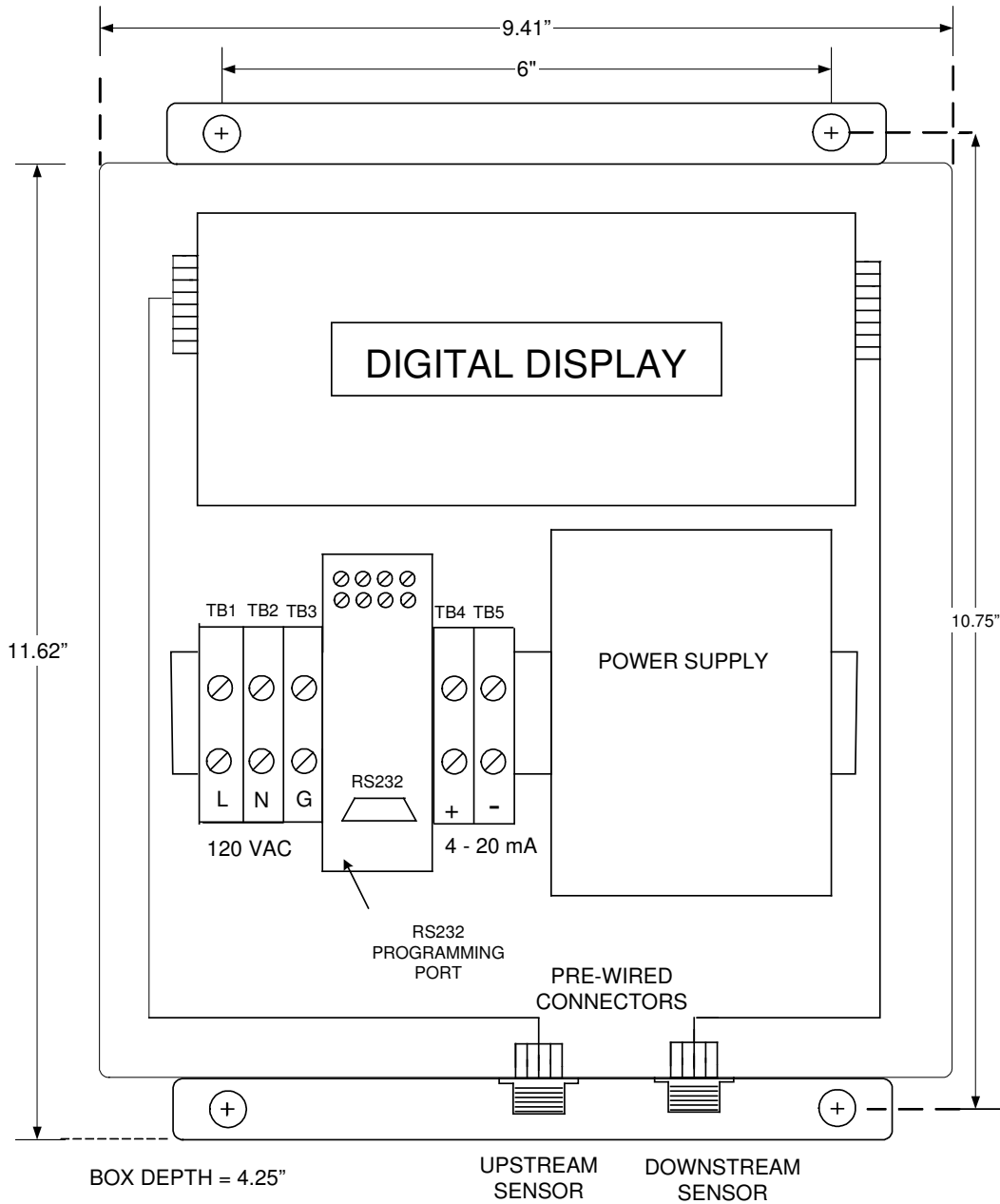


Figure 1. Dimensions & Wiring detail.



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Max Airflow: greater than 1 000 000 CFM

\* This accuracy figure assumes perfect symmetry in the airflow distribution about the “imaginary line” between the (2) transducer assemblies. The actual accuracy would be dominated by the degree of “asymmetry” of the airflow distribution about the line between the master and slave units, and this generally not perfectly symmetrical in mine tunnels, as explained in a later section.

In the case of perfect symmetry in the airflow distribution about the line between the master and slave units, the accuracy of the Accutron B-MOD is dependent on how accurately the transit times can be measured.

The percent error for a given measurement is governed by the equation for the Accutron B-MOD

$$\text{Error \%} = 24 \times A \times 100 (\%) / [(\text{CFM reading}) \times B]$$

Where: A is the area in ft squared  
CFM Reading is the airflow reading seen on the unit  
B is the separation distance in Meters between the Master and Slave units in the direction of the drift axis

**Example:** suppose the unit is reading 10,000 CFM, B is 2 meters, and A is 100 sq. ft.  
The error is 12%  
If – the airflow was 50,000 CFM, then the error is 2.4%

Other sources of error are the errors in measuring the area and the B (base line) dimension. If there is a 2% error in measuring the length, and a 2% error in measuring the height, then the total error in the area is 4%. If there is a 2% error in measuring the B dimension, then this will introduce a further 2% error for a total of 6%, contributed only from measurement uncertainties. This does not mean the instrument is necessarily out by 6% - it only means that it could be if all the uncertainties “ganged up” in the worst possible way.

A further source of error is due to any unsymmetries in airflow distribution about the imaginary line between the (2) transducer assemblies units across the mine tunnel.

It is recommended to do a quick survey using a pitot tube anemometer to check the airflow distribution prior to the installation. In some cases, we may be required to install the unit in less-than-ideal location that may not yield the actual airflow. It is possible to multiply up or multiply down the reading in these cases to yield the amounts determined by the ventilation engineer. This is done during set-up by using the “calibration correction”, nominally set a 1.000. It may seem that this is defeating the purpose of using such an instrument, but in the hands of knowledgeable people, it still can be a useful tool that will then track the airflow as it increases or decreases.

#### **Application Example:**

To illustrate the point regarding airflow distribution in tunnels, we give the following example from a test done at Holt McDermott mine. In the drift, 90,000 cfm was the expected airflow. The Accutron B-MOD was installed, and indicated airflow of 73,000 cfm.

In an attempt to explain the discrepancy, a quick 9-point survey was done, and yielded the following values in fpm, using a pitot tube anemometer:





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675	600	715
860	940	880
885	845	830

The tunnel area was measured to be 95 sq.ft.

If we consider the average of the indicated airflows, we obtain 803 fpm. Using the 803 fpm in the calculation, we obtain 76, 317 cfm, which is in good agreement with the ACCUTRON B-MOD airflow sensor.

### **Ultrasonic Airflow Measurements vs. Other Techniques of Airflow Measurements**

When airflow is measured using different instruments, such as moving vane anemometers, hot wire anemometers, pitot tubes, tracer gas tests, the results often can vary from 10 to 15%. In tests done by Canmet, at their Val D'OR research mine, the researchers found that the results from ultrasonic anemometers compared most closely to the results obtained by the tracer gas method, recognized as the most accurate.

Other instruments tend to bias readings upward. However, the other instruments are still recognized as measurement methods. The ACCUTRON B-MOD may, if desired, be set up with airflow readings normalized to another measurement method. This is accomplished by using the "calibration correction", nominally set at 1.000. To increase or decrease the readings, simply adjust the calibration correction factor accordingly.

### **PROGRAMMING THE UNIT**

A special software program that runs on an IBM compatible computer is supplied with the unit. It permits the user to program the unit for different site configurations. To start the software, type **AIRFLOCK.EXE** followed by "**Enter**" at the prompt on your screen. The application software prompts the user to enter the data about the configuration, such as distance between the units, and angles between the ultrasonic beam direction, and measurement units. When done, the information is saved in a non-volatile EEPROM memory in the ACCUTRON B-MOD.

### **SPECIAL FEATURES FOR AUTOMATED VENTILATION CONTROL**

4-20 mA output      4-20 mA output – 20 mA corresponds to full scale  
4 mA corresponds to zero airflow

Measurement Units      Output can be programmed as cmm, dfm, f/s or m/s (standard), or any other units.  
Units are shown on the display, arbitrary units are indicated as "spc", for special.





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Data averaging: The unit may be programmed to output a moving average of measured data. Averaging parameters are set by programming.

Negative airflow: If the airflow reverses, the unit indicates this using a (-) sign in front of the displayed number. For 4-20 mA usage, the absolute value is output, however, a digital signal is available on the connector that changes state to indicate a reversal of airflow direction. In automated systems, this may be connected to PLCs or other control equipment.

An alternate 4-20 mA output format is available, where the 0 airflow corresponds to 12 mA (mid point between 4 and 20 mA). Full-scale positive airflow corresponds to 20 mA, and full-scale negative airflow corresponds to 4 mA.



## INSTALLATION

### INSTALLATION

IN A TYPICAL INSTALLATION ONE SENSOR IS MOUNTED APPROX. 1.5X THE WIDTH OF THE DRIFT AS ILLUSTRATED.

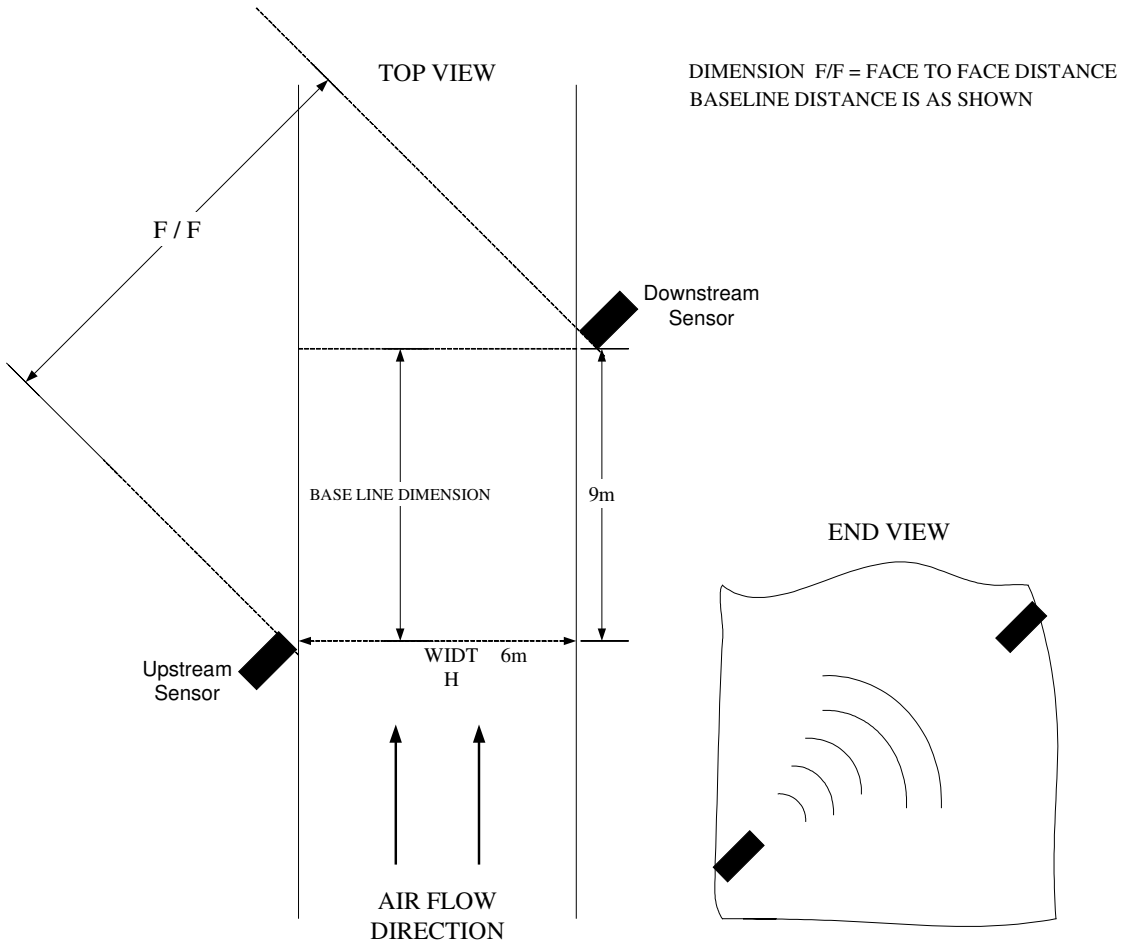


Figure 6. Typical Installation

Figure 7. Typical Installation Plan View

UPSTREAM SENSOR IS MOUNTED AT THE BASE OF THE DRIFT AND IS ALIGNED WITH THE DOWNSTREAM SENSOR WHICH IS MOUNTED NEAR THE TOP OF THE DRIFT. THIS TYPE OF INSTALLATION ALLOWS FOR BETTER AIR FLOW VELOCITY AVERAGING, AS NORMAL AIR VELOCITY WILL VARY FROM UPPER TO LOWER POINTS WITHIN THE DRIFT

DRIFT / TUNNEL INSTALLATION LOCATIONS

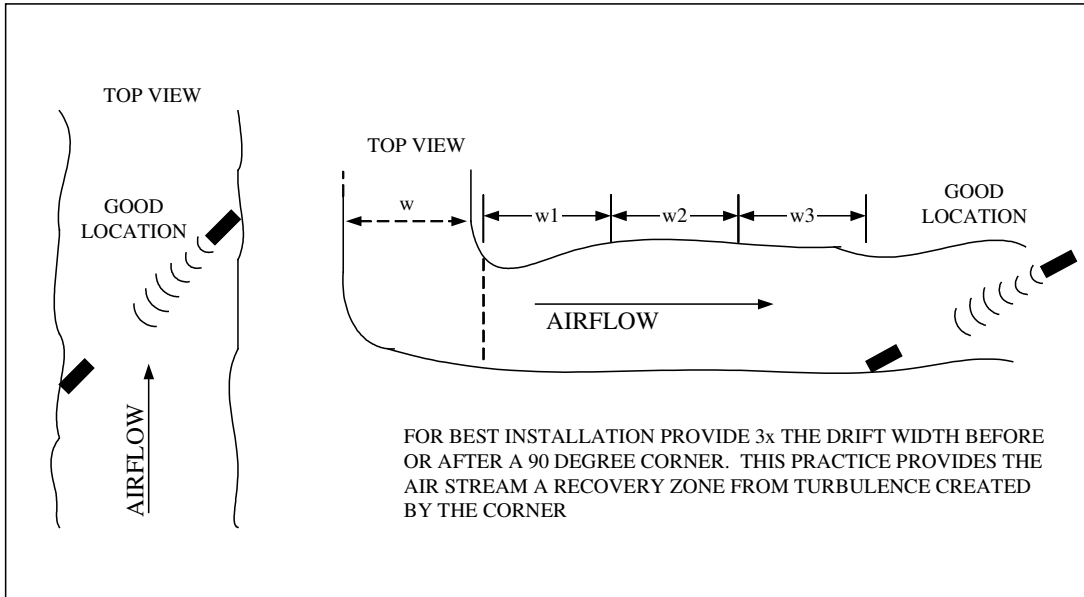


Figure 8. Example of Recommended Locations

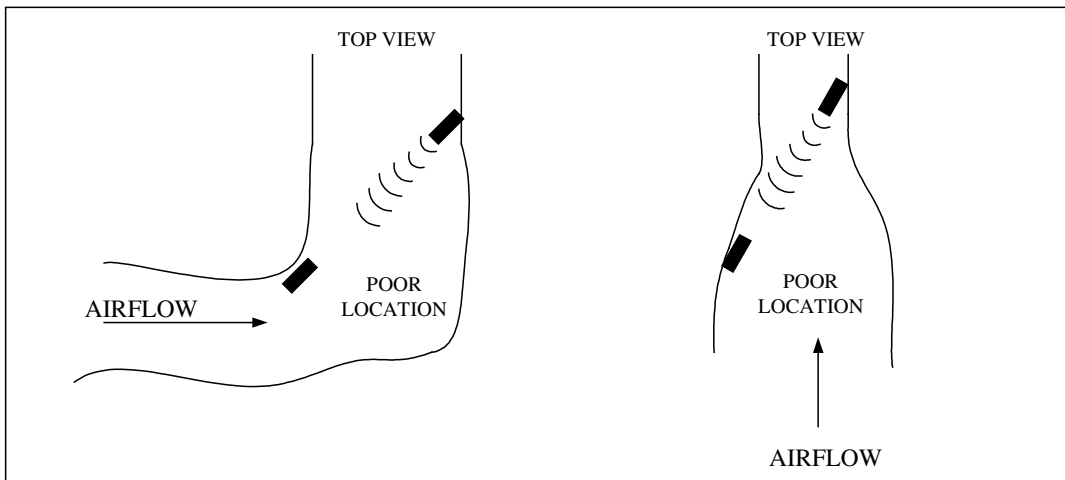


Figure 9. Examples of Poor installation locations



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## **INSTALLING THE SETUP PROGRAM**

To install the setup program, place the CD ROM into the disk drive. There are 3 directories on the CD ROM. These are AIRKD1, AIRKD2 and AIRKD3. Copy the files from AIRKD1 to a 1.44M floppy. Label as Disk 1. Do the same for AIRKD2 and AIRKD3 (these will be Disk 2 and Disk 3 respectively). You now have a set of distribution diskettes that may be installed on any PC.

To install, be sure to shut down any programs currently running, as well as those running in the background. Insert Disk 1 into the floppy drive, and from the file manager, run SETUP.EXE from Drive A. Setup will then guide you through the installation process and prompt you when it is time to insert Disk 2 and 3.

## **PROGRAMMING**

To program a unit, simply connect the "power / programming cable" in series with the main power cable to the control unit. On power-up, the Control Unit automatically enters "Program Mode", and this is shown by "PMG" being displayed on the LED display. Then connect the RS232 serial cable to the laptop computer, and run the program "AIRFLOK.EXE". Enter your data regarding geometry of the setup, airflow units required and 4-20 parameters. Then click on the "Generate" button, and then the "PROGRAM" button.

The computer then passes the generated data to the Control Unit, and verifies, and the programming is complete.

All setup data is held permanently in a non-volatile EEPROM in the Control Unit. On power failure or restart, the setup information is automatically reloaded from memory.

The setup program is supplied on a CD ROM disk.





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## Accutron B-MOD Setup Screen Data Entry – AIRFLOK.EXE

1. Enter distance between master and slave in (M) meters ex: 10.12
2. Enter horizontal baseline separation between master and slave (M)  
[Items 1 and 2 are used to compute trigonometric data.]
3. Enter the area of the tunnel in sq ft.
4. Enter display units (Select 0, 1, 2, 3, 4)
  - 0 = velocity m/s meter/sec
  - 1 = volume cfm cubic feet per min
  - 2 = volume kcfm thousands of cubic feet per minute (3 digit XXX.X)
  - 3 = volume kcfm thousands of cubic feet per minute (4 digit XXXX)
  - 4 = special units
5. Enter Airflow Sense (select):
  - 0 for positive values when air blows toward Master
  - 1 for positive values when air blows away from Master
  - **Note:** this setting was used with the Accutron B-MOD, and is not important for the Accutron B-MOD. The effect is to reverse the “sign” of the airflow reading from + to - and vice versa. The same may be accomplished by reversing the cables that go to the transducer assemblies at the Control Unit.
6. Moving Average (select): Enter number of points involved in averaging (1 to 255)
7. Enter 4 to 20 mA Mode (select)
  - 0 for normal (4mA = 0 airflow, 20mA = max full scale)
  - 1 for split (12mA = 0 airflow, 20mA for max full scale, and 4mA = max full scale neg (-) airflow)
8. Enter 4-20 mA maximum full-scale value in the units selected in (4)
  - Ex: if KCFM was selected, and 100 KCFM is to be the maximum full scale for the 4-20mA link, then enter 100.
  - If the airflow exceeds the full scale programmed, it will output the maximum value, ie; 20mA.
  - The visual LED display is not limited by the 4-20 mA full-scale value.
9. Enter Calibration correction: This is nominally 1.0000, but may be manually overridden.
  - The effect is that measurements are multiplied by this factor, and can be used to take into account special circumstances.
10. Digital Discriminator: Enter the maximum airflow velocity expected M/S, at which point measurement samples are rejected. This makes the instrument very immune to false readings (for example if a scoop tram parked between the Master and Slave. The display also indicates when a pulse is being rejected, by lighting a small circle in the LED display.

