Report BAY-00159 (Rev. 1)

# VENDING MACHINE ENERGY EFFICIENCY DEVICE ENGINEERING EVALUATION AND TEST REPORT

## Bayview Technology

**Model:** **Vending Mi$er**
**Serial No.** **1200-260 (Evaluation Unit)**
**1200-261 (Test Unit)**

***Prepared for:***


**Mr. David J. Schanin**
**President**
**Bayview Technology Group, Inc.**
1091 Industrial Rd., Suite 106
San Carlos, CA 94070


***Prepared by:***


**Foster-Miller, Inc.**
195 Bear Hill Rd.
Waltham, MA 02451-1003


June 1, 2000

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# 1. Engineering Evaluation

The Vending Mi$er (VM) was carefully inspected and disassembled, as required, to gain visual access to internal components. The evaluation included the three categories outlined below.

***Integrity***
General impression of how components satisfy their design function, including areas such as suitability, durability, safety and simplicity.

***Manufacturing Quality***
How well the device was fabricated, assembled, adjusted, etc.

***Serviceability***
How easily the device is set up.

A numerical rating of 1 (poor) to 5 (excellent) was assigned for each category. Comments were provided for each category and classified as advantages, disadvantages or observations. As necessary, the comments will be followed with recommended improvements. We relied on Bayview to provide FMI with schematics, assembly drawings and component information. Engineering Evaluation Scores are provided in Table 1.

## 1.1 Mechanical

A The control box is a robust molded plastic two-piece assembly. The plastic walls are relatively thick. Four screws secure the two halves.

A/D A robust plated steel wall mounting bracket is provided. No mounting screws were provided.

A Large molded strain relief on power cord.

A/D The motion sensor is contained in a robust, two-piece, plastic enclosure. It is designed for flat wall or inside corner mounting. Front-to-back angular adjustment is provided. This component is manufactured by Sensor Switch, Inc. No mounting screws were provided.

A A conventional telephone type cable/connectors is used to connect the sensor to the control unit – less expensive due to high volume production. Connectors lock in place. Known reliability.

A Circuit boards appear to be of high quality – glass reinforced.

A Component mounting and soldering are very good.

A Two-page instruction manual provided separately.

A-Advantage O-Observation
D-Disadvantage R-Recommendation

## 1.2 Electrical Review

A brief electrical evaluation was performed. Emphasis was placed on the components most likely to fail. The results are as follows:

| | |
|---|---|
| **Vending Machine Power Requirements** | 11 amp @ 120 VAC |
| | 1/3 HP |
| | |
| **Relay** | |
| Mfg. | Siemens |
| Model | RT Series |
| | UL/CSA Recognized |
| | 16 amp @ 240 VAC |
| | ½ HP @ 120 VAC |
| | 30,000 Operations at approximately 12 amps general purpose current* |
| Life @ 6 Operations / Day | greater than 13 years* |
| | |
| **Transformer** | UL/CSA Recognized |
| Model | 4-01-3010 |
| Current rating | 0.25 Amp |
| Isolation | 2500 V RMS |
| | |
| **Receptacle** | 15 amp |
| **Power cord** | UL Recognized |
| | 16-3 SJW |
| | Rating 13 Amp @ 105°C |

**Electrical Conclusions:**
This product meets all of the power requirements for controlling vending machines with the ratings listed above. General construction and labeling are excellent.

* **Please note that relay cycle life is based on the older vending machines with mechanical thermostats that start under full compressor motor current and open under limited load which consists of all devices except the compressor and condenser fan. These two devices shut off before the VM relay opens. If used with the newer, electronic thermostat machines, life should be greater because the compressor and condenser fan turn on minutes after the VM relay closes.**

***Table 1. Overall Engineering Evaluation Results***

| **Manufacturer Model** | Engineering Evaluation Ratings: 1 Poor, 2 Fair, 3 Good, 4 V. Good, 5 Excellent. A passing score is ≥ 3 | | |
|---|---|---|---|
| | Integrity | Mfg. Quality | Serviceability |
| Bayview Technology Vending Mi$er | 4.5 | 4 | 5 |

## 2. Performance Testing

To verify that the VM is not detrimental to beverage temperature during its power–down mode, we tested it on a Vendo Model 630 vending machine. The following test procedure was followed.

### 2.1 Setup

- Locate the vending machine in a 90°F test chamber.
- Fully load the machine with 20 oz Pepsi beverage. Locate 18 instrumented bottles in the load of beverage by placing 6 instrumented bottles in the bottom layer at the four corners and two at the center. Repeat this array every other layer (3 layers).
- Attach a thermocouple to the compressor discharge tube to monitor compressor activity. Locate an ambient temperature probe near the exterior of the vending machine.
- Connect a relay to the VM power output and attach the relay contacts to one channel of the temperature data logger to provide a signal indicating that the vending machine has power. Mount the VM module and sensor as described in the manual.

### 2.2 Procedure

- Plug the vending machine into the metered (digital) power outlet and allow it to operate for at least 48 hours in the 90°F ambient environment to assure steady-state operation has been achieved.
- At the end of the 48+ hour cool-down period start the data logger to record the temperatures. Record the power meter reading. At the end of a 24 hour time period stop the data logger and record the power meter reading.

- Unplug the vending machine, install the VM in the power circuit, wait approximately 5 minutes before plugging the vending machine into the VM to assure a low head pressure in the compressor. Cover the sensor with a cardboard box to prevent light from entering and false triggering.

- Again start the data logger to record the temperatures. Record the power meter reading. At the end of a 24 hour time period record the power meter reading and time of reading. Keep the data logger running.

- Enter the chamber at the end of the 24 hr time period and remove the box from the sensor to cause a VM response and machine power-up. Check the data logger periodically to see when the compressor cycles off. Stop the data logger once the compressor cycles off.

- Compare data with and without the VM installed.

## 3. Results

Results of the tests described in Section 2 are summarized below in Table 2. Raw test results graphs are provided in Appendix A of this report. The peak beverage temperature recorded was 41.1°. That bottle was located at the bottom (next-to-be-vended), left front. Average temperature for that bottle was 39.8°F.

The occupancy sensor was able to detect our presence at the end of the test and immediately reapplied electrical power to the vending machine. It kept electrical power on until the refrigeration system completed its cycle. This can be seen in the last graph in Appendix A.

***Table 2. Test Results***

| | **Energy in 24 hr*** | **Next-to-vend Beverage Avg. Temp.** | **Third Layer Beverage Avg. Temp.** | **Fifth Layer Beverage Avg. Temp.** |
|---|---|---|---|---|
| **Without VM** | 10,024 watt-hr | 35°F | 34.7°F | 34.3°F |
| **With VM** | 5,194 watt-hr | 36.6°F | 35.7°F | 35.1°F |
| **Change** | 48.2% reduction | +1.6°F | +1°F | +0.8°F |

* The energy savings presented above is when there is no activity at the vending machine. The amount of savings is dependent upon the time when there is no sensed activity near the vending machine.

## 4. Conclusions

The VM appears to be a well-constructed device both mechanically and electrically. Our tests indicate that it should reduce operating costs when used in conjunction with a conventional beverage vending machine. As shown in Table 2, the negative impact on beverage temperature in minimal. The average next-to-be-vended beverage temperature increased less than 2°F and no instrumented beverage exceeded the Pepsi-Cola maximum temperature of 42°F.

The energy savings test result presented is based on a 24 hour time period. Actual savings will be less due to activity at the vending machine. If we assume that the machine is located in a place of business and is idle, such as overnight, actual savings may be based on a 12 hour time period which is approximately 2,400 watt-hours per day. In a facility that is open seven days a week, this translates into a savings of approximately $88/yr at $0.10/kilowatt-hour or $131/yr at $0.15/Kw-hr. In a facility that is open five days a week, at 12 hours per day, and no vending activity on the weekends, this translates into a savings of $113/yr at $0.10/Kw-hr or $170/yr at $0.15/Kw-hr. These examples are based upon the Vendo Model 630 vending machine. Results may vary when the VM is used in conjunction with other vending machines.

An additional benefit of the VM may be increased life of the compressor, condenser fan and fluorescent lamps. The compressor and condenser fan will cycle less and for longer periods of time when the VM is in operation. Motors and compressors typically last longer if they are cycled less frequently even if the total on time remains the same.

Although a slight penalty in fluorescent lamp life will be realized because the lamp is switched on and off, the benefit of the lamp off time will most likely be greater, thereby increasing the lamp replacement interval.

# APPENDIX A

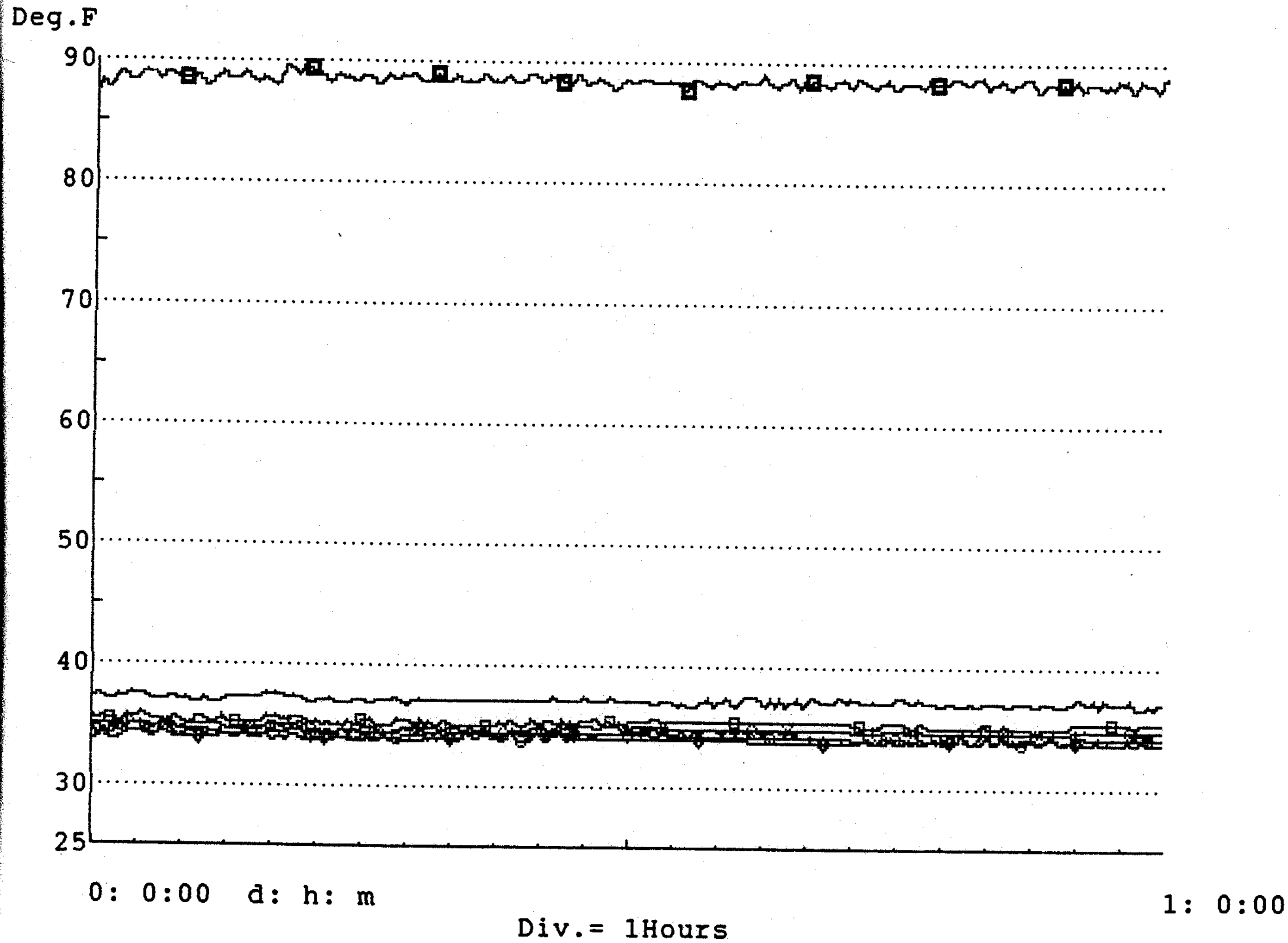
Performance Graphs

**Graph Legend:**

| | | |
|---|---|---|
| Bot | -- | Bottom bottles, next to be vended |
| Mid | -- | Layer 3 from bottom |
| Top | -- | Layer 5 from bottom |
| LF | -- | Left-front |
| RF | -- | Right-front |
| LR | -- | Left-rear |
| RR | -- | Right-rear |
| CF | -- | Center-front |
| CR | -- | Center-rear |
| Ambient | -- | Operating environment temperature |
| Comp-HI | -- | Compressor discharge temperature |

# Vending Miser 90DegF S.S. Power WO/Miser

(File - VMISER1.LG8 04-17-2000/10:04:56)



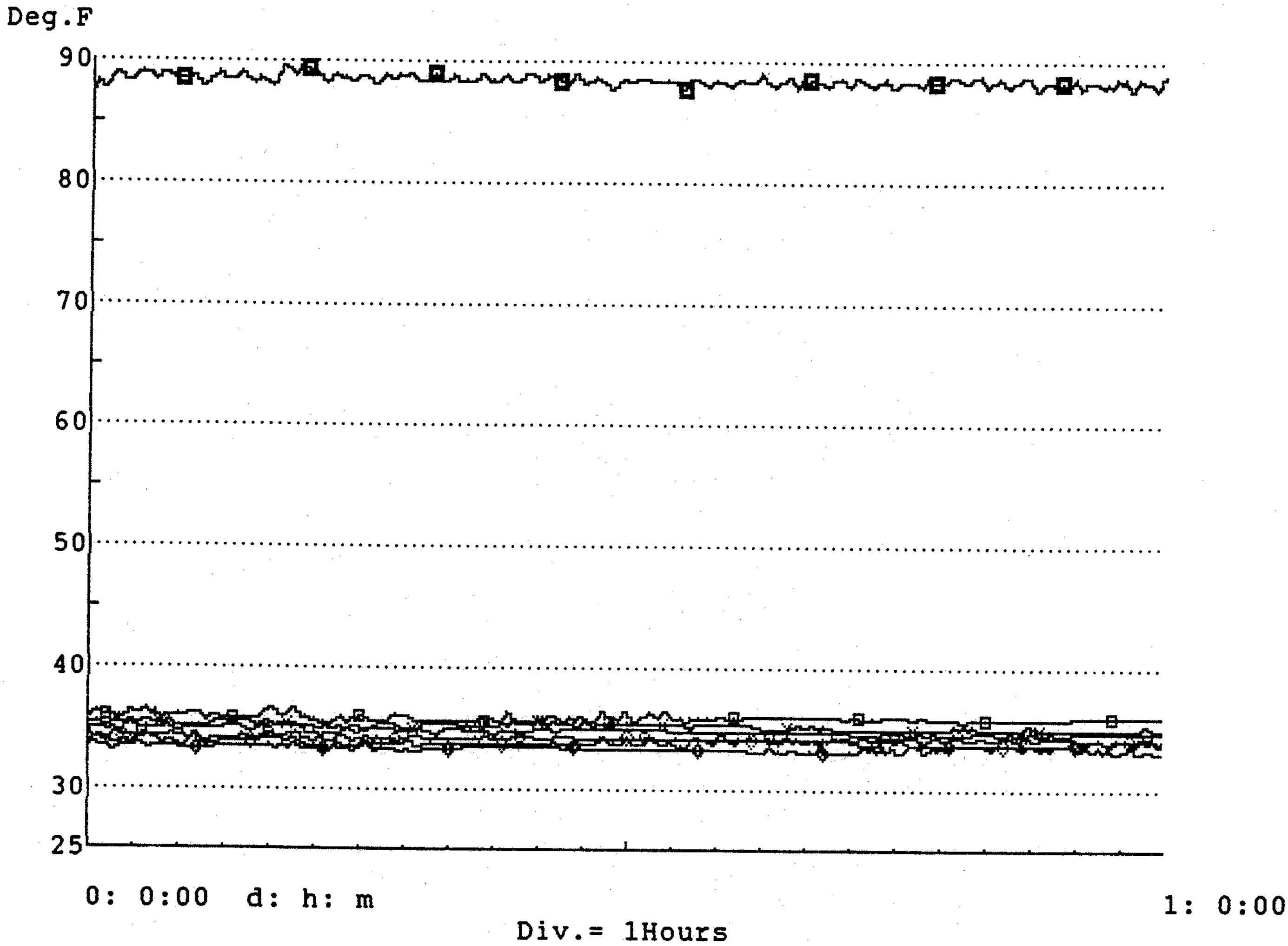

| Channel | | Min. | Max. | Avg. | Std.Dev. |
|---|---|---|---|---|---|
| Bot-LF | — | 36.5 | 38.1 | 37.1 | 0.278 |
| Bot-RF | -□- | 34.5 | 36.1 | 35.3 | 0.262 |
| Bot-LR | -◇- | 34.0 | 35.4 | 34.6 | 0.248 |
| Bot-RR | -○- | 33.4 | 35.0 | 34.2 | 0.283 |
| Bot-CF | -✳- | 34.1 | 35.4 | 34.8 | 0.245 |
| Ambient | -▣- | 86.2 | 89.9 | 88.5 | 0.449 |
| Bot-CR | -◆- | 33.4 | 34.7 | 34.0 | 0.262 |

*Bot Avg Temp = 35°F*

For each Ch; Points plotted = 240 . Rdngs averaged per point plotted = 2

# Vending Miser 90DegF S.S. Power WO/Miser

(File - VMISER1.LG8 04-17-2000/10:04:56)



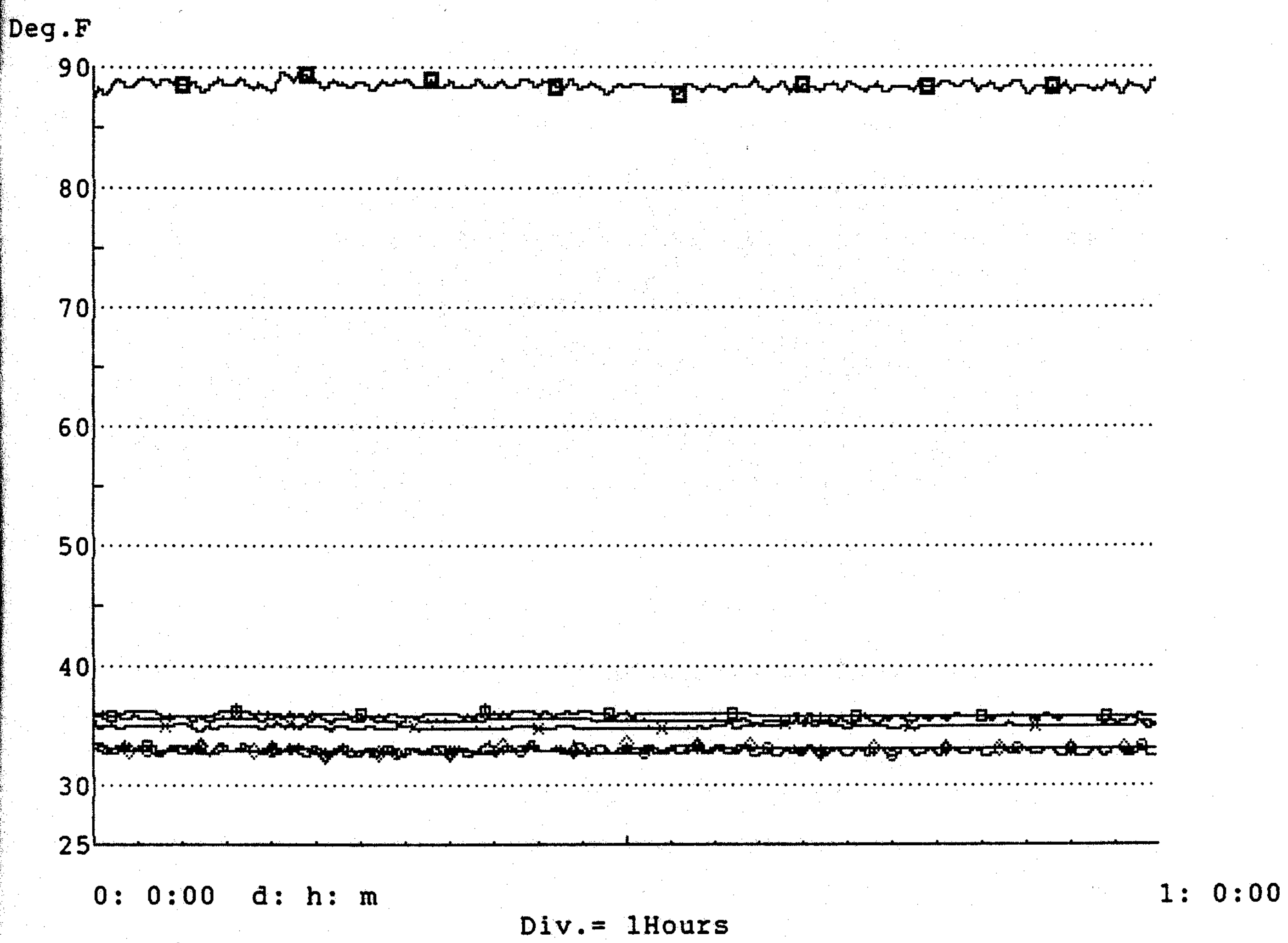

| Channel | | Min. | Max. | Avg. | Std.Dev. |
|---|---|---|---|---|---|
| Mid-LF | — | 34.2 | 35.7 | 34.9 | 0.252 |
| Mid-RF | -□- | 35.1 | 37.1 | 36.0 | 0.279 |
| Mid-LR | -◇- | 33.1 | 34.8 | 33.9 | 0.258 |
| Mid-RR | -o- | 33.7 | 35.0 | 34.3 | 0.247 |
| Mid-CF | -x- | 34.7 | 35.9 | 35.3 | 0.236 |
| Ambient | -■- | 86.2 | 89.9 | 88.5 | 0.449 |
| Mid-CR | -◆- | 32.9 | 34.3 | 33.5 | 0.226 |

Mid Avg Temp = 34.7°F

For each Ch; Points plotted = 240 . Rdngs averaged per point plotted = 2

# Vending Miser 90DegF S.S. Power WO/Miser

(File - VMISER1.LG8 04-17-2000/10:04:56)



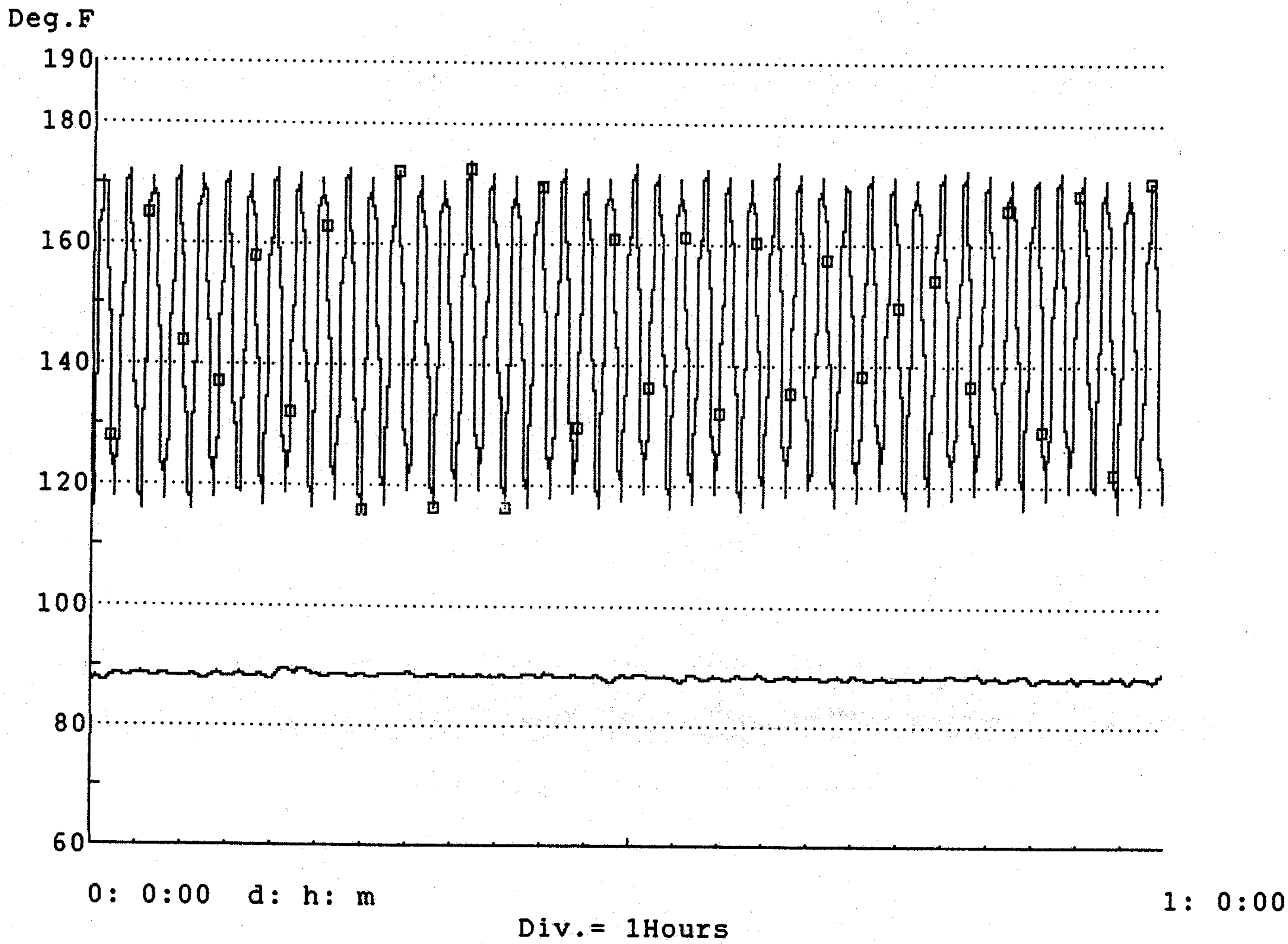

| Channel | | Min. | Max. | Avg. | Std.Dev. |
|---|---|---|---|---|---|
| Top-LF | —— | 35.1 | 36.3 | 35.6 | 0.260 |
| Top-RF | -□- | 35.4 | 36.4 | 36.0 | 0.192 |
| Top-LR | -◇- | 32.5 | 33.8 | 33.2 | 0.245 |
| Top-RR | -○- | 32.1 | 33.7 | 32.9 | 0.260 |
| Top-CF | -×- | 34.4 | 35.8 | 35.0 | 0.236 |
| Ambient | -⊠- | 86.2 | 89.9 | 88.5 | 0.449 |
| Top-CR | -◆- | 32.4 | 33.8 | 33.1 | 0.252 |

Top Avg Temp = 34.3°F

For each Ch; Points plotted = 240 . Rdngs averaged per point plotted = 2

# Vending Miser 90DegF S.S. Power WO/Miser

(File - VMISER1.LG8 04-17-2000/10:04:56)

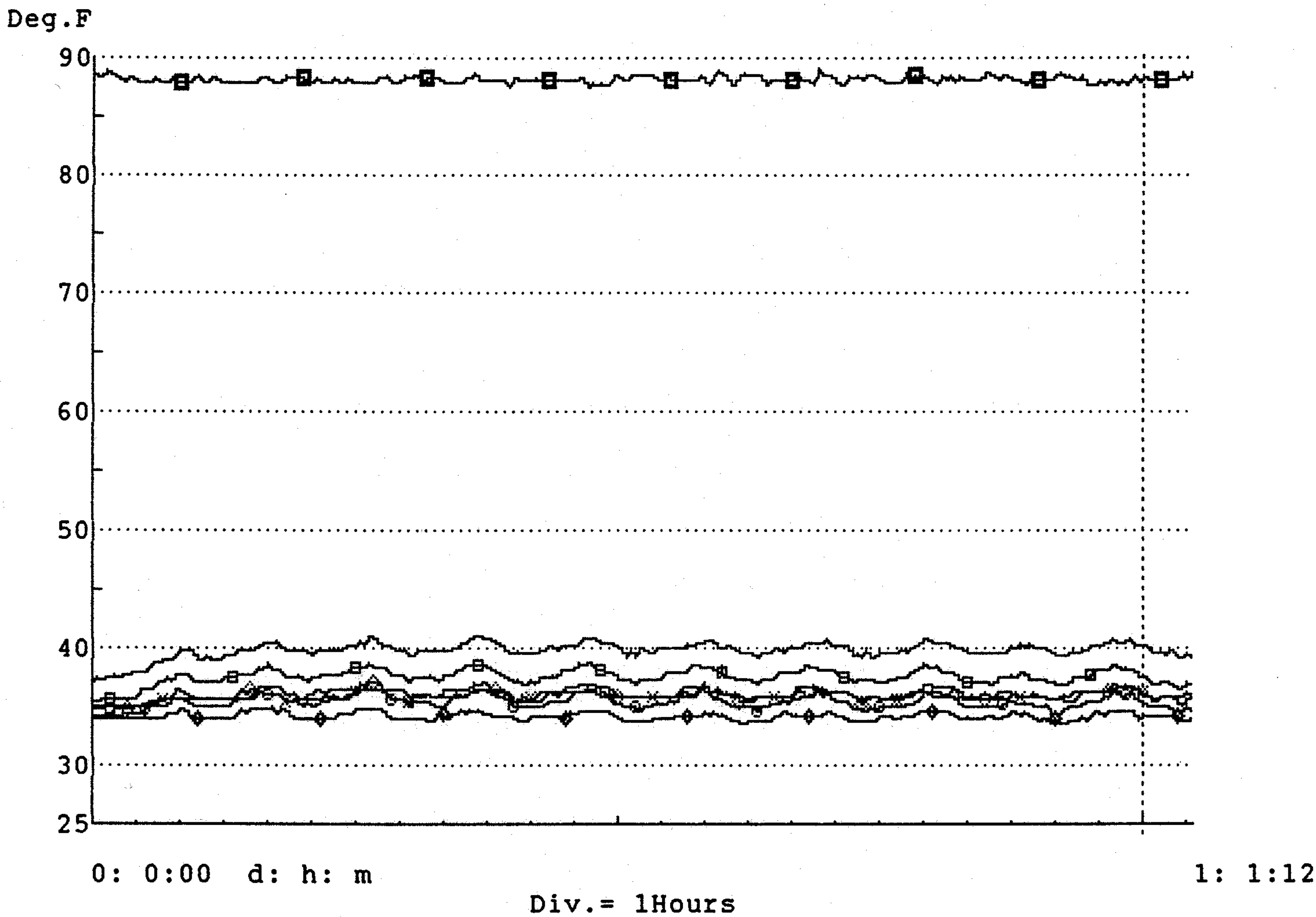



| Channel | Min. | Max. | Avg. | Std.Dev. |
|---|---|---|---|---|
| Ambient —— | 86.2 | 89.9 | 88.5 | 0.449 |
| Comp-HI -□- | 114.8 | 175.3 | 146.2 | 23.160 |

For each Ch; Points plotted = 240 . Rdngs averaged per point plotted = 2

# Vending Miser 90DegF S.S. Power W/Miser

(File - VMISER2.LG8 04-18-2000/10:22:38)



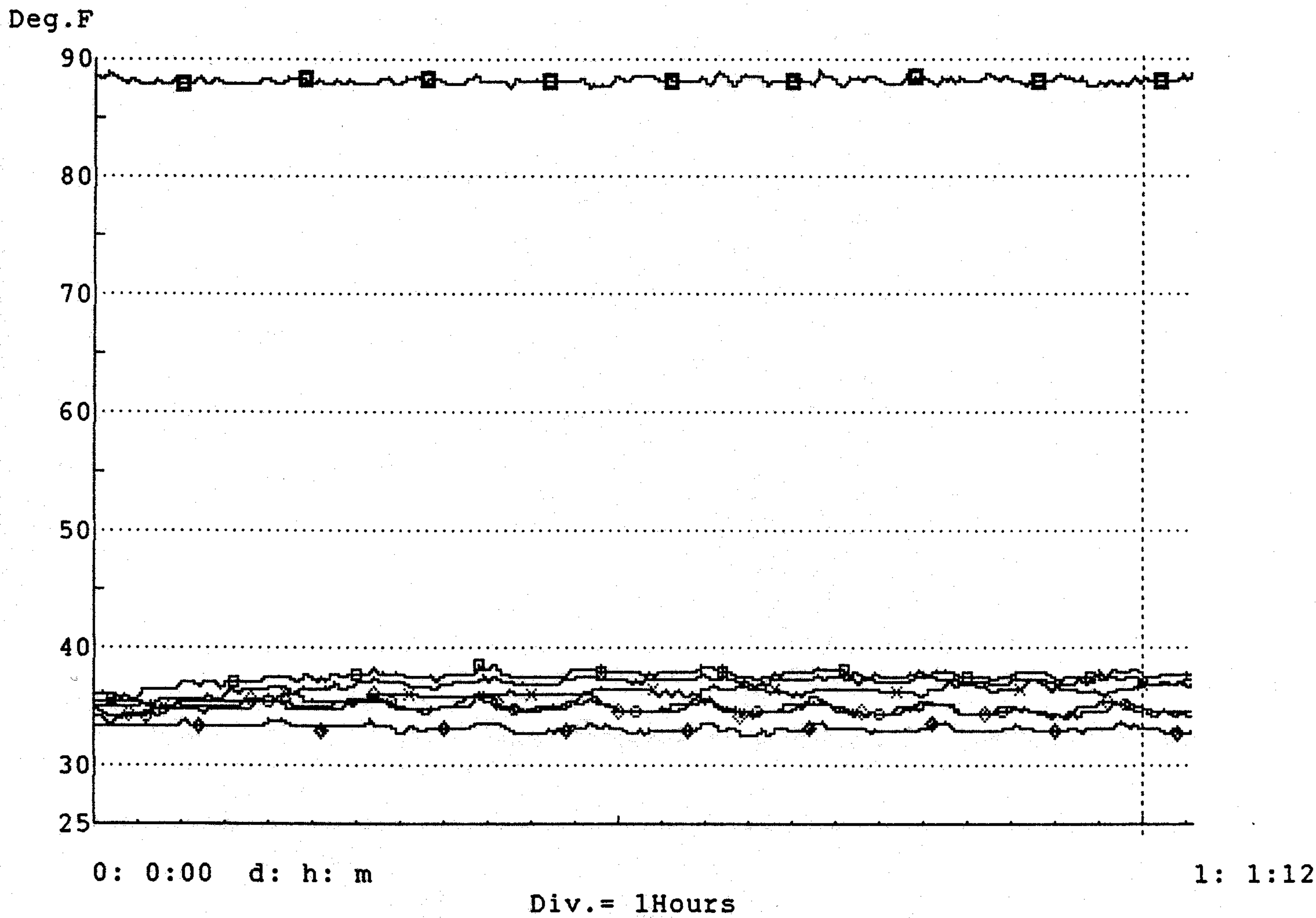

| Channel | | Min. | Max. | Avg. | Std.Dev. |
|---|---|---|---|---|---|
| Bot-LF | —— | 36.7 | 41.1 | 39.8 | 0.728 |
| Bot-RF | -□- | 35.4 | 39.0 | 37.6 | 0.706 |
| Bot-LR | -◇- | 34.1 | 37.1 | 36.1 | 0.536 |
| Bot-RR | -○- | 33.7 | 36.9 | 35.4 | 0.577 |
| Bot-CF | -×- | 34.8 | 36.9 | 35.9 | 0.390 |
| Ambient | -■- | 87.5 | 89.4 | 88.2 | 0.340 |
| Bot-CR | -◆- | 33.2 | 35.1 | 34.2 | 0.333 |

From 12 to 24hr
Bot Avg Temp = 36.6°F

For each Ch; Points plotted = 252 . Rdngs averaged per point plotted = 2

# Vending Miser 90DegF S.S. Power W/Miser

(File - VMISER2.LG8 04-18-2000/10:22:38)



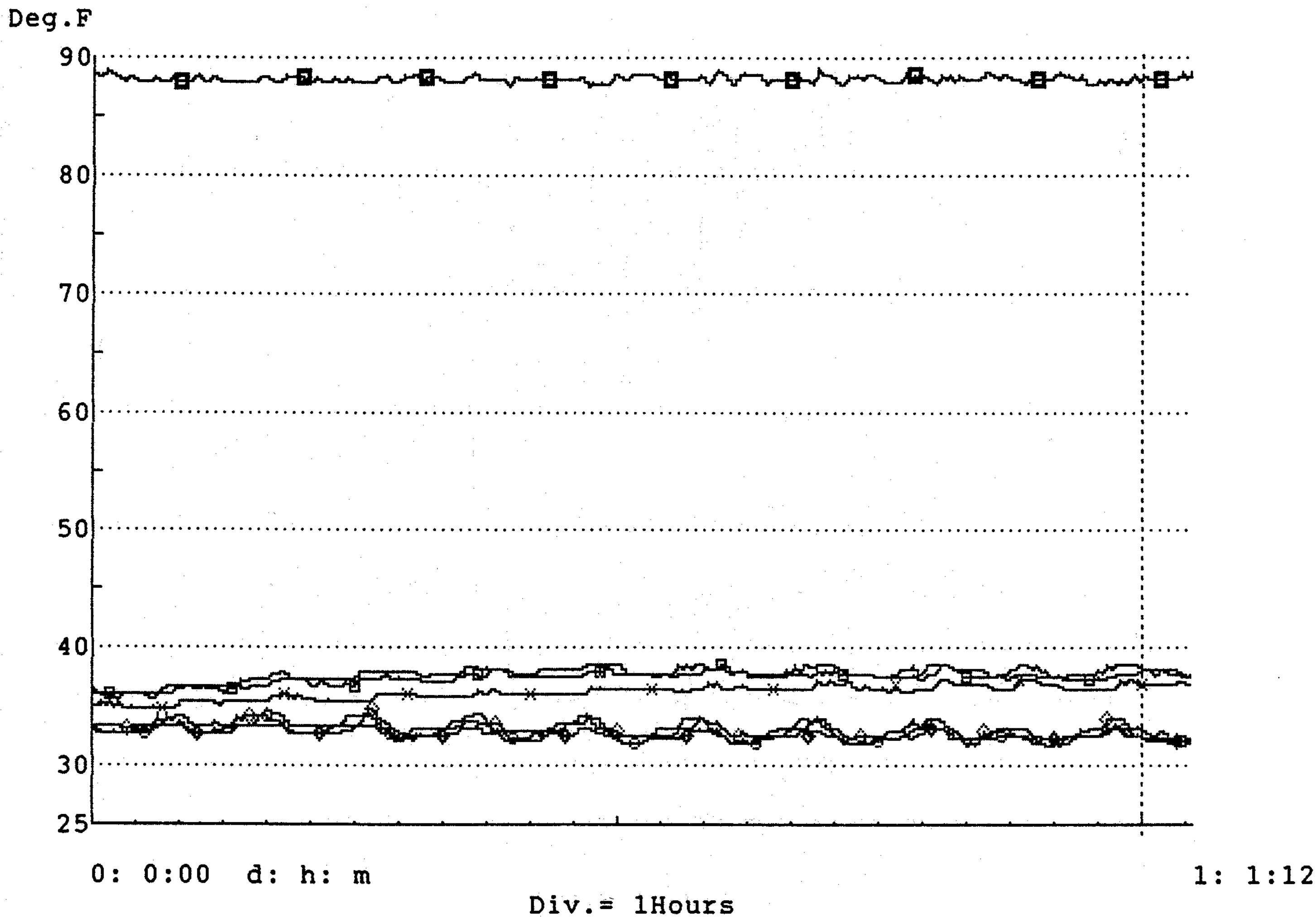

| Channel | | Min. | Max. | Avg. | Std.Dev. |
|---|---|---|---|---|---|
| Mid-LF | — | 34.8 | 37.9 | 36.9 | 0.654 |
| Mid-RF | -□- | 35.4 | 38.6 | 37.6 | 0.580 |
| Mid-LR | -◇- | 33.4 | 36.5 | 35.0 | 0.518 |
| Mid-RR | -○- | 33.6 | 36.1 | 34.8 | 0.437 |
| Mid-CF | -×- | 34.7 | 37.2 | 36.1 | 0.530 |
| Ambient | -■- | 87.5 | 89.4 | 88.2 | 0.340 |
| Mid-CR | -◆- | 32.5 | 34.0 | 33.2 | 0.313 |

From 12 to 24 hr
Mid Avg Temp = 35.7°F

For each Ch; Points plotted = 252 . Rdngs averaged per point plotted = 2

# Vending Miser 90DegF S.S. Power W/Miser

(File - VMISER2.LG8 04-18-2000/10:22:38)



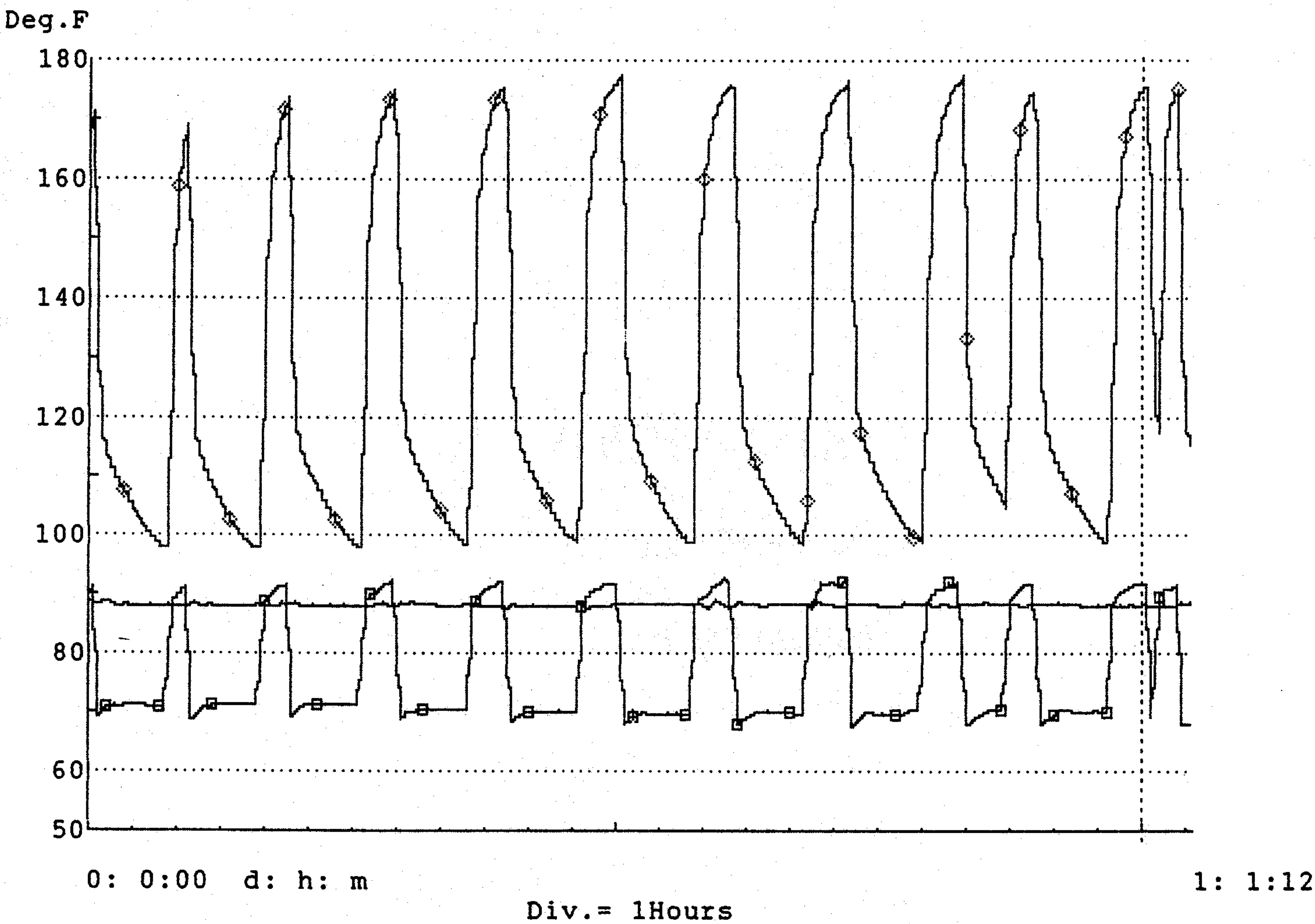

| Channel | | Min. | Max. | Avg. | Std.Dev. |
|---|---|---|---|---|---|
| Top-LF | — | 35.4 | 38.7 | 37.8 | 0.689 |
| Top-RF | -□- | 35.4 | 38.5 | 37.4 | 0.629 |
| Top-LR | -◇- | 31.9 | 34.7 | 33.3 | 0.585 |
| Top-RR | -○- | 31.5 | 34.2 | 32.8 | 0.614 |
| Top-CF | -×- | 34.7 | 37.2 | 36.2 | 0.649 |
| Ambient | -■- | 87.5 | 89.4 | 88.2 | 0.340 |
| Top-CR | -◆- | 31.5 | 33.7 | 32.6 | 0.474 |

*From 12 to 24 hr*
*Top Avg Temp = 35.1°F*

For each Ch; Points plotted = 252 . Rdngs averaged per point plotted = 2

# Vending Miser 90DegF S.S. Power W/Miser

(File - VMISER2.LG8 04-18-2000/10:22:38)




| Channel | | Min. | Max. | Avg. | Std.Dev. |
|---|---|---|---|---|---|
| Ambient | —— | 87.5 | 89.4 | 88.2 | 0.340 |
| on/off | -□- | 67.4 | 93.1 | 77.4 | 9.891 |
| Comp-HI | -◇- | 96.9 | 178.2 | 128.1 | 29.236 |

For each Ch; Points plotted = 252 . Rdngs averaged per point plotted = 2

# APPENDIX B

Vending Mi$er Manual

Relay Information

# VendingMI$ER™

## Instructions for Permanent Installation

VendingMiser™ (patent pending) is designed to operate as an intelligent power controller for cold product vending machines. Note that VendingMiser may not be used on any vending machine which contains perishable products.

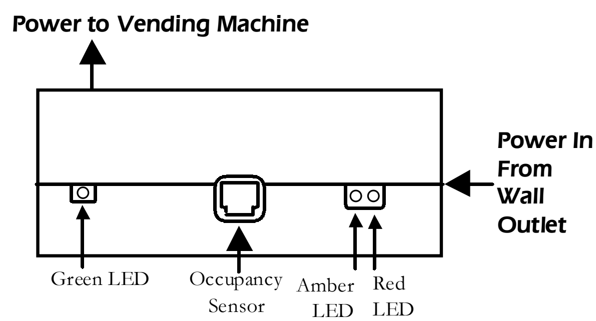
## General Theory of Operation

Using a Passive Infra Red (PIR) sensor, VendingMiser will automatically shut down the attached vending machine when the area around the machine has been vacant for 15 minutes. However, VendingMiser will periodically re-power the vending machine automatically to ensure that the vended product stays cold. The re-power period will be modified dynamically based on the room's temperature - the warmer the room, the shorter the delay.

In addition, VendingMiser contains a current sensor so it can determine if the vending machine's compressor is operating. VendingMiser will delay power down of the vending machine until the compressor has completed its cooling cycle.

To install the VendingMiser, follow these simple steps:

## Locating the VendingMiser




1. Unplug the vending machine's power cord from the outlet. If it is necessary to move the machine, be careful as it can be very heavy.
2. Identify a suitable mounting location for the VendingMiser. The most likely place would be on the wall adjacent to or behind the vending machine. The VendingMiser must be located so that the machine's power card can reach VendingMiser, and VendingMiser's power cord can reach the power outlet. It is also desirable to have the operational lights on VendingMiser be viewable by maintenance personnel. **NOTE**: DO NOT locate VendingMiser lower than four feet above the floor if mounted behind the vending machine to ensure that the compressor hot exhaust does not blow on VendingMiser. Failure to do so may damage the VendingMiser.
3. Using screws appropriate for the wall material, attach VendingMiser's mounting bracket to the identified location. Locate the lip inside the bracket at the lower edge, so that VendingMiser can be dropped down into the mounting bracket.
4. Plug the vending machine's power cord into the VendingMiser. Do not yet plug the VendingMiser into the wall outlet at this stage of the installation process.

## Occupancy Sensor Installation

5. The PIR sensor must now be mounted in an appropriate location. The sensor must be located so that it can "See" anyone in front of or approaching the vending machine. The best location for the sensor is on the wall behind the vending machine, about two feet above the machine. If low ceiling height does not allow this, an optional location is on the ceiling in front of the vending machine.

**Please turn this sheet over to continue...**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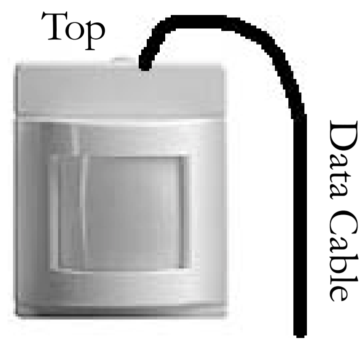
VendingMI$ER™

# Instructions for Permanent Installation (cont'd.)

Mounting the sensor to the ceiling requires that the "TOP" of the sensor where the cable exits points towards the vending machine to ensure proper occupancy detection.

Avoid placement near ceiling air ducts, as the warm air currents they cause can falsely trigger the PIR sensor. Also, the hot air may mask the PIR sensor from seeing people in the area.




6. To mount the sensor, remove its rear cover by prying out the plastic button on top of the sensor and tilting it out of the rear cover. Use the predrilled plastic holes in the rear cover and the appropriate fasteners to secure it to the surface or corner on which the sensor will be mounted. Then replace the sensor onto the rear cover and replace the plastic button to hold the sensor in place.
7. The occupancy sensor has a telephone style connector at the end of its cable. After carefully uncoiling the cable, plug this connector into the center socket on the VendingMiser (see diagram over). Do NOT plug the sensor into anything other than the VendingMiser, or it may be damaged. It is highly recommended that the sensor cable be secured either by placing it behind the wall on which it is mounted, or by covering the cable with plastic low voltage wire raceway.

## Power-Up Testing and Installation Validation

Connect the VendingMiser's power cord the wall outlet. The following events should occur:

- The vending machine should power up immediately
- The Green LED should flash twice to indicate that the temperature sensor is functional
- The Orange LED should then come on as the VendingMiser attempts to synchronize with the compressor's operation. This typically will require that the compressor cycle on and off once.
- The Red LED should come on, indicating that occupancy is detected.

| Green LED Operation | |
|---|---|
| On | Unit OK |
| Off | Unit Failure |

| Red LED Operation - Occupancy | |
|---|---|
| On | Occupancy Detected |
| Off | No Occupancy Detected |

| Amber LED Operation - Compressor | |
|---|---|
| On | Compressor ON |
| Blink | Compressor ON-Power Off Delayed |
| Off | Compressor OFF |

The PIR sensor must be allowed to warm up and stabilize for several minutes before its placement can be verified. During this warm-up period, the sensor's Green LED may go dark – this is normal behavior. Once the sensor is warmed up, it will flash green at the slightest movement within its field of view. Validate that the sensor can "See" an occupant at or approaching the vending machine. If necessary, relocate the sensor and repeat the coverage test. The Red LED on the VendingMiser will mirror the state of the PIR sensor, with an additional 5 second delay. This allows verification that the VendingMiser is communicating with the PIR sensor.

As a final functional test, the VendingMiser will power down the first time only after installation approximately two minutes after the area around the machine is vacant and the compressor is determined to be not running. Covering the PIR sensor or temporarily setting it to face the wall will allow validation of the power down operation if so desired. Following this initial power down, the VendingMiser will operate with standard timeouts.

# RT series (DC Coil)

## 16 Amp PC Board Miniature Relay

Meets VDE 10mm Spacing, 5KV Dielectric

File E22575

File LR15734

NR 6106

### Features

- SPST through DPDT contact arrangements.
- Immersion cleanable and flux tight versions available.
- VDE 10mm spacing, 5kV dielectric, coil to contacts.
- UL Class F coil insulation system.
- Conforms to UL 508, 1873, 353 and 1950.
- Low profile; 15.7mm height.
- Sensitive coil; 400mW.
- Withstand surge voltage of 10,000V.

### Contact Data

**Arrangements:** 1 Form A (SPST-NO) Wiring Diagram Code 1, 3.
2 Form A (DPST-NO) Wiring Diagram Code 5.
1 Form C (SPDT) Wiring Diagram Code 1, 3.
2 Form C (DPDT) Wiring Diagram Code 5.
**Material:** Silver-nickel 90/10.
**Minimum Load:** 12V/100mA.
**Expected Mechanical Life:** 10 million operations.
**Initial Contact Resistance:** 100 milliohms max @ 1A 12VDC.

### Designed to meet UL/CSA/VDE ratings with relay properly vented. Remove vent nib after soldering and cleaning.

**UL/CSA/VDE Ratings @ 25°C**

| Code | NO/NC Load | Type | Operations |
|---|---|---|---|
| 1 | 10A/10A @ 277VAC | Resistive/GP | 100K |
| | 10A/10A @ 30VDC | Resistive | 100K |
| | 12A/12A @ 250VAC | Resistive/GP | 30K |
| | 12A/12A @ 30VDC | Resistive | 30K |
| | 3/4 HP @ 480VAC* | Motor | 6K |
| | 1/2 HP @ 240VAC* | Motor | 6K |
| | 1/3 HP @ 120VAC* | Motor | 6K |
| | 48 LRA/10 FLA @ 240VAC* | Motor | 30K |
| | TV-3 @ 120VAC* | Tungsten | 25K |
| | A300, 720VA @ 240VAC* | Pilot Duty | 30K |
| 3 | 16A/16A @ 250VAC | Resistive/GP | 50K |
| | 20A/20A @ 277VAC | Resistive/GP | 30K |
| | 20A/20A @ 24VDC | Resistive | 30K |
| | 16A/16A @ 30VDC | Resistive | 30K |
| | 1 HP @ 480VAC* | Motor | 6K |
| | 1 HP @ 240VAC* | Motor | 6K |
| | 1/2 HP @ 120VAC* | Motor | 6K |
| | 60 LRA/10 FLA @ 250VAC* | Motor | 30K |
| | TV-5 @ 120VAC* | Tungsten | 25K |
| | A300, 720VA @ 240VAC* | Pilot Duty | 30K |
| | B300, 360VA @ 240VAC** | Pilot Duty | 30K |
| 5 | 8A/8A @ 277VAC | Resistive/GP | 100K |
| | 8A/8A @ 30VDC | Resistive | 100K |
| | 10A/10A @ 250VAC | Resistive/GP | 30K |
| | 10A/10A @ 30VDC | Resistive | 30K |
| | 1/2 HP @ 240VAC* | Motor | 6K |
| | 1/4 HP @ 120VAC* | Motor | 6K |
| | 34.8 LRA/6 FLA @ 120VAC* | Motor | 30K |
| | 17.4 LRA/5 FLA @ 240VAC* | Motor | 30K |
| | B300, 360VA @ 240VAC* | Pilot Duty | 30K |
| | TV-3 @120VAC* | Tungsten | 25K |

* Form A only
** Form B only

### Initial Dielectric Strength

**Between Open Contacts:** >1,000VAC (1 minute).
**Between Poles (code 5):** >2,500VAC (1 minute).
**Between Coil and Contacts:** >5,000VAC (1 minute).
**Surge Voltage (DC):** >10,000VAC x (1.2 x 50 µsec).

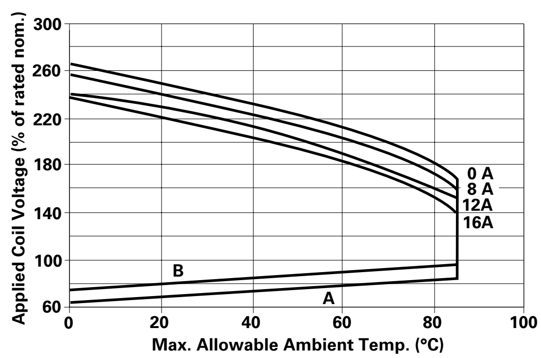
### Coil Data @ 25°C

**Voltage:** 5 to 48VDC.
**Nominal Power @ 25°C:** 400mW.
**Duty Cycle:** Continuous.
**Initial Insulation Resistance:** 10,000 megohms, min., at 25°C, 500VDC and 50% rel. humidity.

### Coil Data @ 25°C

| Nominal Voltage VAC | DC Resistance in Ohms ±10% | Must Operate Voltage VAC | Nominal Coil Current (mA) – 50/60Hz. |
|---|---|---|---|
| 005 | 62 | 3.5 | 80 |
| 006 | 90 | 4.2 | 66.7 |
| 009 | 202 | 6.3 | 44.4 |
| 012 | 360 | 8.4 | 33.3 |
| 018 | 810 | 12.6 | 22.2 |
| 024 | 1,440 | 16.8 | 16.7 |
| 048 | 5,760 | 33.6 | 8.3 |

### Max. Ambient Temp. vs. Coil Voltage




A: Coil temperature = Ambient temperature.
B: 110% of nominal coil voltage at rated contact load.

### Operate Data @ 25°C

**Must Operate Voltage(DC):** 70% of nominal.
**Must Release Voltage(DC):** 10% of nominal.
**Operate Time (Excluding Bounce):**
7 ms, typ., 15ms max. at nom. voltage.
**Release Time (Excluding Bounce):**
3 ms, typ., 6ms max. at nom. voltage.

### Environmental Data

**Temperature Range:**
**Storage:** -40°C to +105°C.
**Operating:** -40°C to +85°C at rated current.
**Vibration, Operational**
N.O.:0.065"(1.65mm) max. excursions from 10 - 55 Hz:
N.C.:0.032"(0.82mm) max. excursions from 10 - 55 Hz:
with no contact opening >10µs

### Mechanical Data

**Termination:** Printed circuit terminals.
**Enclosures: RT 1, 3, 4:** Flux-tight, top vented, plastic case.
**RT B, D, E:** Immersion cleanable, plastic case.
**Weight:** 0.35 oz. (10g) approximately.