

# **EXHIBIT H**

## **USER MANUAL**



**SECTION 3**

**OPERATING INSTRUCTIONS**

## SECTION 3 OPERATING INSTRUCTIONS

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## OPERATING PROCEDURES

### Normal Mode

Upon power-up, the VECTRON meter operates in the Normal display mode. The display continuously scrolls through the Normal display sequence, displaying each selected quantity, annunciator, and ID code for a program-specified duration.

The meter operates in Normal mode until power is disconnected, the Alternate display sequence is initiated, Test mode is accessed, or the Toolbox mode is accessed.

### Alternate Mode

Alternate mode is entered from Normal mode by using the magnetic reed switch or one of the programming devices. Alternate mode is indicated by the flashing ALT annunciator.

To activate this mode with the magnetic reed switch, momentarily (less than four seconds) move a small magnet (30 gauss) near the reed switch. The reed switch is located in the twelve o'clock position just above the nameplate, and labeled ALT/TOOLBOX. It can be accessed with the cover in place. The reed switch, hidden from view by the meter module enclosure (see Figure 3.1), is activated by the magnet and the meter enters the Alternate display mode.

To activate this mode with an auxiliary programming device, refer to the PC-PRO or PRO-READ software users manual.

Once the Alternate mode has been activated, the display scrolls once through the programmed items and then returns to the Normal display sequence. Operation of the register in Alternate mode is identical to that of Normal mode. The quantities displayed and the length of each display item are selected during programming. Like the displays in Normal mode, each display item in Alternate mode can have a two-digit identifier. If selected, this code can be from 01 to 99. All calculations performed in Alternate mode are identical to those performed in Normal mode.

As an option, the Alternate mode can be programmed for manual scrolling. When this option is selected, the meter will not advance to the next display item until the magnetic reed switch is activated.

### Test Mode

The Test mode can be accessed from either the Normal or Alternate mode by removing the meter cover and pressing the Test button until it locks. (See Figure 3.3) To release the Test button, simply slide the nameplate up slightly.

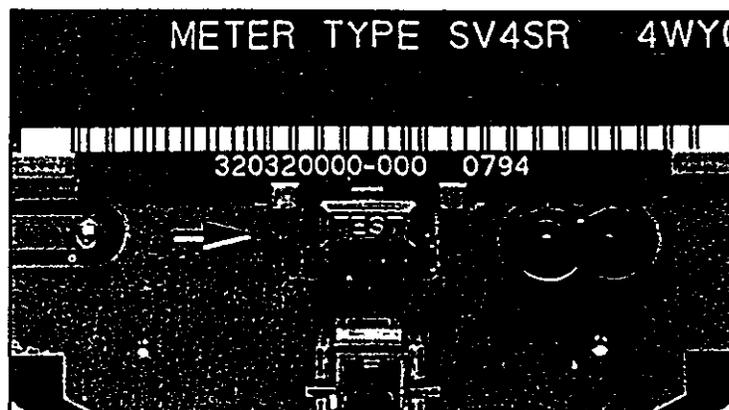


Figure 3.3  
Test Mode Button

To activate this mode with a programming device, refer to the appropriate software users manual. A programmable Time-Out Length from 1 to 99 minutes is available when entering Test mode through the software. After the programmed Time-Out Length has ended, the register will exit Test mode automatically. This applies only if Test mode was entered through the software.

The Test mode annunciator (See Figure 3.4) continuously flashes while the VECTRON meter is in Test mode or SiteScan Toolbox mode. In Test mode each programmed display item remains on the display until manually scrolled to the next item by activating the magnetic reed switch.

Activating Test mode causes all billing data to be transferred to nonvolatile memory. Upon entry of Test mode, if any of the present interval's calculated demand values are higher than the stored maximum demand values, the new values are stored as maximum demands. All Test mode program parameters are then retrieved from nonvolatile memory for use in Test mode. The parameters are demand test interval length, number of subintervals, and Test Kh. Each is independent from those specified for Normal mode. Activating the Demand Reset while in Test mode initializes the demand test interval. (This interval is not synchronized to the top of the hour.)

To exit Test mode and place the register in Normal mode, perform one of the following :

- If Test mode was activated manually, slide the nameplate slightly upward to release the locking Test mode button.
- If Test mode was activated via programming communications, do any of the following:
  - De-energize the meter.
  - Press and then release the manual Test mode button.
  - Wait for selected Test mode time-out to occur.

Values calculated in Test mode are not added to previous billing values or stored for retrieval. After exiting Test mode, all billing data previously transferred to nonvolatile memory is retrieved, an End-of-Interval (EOI) is initiated, and a new demand interval begins.

Any time-related activities, such as TOU rate changes or Daylight Savings Time (DST) changes that occur while the meter is in Test mode, are performed upon exiting Test mode.

## SiteScan Toolbox Mode

You can enter the SiteScan Toolbox mode from either Normal or Alternate mode. The Toolbox mode is accessed by activating the magnetic reed switch for four consecutive seconds. Upon activation, a flashing "TEST" appears on the left side of the display and a continuous PhA appears in the upper left-hand corner.

To activate this mode with the reed switch, place a small magnet (approximately 30 gauss) near the reed switch located at the 12 o'clock position on the meter. The nameplate is marked ALT/TOOLBOX to indicate the correct location. The switch, hidden from view by the meter module housing, is activated by the magnet and the meter enters the Alternate mode. After *four consecutive seconds* the meter enters the Toolbox mode. The magnetic reed switch can be activated with the meter cover in place.

Once activated, the Toolbox mode scrolls through a defined list of per phase items and diagnostic counters. See Table 3.1, SiteScan Toolbox Display List, for an example of a 3-element VECTRON meter. As long as the reed switch is activated, the meter contin-

ues to scroll through the display list. For a more detailed discussion about the SiteScan Toolbox Display List, refer to Section 4, SiteScan On-site Monitoring System.

Table 3.1  
SiteScan Toolbox Display List

Description	Display
Phase A voltage angle	PhA 0.0° U
Phase A voltage	PhA xxx.x U
Phase A current angle	PhA xxx.x° A
Phase A current	PhA xxx.x A
Phase B voltage angle	PhB xxx.x° U
Phase B voltage	PhB xxx.x U
Phase B current angle	PhB xxx.x° A
Phase B current	PhB xxx.x A
Phase C voltage angle	PhC xxx.x° U
Phase C voltage	PhC xxx.x U
Phase C current angle	PhC xxx.x° A
Phase C current	PhC xxx.x A
# of Diagnostic 1 errors	d1 xxx
# of Diagnostic 2 errors	d2 xxx
# of Diagnostic 3 errors	d3 xxx
# of Diagnostic 4 errors	d4 xxx
# of Diagnostic 5 errors	d5 xxx

Note: All "PhA", "PhB", and "PhC" quantities are displayed with a fixed decimal and no leading zeros. The Watthour Disk Emulator is not displayed while the diagnostic counters are displayed. The diagnostic counters are displayed with leading zeros (000-255).

When the magnet is removed, the meter finishes scrolling through the remaining items in the Toolbox display list and returns to the Normal display sequence. The meter continues to perform all normal metering operations while the Toolbox mode is active.

The per phase Volt and Amp readings are Root-Mean-Square (RMS) values which are updated every second. The voltage and current angles are updated every five seconds. The direction of the watthour disk emulator, which scrolls at a constant rate of one revolution per 1.33 seconds, is the same as the direction of energy flow for the phase being displayed (left to right if delivered to the load; right to left if received from the load). If any quantity is undefined due to the meter's form, the per phase information for that quantity is skipped.

If the magnitude of the current for that phase is too low, the current magnitude and angle for a particular phase (A, B, or C) are displayed as dashed lines (---). This low current threshold is defined as 0.5% of class current.

The SiteScan diagnostic counters represent the number of times each diagnostic error occurred since the last time the counters were reset. (For detailed information about the SiteScan Diagnostic Checks, refer to Section 4, SiteScan On-site Monitoring System.)

The diagnostic counters range from 0 to 255 and can only be reset to zero through the PC-PRO or PRO-READ software packages.

## Display

A nine-digit liquid crystal display with a variety of annunciators is provided on the VECTRON meter (See Figure 3.3). Six large data digits are available to display all billing and informational data. Three decimal points are provided for programmable resolution of billing data.

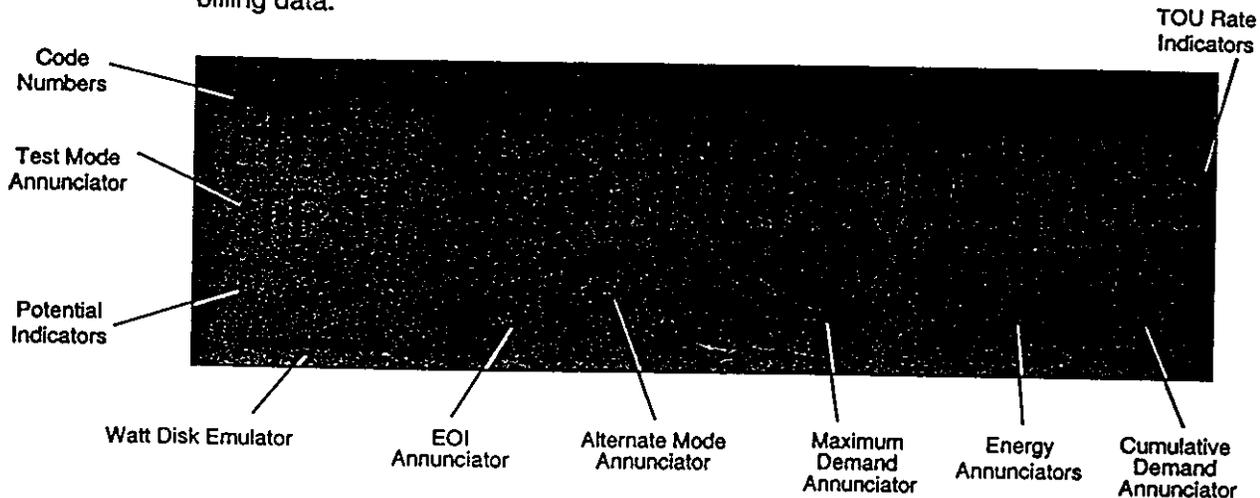


Figure 3.4 VECTRON LCD Display

Two small digits in the upper left-hand corner of the display are used to provide code numbers to identify any display item. These three digits are used along with the six data digits to display ID numbers such as the meter serial number and user fields.

Directly below the three code number digits is the Test mode annunciator (TEST). This annunciator flashes on and off once per second while the meter is in Test mode or Toolbox mode.

To the right of and slightly below the Test mode annunciator is the Alternate mode annunciator (ALT). This annunciator flashes on and off while the meter is in Alternate mode.

At the far right side of the display are the TOU rate indicators (rates A, B, C, D, and E [total]). These indicators correspond to the four programmable TOU rates and the total rate which is always active. The TOU rate indicators can be programmed to be displayed with the appropriate energy and demand quantities. When an energy or demand quantity for the currently active TOU rate (A, B, C, or D) is displayed, the corresponding TOU rate indicator flashes on and off.

The energy annunciators are displayed on the bottom line, to the right of the MAX annunciators. The annunciators can be programmed to display with all TOU rates. This same annunciator can be programmed to display as a demand with any demand quantity.

The EOI annunciator is located to the left of the MAX annunciator on the bottom line. This annunciator turns on for four seconds at the end of each demand interval (or at the end of each subinterval when rolling demand is used).

Located at the lower left-hand corner of the display are the potential indicators. Any time the voltage on phase B or phase C drops 20 percent below the lowest nominal point of the voltage range, the potential indicator for that particular phase flashes. If phase A drops below 20 percent of the lowest nominal point of the voltage range, the meter recognizes this as a power outage.

At the bottom of the display is the watt disk emulator. The watt disk emulator simulates mechanical disk revolution and scrolls at a rate based on the programmed  $K_h$  value.

## PROGRAMMABLE FUNCTIONS

### Register Programs

Register programs are generated using Schlumberger's PC-PRO register programming software. VECTRON meters are programmed using PC-PRO software or PRO-READ software via the optical tower. Cable configurations for connections are given in Section 6, Replacement Parts, Accessories, and Drawings.

### Register Selection (Demand and TOU Versions)

The calculated billing quantities to be displayed are specified by the program. The following billing quantities are available for display in Normal and Alternate Modes:

- kWh
- Maximum kW
- Cumulative kW Demand (rate E only)
- Continuous Cumulative kW Demand (rate E only)
- Previous Demand
- Instantaneous kW
- Present Interval kW

### Register Selection (Extended Function Version)

In addition to active energy, the Extended Function version of the VECTRON meter allows either reactive or apparent energy quantities to be measured also. Along with kWh, a maximum of three additional registers can be selected from either group A or group B through the programming software.

<u>Group A</u>	<u>Group B</u>
watts	watts
var lag	VA lag
varh lead	VA total
varh lag	VAh lag

Energy and demand registers can be programmed to display in any of the formats shown in Table 3.2, Register Display Formats.

Table 3.2  
Register Display Formats

Maximum Demand	XXX	XX.X	X.XX	.XXX
Previous Demand	XXXX	XXX.X	XX.XX	X.XXX
Instantaneous Demand	XXXXX	XXXX.X	XXX.XX	XX.XXX
Present Demand	XXXXXX	XXXXX.X	XXXX.XX	XXX.XXX
Cumulative Demand				
Continuous Cumulative Demand				
Energy				

All formats can be programmed for leading zeros and a floating decimal point.

## PROGRAMMABLE PARAMETERS

Programmable parameters establish the meter's configuration and define its operation in Normal, Alternate, and Test modes. Programmable parameters specific to Test mode can be displayed in Test mode only. All other programmable parameters can be displayed in Normal and Alternate modes. Following are the programmable parameters used to configure the VECTRON meter:

Display Scroll Time	The number of seconds (1 to 15) that each register quantity is to be displayed before the next quantity appears.
Cold Load Pickup Time	CLPU. The number of minutes (0 to 255) before demand calculations are restarted after a recognized power outage occurs. Defining this value as zero will cause demand calculations to restart after any recognized power outage.
$K_h$ (watt-hour meter constant)	$K_h$ is the energy represented by one equivalent disk revolution. Valid entries range from 0.03 to 99.9 in .01 increments. <i>This value only affects the rate at which the VECTRON meter's watt disk emulator scrolls and the infrared test LED pulses. Meter energy and demand values are unchanged by this constant.</i>
IR Test LED Units	(Extended Function versions only) If a reactive energy register is selected, the IR LED can be programmed to drive the LED with either Wh or lagging varh.
Register Full Scale	A demand value that defines the maximum rated demand for a particular meter installation. Valid entries can be as large as 999,999 or as small as 0.001 and can be adjusted in 0.001 increments. For Extended Function VECTRON meters, this error is only applicable to register 1.
Register Multiplier	This multiplier is defined as $CTR \times VTR$ . The register multiplier can be displayed for information purposes, or can be used in meter calculations so that the display shows primary readings, or both. The value entered for register multiplier is not applied to instantaneous quantities. Instantaneous KYZ and mass memory values will remain secondary. Care should be taken so that the display value with a register multiplier does not exceed the programmed display format. If exceeded, the display will show the correct number with one or more significant digits not displayed.
Demand Interval Length	The time in minutes (1 to 60) that each demand interval lasts before a new interval begins. Valid interval lengths are 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, and 60 minutes.

**Number of Subintervals**

The interval length divided by the subinterval length is equal to the number of subintervals. Valid entries are from 1 to 15 and must be evenly divisible into the demand interval length. For block demand, the number of subintervals is one. (See Table 3.3.)

**Table 3.3**  
Typical Demand Subinterval Lengths

		Number of Intervals							
		1	2	3	4	5	6	10	15
Interval Length (in minutes)	5	5	X	X	X	1	X	X	X
	15	15	X	5	X	3	X	X	1
	30	30	15	10	X	6	5	3	2
	60	60	30	20	15	12	10	6	4

**INFORMATIONAL DATA**

**Normal and Alternate Display Mode Items**

The following items can be displayed in Normal and Alternate modes:

**Time and Date Stamps**  
(TOU and Extended Function versions only)

Time and Date Stamps are available for the following: Maximum Demand, last Demand Reset, and last Reprogram.

**Time on Battery Carryover**  
(TOU and Extended Function versions only)

Number of minutes that meter clock has operated on battery carryover.

**Day Type Indicator**  
(TOU and Extended Function versions only)

The watt disk emulator indicates the TOU day type on the display. Position 1 (far left) is a weekday, 2 is a Saturday, 3 is a Sunday, and 4 is a holiday.

**Time Remaining in Interval**

The amount of time in minutes and seconds before the end of the current demand interval. (Note: This option is available for 60 Hz operation only.)

**Segment Test**

The display illuminates all segments and annunciators on the LCD in order to verify proper operation. The watt disk emulation annunciator continues to function normally.

**Meter ID**

Two numbers (up to nine digits each) used to identify the meter.

**User Fields**

Up to three separate user fields are available to display any desired numerical information. Each user field can be up to nine digits in length.

Firmware Revision	A sequential number identifying the firmware revision level of the meter (both the front and back end). This number is automatically provided and does not require operator input.
Software Revision	A sequential number identifying the revision level of the programming software used to program the meter. This number is automatically provided and does not require operator input.
Number of Times Programmed	A counter identifying the number of times the meter has been programmed. This counter will increment up to 9999 and will roll over to zero.
Number of Power Outages	A counter identifying the number of times the meter has recognized a power outage. This counter will increment up to 9999 and will roll over to zero.
Number of Demand Resets	A counter identifying the number of times a demand reset has occurred. This counter will increment up to 9999 and will roll over to zero.
Number of Days Since Reset	(Demand only) A counter identifying the cumulative number of elapsed days since the last demand reset. This counter will increment up to 99 and will roll over to zero.
Program ID	A three-digit number identifying the program downloaded to the meter.

### **Test Display Mode Items**

The following items can be displayed in Test mode:

Time Remaining in the (Sub) interval	The amount of time in minutes and seconds before the end of the current Test mode demand interval.
Time Remaining Till Test Mode Time-out	The amount of time in minutes and seconds before the programmed Test Mode time-out counter will expire and the display will return to Normal mode. The Test Mode Time-out period is only activated if Test Mode was entered remotely through a programming device.
Test Kh	(Watt-hour meter constant) Valid range is from 0.03 to 600 in increments of 0.01.
Input Pulse Count	The number of pulses seen by the meter for the present Test mode subinterval/interval. Ten pulses are counted for each revolution of the watt disk emulator.

Previous Interval Input Pulse Count      The pulse count of the previous Test mode subinterval/interval.

## DEMAND

The VECTRON demand meter calculates energy values and various types of demand values such as maximum, cumulative, continuous cumulative, previous interval, instantaneous, and present demand. The meter can be programmed to calculate demand using block, rolling window, or thermal emulation.

### Demand Calculation

To calculate demand, incremental energy values are accumulated over a fixed time period depending on the demand interval length for which the meter is programmed. At the end of the interval the energy totals are arithmetically converted to demand values.

These demand values are then compared against the stored maximum demand values. If a demand value is greater than the corresponding maximum demand, it is then saved as the new maximum demand. If a demand value is less than the corresponding maximum demand it is discarded. At the beginning of an interval, the current interval demand is reset to zero and new demand values begin accumulating. This process is carried out every time an interval or subinterval is completed.

The various methods of reporting demand calculations are described below.

#### Block Interval Demand

Block interval demand corresponds to the number of subintervals being equal to one block interval. At the end of every interval, the microprocessor compares the last completed block interval demand value to the demand value in memory. If the new value is equal to or greater than the stored value, the memory location is erased and the new demand value is stored as Maximum Demand. When a demand reset occurs, maximum demands are reset to zero and the current interval continues. At the end of the current interval, new maximum demand values are calculated.

#### Rolling Interval Demand

For rolling interval demand, the programmed number of subintervals make up the demand interval. At the end of every subinterval, the microprocessor calculates a demand value based on the last full demand subinterval. When demand reset occurs, all Maximum Demands are reset to zero along with all completed subintervals. The current subinterval continues accumulating data and the new maximum demand value(s) is calculated at the end of this subinterval.

Note: Rolling interval demand is available for kW only.

#### Thermal Demand

The VECTRON meter will emulate the response of a thermal demand meter for kW and kVA (Extended Function meters only). This type of demand calculation is approximated exponentially. The meter will record 90% of a change in load in 15 minutes, 99% in 30 minutes, and 99.9% in 45 minutes. The four characteristics of a thermal demand meter that the VECTRON meter will emulate are:

- Arithmetic phase summation
- Continuous rolling average demand
- Response calibrated to RMS values
- No End-of-Interval (EOI)

### **Cumulative Demand**

When a Demand Reset is performed, Maximum Demand values are added to the existing corresponding Cumulative Demand values and written into memory as the new Cumulative Demand values. These values remain in storage until cleared.

### **Continuous Cumulative Demand**

Continuous Cumulative Demand is the sum of Maximum and Cumulative Demands at any time. At the end of each interval or subinterval, the calculated interval demand is compared to the previous Maximum Demand. If this demand is a new peak, it is stored as a Maximum Demand and the continuous cumulative register is adjusted to reflect the new demand. A demand reset signal clears the Maximum Demand value, but does not affect the Continuous Cumulative reading.

### **Previous Demand**

Previous demand is the stored maximum demand at the last demand reset. Previous demand is saved in nonvolatile memory when a power outage occurs.

### **Present Interval Demand**

The Present Demand value is the demand value at the present time normalized to the demand interval length. Present Demand reports the calculated demand value as it increases from the start of a demand interval to the end of the interval. For Rolling Demand intervals, Present Demand reports the calculated demand value from the present subinterval as it is accumulating with the previous set of subintervals.

### **Demand Reset**

A Demand Reset can be initiated by pressing the demand reset switch or using a programming device (through the optical tower). Reset of maximum demand billing values can occur in either Normal or Alternate mode. When a demand reset is initiated, the following takes place in the meter:

1. To indicate the demand reset, the display flashes all eights for approximately six seconds.
2. The current maximum demand values are added to the corresponding cumulative demand values. Also, continuous cumulative demand is copied to cumulative demand.
3. All maximum demand values are reset to zero and all corresponding times and dates of maximum demands are cleared (TOU only).
4. The number of demand resets counter is incremented.
5. The number of days since reset is set to zero (demand only).
6. The date and time of last reset are updated (TOU only).
7. The normal display sequence resumes.
8. As a security feature, further manual demand resets are prevented with a one-minute reset lock-out time. A remote demand reset is not subject to this delay and can be initiated as frequently as required.

## TIME-OF-USE

The Time-Of-Use (TOU) function is available on TOU versions of the VECTRON meter and comes standard with the Extended Function VECTRON meters. Schedule information is programmed on a PC using the PC-PRO Programming software.

### TOU Schedules

When using the TOU functions of the meter, energy and demand registrations are segregated into time blocks during the day. Each time block is assigned one of four rate periods. In addition to these four rate periods, a total rate is always available.

#### Calendar Schedule

The calendar schedule contains all daily and yearly information needed for a VECTRON meter to measure and register data in real time. The schedule contains Rate Schedules, Daily Schedules, Seasons, Holidays, and Daylight Savings Dates. For information concerning the entry of these parameters into VECTRON software package, consult the PC-PRO software user's manual.

#### Rate Schedules

Four independent rates are available for TOU registration. These are designated A, B, C, and D. Only one of these rates can be active at a time. The TOTAL register, designated Rate E, is always active, regardless of the active rate period.

#### Daily Schedules

Up to four daily schedules—weekday, Saturday, Sunday, and holiday—are available. Each schedule defines the times during the day that rate period A, B, C, or D begins and ends. Up to eight rate period changes per rate may be specified for each daily schedule.

Each day of the week is assigned to one of the four daily schedules. Therefore, one to four of the daily schedules can be used in any combination with the days of the week.

#### Seasonal Schedules

A season is a period of months during the year when a particular rate is in effect. The year can be divided into a maximum of eight seasons. If multiple seasons are not used, the TOU schedule contains one year-round season. The Daily Schedules (1, 2, 3 and 4) can be defined differently for each season. Up to eight Season Change dates are specified for each year in the Calendar Schedule.

Season changes occur at midnight of the Season Change date (where midnight corresponds to 00:00 hours) or, can be designated through programming to occur at the first demand reset following the Season Change date.

#### Holiday Schedules

A maximum of 22 holidays per year can be designated in the Calendar Schedule. One of the four Daily Schedules is assigned to each of the Holidays in the Calendar Schedule.

## Daylight Savings Time

Daylight Savings Time switch points occur at 2:00 AM on the first Sunday in April and the last Sunday in October of each year. These dates are already assigned in the Calendar Schedule; however, they can be modified by the user. The user can also elect not to recognize Daylight Savings Time and operate the meter in standard time only.

## Registers

Several energy and demand quantities can be measured by the meter. Any energy register and any demand register except previous, present, cumulative, continuous cumulative, and instantaneous can have a TOU rate schedule applied to it. The Extended Function version of the VECTRON meter can have a maximum of two TOU registers which follow a defined TOU schedule.

### Current Season Registers

All energy and demand registers selected for a specific season are considered current season registers. If a single rate schedule is applicable year-round, then only current season registers are used. Cumulative and continuous cumulative registers are not TOU functions of the VECTRON meter.

### Last Season Registers

Last Season Registers are selected when two or more seasons are used during the year. For every Current Season Register (with the exception of the E rate continuous cumulative register) there is a Last Season register for the same quantity. Last Season Registers are designated LS in the programming software. Last Season Registers can be selected for display in Normal and Alternate display modes.

## Operation

This section describes operations specific to the meter display

Several programmable TOU indicators are available on the Liquid Crystal Display (LCD).

### Rate Annunciators and Active Rate Indicators

Rate annunciators are available with each demand and energy register. An A, B, C, D or E will appear in the far right side of the LCD (Figure 3.4) to indicate the rate period for each quantity being displayed.

If the rate annunciator is flashing while a demand or energy value is displayed, the annunciator indicates that it is the current rate in effect. This gives a quick indication that the register is programmed with the correct TOU schedule and that it is currently storing the correct time.

### Season Change

At the end of a specified season, all Last Season registers are updated with current season register data. The meter can be programmed to activate an automatic demand reset at season change. A season change occurs at midnight at the end of the programmed Season Change date, or at the first demand reset following the Season Change date, depending on how the meter has been programmed. Some utilities program the season change to occur at the first demand reset following the Season Change date to make season changes concurrent with the meter reading cycles.

The following events take place when an automatic demand reset occurs at season change:

1. The current season energy registers are copied directly to the Last Season energy registers.
2. The current season maximum demand registers are copied directly to the Last Season maximum demand registers, and E rate is added to the cumulative demand register.
3. After the demand reset, the maximum demand registers are reset to zero and the E rate cumulative demand register is copied to the Last Season cumulative demand register.

If there is no demand reset at season change, all current season registers are directly copied to Last Season registers at season change but no current season registers are zeroed.

#### Battery Carryover

When the meter recognizes a power outage, it begins battery carryover operations. All billing data are transferred to non-volatile memory at this time and all circuits, except the timekeeping circuit and battery backed RAM, are de-energized. The timekeeping circuitry, powered by the lithium battery, keeps time while the meter is in battery carryover mode.

Upon restoration of ac power all self-diagnostics are completed and all data is retrieved from non-volatile memory. The real time is retrieved from the real time clock. The elapsed time of the outage is also added to the stored value for time spent on battery.

## MASS MEMORY

### Mass Memory Specifications

The mass memory option is available on all TOU and Extended Function versions of the VECTRON meter.

#### Capacity

The VECTRON meter with Mass Memory option provides 32KB of random access memory (RAM) for either one or two (Extended Function version) channels of interval load profile data. The amount of installed RAM actually used for load profile recording is programmable from 1 to 32 Kbytes in one Kbyte increments.

#### Bit Resolution

The mass memory is configured for 12 bit data resolution. Equivalent pulse count resolution per interval is as follows:

Bits	Pulse Counts
12	4,095

### Interval Lengths

The mass memory records data on a block interval basis. The interval length is programmable: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, or 60 minutes. The interval length is the same for all channels and is independent of the interval length for displayed demand quantities.

### Power Outage

The VECTRON meter can flag an interval when a power outage exceeds a specified number of seconds. The range for power outage length is programmable from 0 to 255 seconds and must not exceed the programmed interval length.

### Channel Configuration

The meter can be programmed to have one or two channels of interval load profile data. Each channel must correspond to an energy register selected during the programming process. If two channels are selected, one of the energy quantities must be watthours.

Selection of channel configuration and pulse constants is accomplished through the programming software. Each data channel is programmed to record load profile data from a user selected register. The following registers can be assigned as interval pulse channels:

- watthours
- varhours (lag)\*
- VAhours (lag)\*
- varhours (lead)\*

\* Available with Extended Function versions only

### Pulse Constants

For each data channel, the pulse constant is programmable from 0.02 to 999,999 unithours per pulse in 0.01 increments. As with the KYZ pulse output constants, the mass memory pulse constants apply to secondary readings only. (A watthour pulse constant of 1.8 corresponds to 1.8 watthours per pulse).

Some example pulse weight calculations follow:

#### Example 1: Calculation of Pulse Weight Replacing an Electromechanical Device

Customer pulls 120V, CL20, 3-element, Form 9S electromechanical meter from installation.

Meter Kh = 1.8 watthours/disk revolution

Pulse Initiator = 4 pulses/disk revolution

This electromechanical meter has the following Pulse Weight (PW):

$$PW = Kh/PDR = \frac{1.8 \text{ watthours/disk revolution}}{4 \text{ pulses/disk revolution}}$$

$$PW = 0.45 \text{ watthour/pulse}$$

If this meter is replaced by a VECTRON meter of the same form number, voltage and current ratings, and if the utility wants the VECTRON meter to operate the same way, the pulse weight would be entered in the configuration file as 0.45 watthours per pulse.

**Example 2: Calculation of Pulse Weight From kWh**

A VECTRON meter, 3-element, 120 volts, CL20 is programmed so that kWh is recorded into mass memory. The maximum 12-bit data resolution is desired for 15 minute intervals.

First, we must calculate the maximum watt-hour accumulation during 15 minute intervals.

$$\text{Wh, Max} = (120 \text{ volts}) \times (20\text{A}) \times (3 \text{ phases}) \times (0.25 \text{ hours})$$

$$\text{Wh, Max} = 1800 \text{ watt-hours}$$

The maximum number of pulses is 4095; therefore, the smallest Pulse Weight (PW) that can be used is:

$$\text{PW, Min} = \frac{1800 \text{ Wh}}{4095 \text{ P}} = 0.44 \text{ Wh/Pulse}$$

Since this value is a multiple of 0.01, it can be entered as the multiplier for the kWh channel in mass memory.

**Data Storage**

The VECTRON meter stores data in mass memory at the end of each interval. Each channel has 12 bits written to mass memory. For example, consider two channels of mass memory. At the end of an interval, a 12-bit number is written into memory for channel 1; a 12-bit number for channel 2 follows immediately.

This process continues for each interval until sixty intervals have been recorded. The mass memory is grouped into segments of sixty intervals, or records. In addition to the profile data, each record contains the following information:

- Time Tag - Specifies the month, day, and hour of the end of the data block.
- Status Bits - There are five types of status bits written into each data block.
  - Power Outage - status bit is set for each interval during which a power outage occurs (interval status).
  - Saturation - status bit is set when the pulse count for any interval in the block exceeds the data resolution (block status).
  - RAM Error - status bit is set if any memory address within the record fails the memory check (block status).
  - Field Test - Status bit is set if Test mode is activated during an interval (block status).
  - SiteScan Error - Status bit is set if a diagnostic error condition occurs (block status).
- Register Readings - a register reading is maintained in the data record for each channel to be used for data validation. These register readings are updated at the end of each interval.

## Recording Duration

Utilize the following equation to determine the recording duration:

$$\text{Recording Duration (days)} = \{(M \cdot 1024 - 133) / [12 + (96 \cdot C)]\} * I / 24$$

M – Memory size in kilobytes

C – Number of channels

I – Interval length in minutes

\* Truncate all decimals before multiplying by 1/24.

Table 3.4 shows the recording duration for a memory size of 32 kilobytes (KB).

Table 3.4  
Recording Duration in Days for 32 Kb of RAM

Interval Length in Minutes	Days Recording for 1 Channel	Days Recording for 2 Channels
1	12	6
2	25	13
3	37	19
4	50	26
5	62	33
6	75	39
10	125	66
12	151	79
15	188	99
20	251	132
30	377	198
60	755	397

## OPTIONAL OUTPUTS

Optional outputs are provided on a separate circuit board mounted beneath the main circuit board. Two versions of output boards are available:

- A form A solid-state contact and *one* form C mercury-wetted relay
- A form A solid-state contact and *two* form C mercury-wetted relays.

The mercury-wetted relays can be programmed as KYZ outputs. Each KYZ can be programmed to output pulses proportional to the energy registers selected through programming software. The KYZ outputs can be assigned the same or different pulse weights for each energy quantity.

All of the outputs can be programmed as any of the following types of outputs:

- Demand Threshold** The contact closes when the programmed demand threshold value number one is reached. The contact remains closed until the demand drops below the programmed value and the end of the demand interval/subinterval is reached. For Extended Function VECTRON meters, this output is only applicable to register 1.
- End-of-Interval** The contact closes for a period of approximately five seconds at the end of each interval/subinterval.
- Independent Output 1 (TOU only)** The contact closes corresponding to the independent output number one time schedule created in the TOU schedule portion of the programming software.
- Independent Output 2 (TOU only)** The contact closes corresponding to the independent output number two time schedule created in the TOU schedule portion of the programming software.
- Independent Output 3 (TOU only)** The contact closes corresponding to the independent output number three time schedule created in the TOU schedule portion of the programming software. Note: The independent outputs can be used as indicators or as load controls.
- Customer Alert A (TOU only)** The contact is closed when TOU rate A is active.
- Customer Alert B (TOU only)** The contact is closed when TOU rate B is active.
- Customer Alert C (TOU only)** The contact is closed when TOU rate C is active.
- Customer Alert D (TOU only)** The contact is closed when TOU rate D is active.
- Diagnostic Condition Alert** The contact is closed when any of the diagnostic checks are triggered.

Refer to Section 6, Replacement Parts, Accessories, and Drawings for Output Board color coding.

## Output Cables

A standard output cable which extends through the base of the meter as a set of pigtail leads is provided whenever an option board is supplied. An optional viking connector cable assembly is available.

Note: KYZ outputs are not wired to the bayonets in the meter base unless they are specifically ordered this way.

## MEASUREMENT TECHNIQUES

The VECTRON meter samples small portions of the input voltages from the voltage and current sensing elements. Each sample is converted into a binary number and then used by the microcontroller to derive the billing values. This phase selection, sampling, and measurement process is described in the following sections.

### Sampling

During one cycle of the power source, the VECTRON meter takes 8 samples for each of the voltages and the currents on each of the phases. The phase A voltage is sampled first,

followed by the phase A current, then the phase B voltage, and so on. These groups of 6 samples are therefore spaced 2.08 milliseconds apart if the register is operating on 60 Hz or 2.5 milliseconds if the register is operating on 50 Hz (see Figure 3.5).

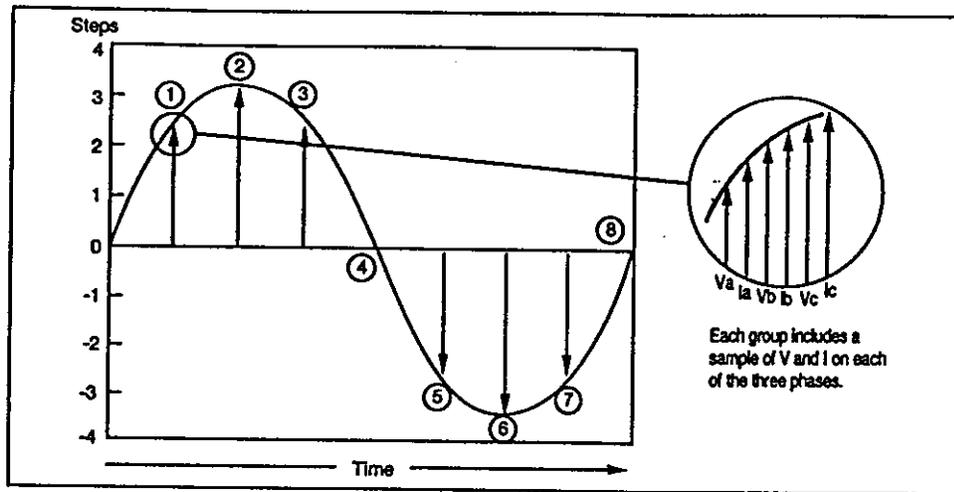


Figure 3.5 Sampling

Before this procedure is repeated for the next cycle, a delay is added so that the relative position of the next group of 8 samples on the waveform is shifted in time with respect to the samples taken during the previous cycle. This ensures that each group of samples is not taken at an identical point during the cycling of the signal. This technique, called *sample migration*, helps the VECTRON meter maintain metering accuracy under harmonic distortion conditions. (see Figure 3.6).

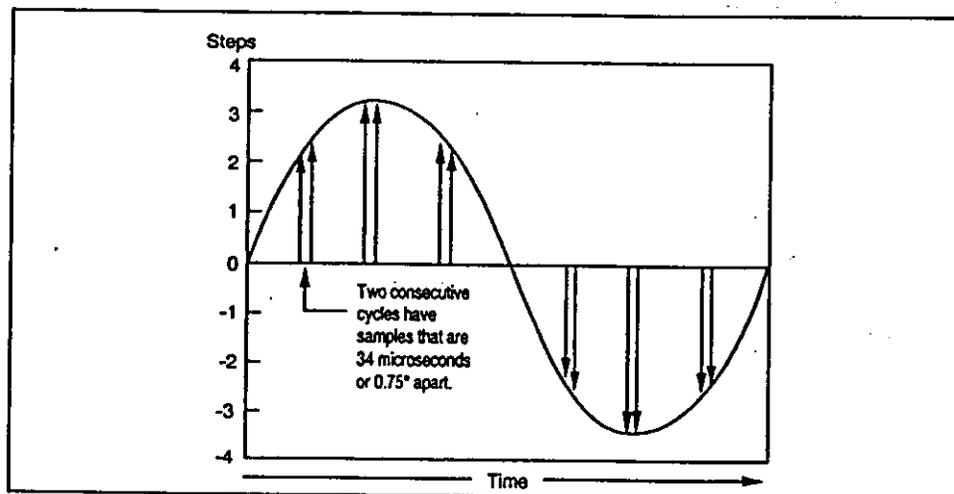


Figure 3.6 Sample Migration

After 60 cycles the microcontroller has a complete picture of the waveform as if it had been sampled 481 times (480 + 1 because of the migration) in one cycle. (see Figure 3.7).

The line synchronization signal is used to derive the time base for the sampling. It dynamically tunes the sample interval to ensure that there are always the correct number of samples regardless of the line frequency (481 samples for 60 Hz, 401 samples for 50 Hz).

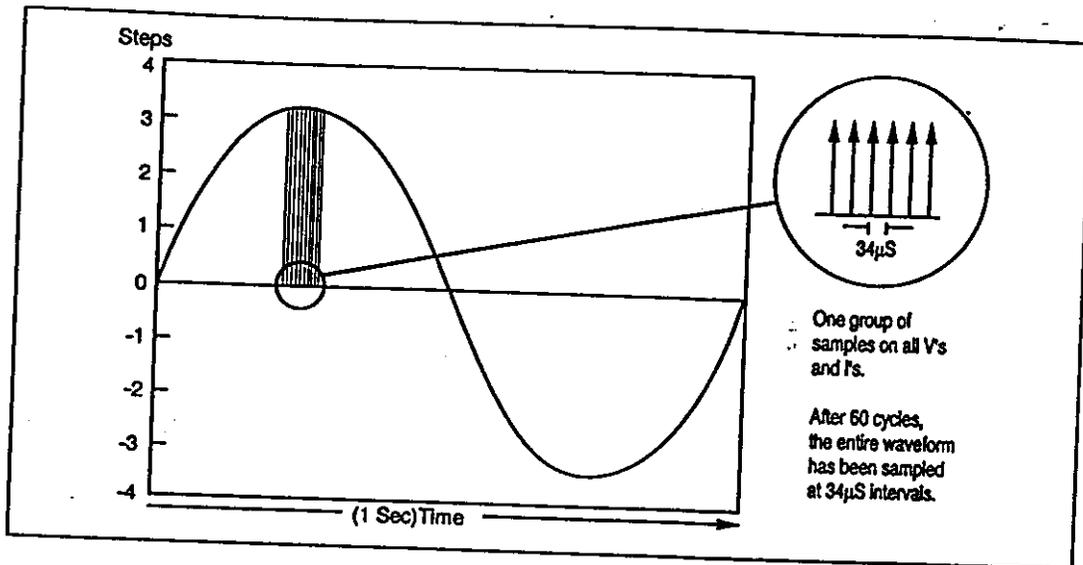


Figure 3.7 Waveform Sampling

### Voltage and Current Measurements

During the sampling process, the voltage and current values from each phase are squared and stored in their respective accumulators.

At the end of the 60th cycle, each accumulator contains the sums of the square of the voltages and currents for each phase (see Figure 3.8). The contents of these accumulators are passed to the consumption routine where they are averaged (divided by 481) and the square root is taken, yielding the RMS voltage and RMS current for each phase. The accumulators are reset before the first of the next set of 481 samples is taken.

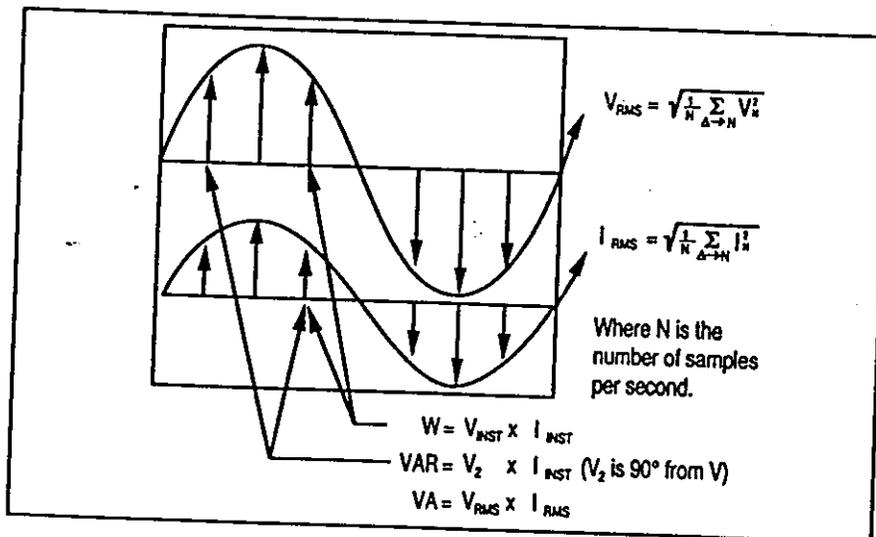


Figure 3.8 Accumulator

### Instantaneous Voltage and Instantaneous Current

Each of the per phase voltage and current values is displayed in the Toolbox mode. The value displayed is the RMS value calculated for the previous 60 cycles.

## Watt-hour Measurement

Watt-hours are measured by multiplying the instantaneous value of the voltage on each phase with the instantaneous value of the current on the same phase (see Figure 3.8).

The resulting values are added to running accumulators. After the completion of 481 samples (one second for 60 Hz supply or 1.2 seconds for 50 Hz supply), the reading in this accumulator is passed to the consumption routine where it is averaged (divided by 481), scaled, corrected, divided by 3600, and then added to the main registers.

The VECTRON meter can be programmed to register watt-hours either in the delivered quadrants only, or in the delivered and received quadrants.

When delivered watt-hours only are measured, any negative watt-hour values are ignored. This has the same effect as a detent mechanism on an induction watt-hour meter.

When delivered and received watt-hours are measured, any negative watt-hour values are made positive and added to the watt-hour register.

## Varh Measurement (Extended Function Version)

Varhours are measured by multiplying the instantaneous value of the first available voltage sample on one phase with the instantaneous value of the third available current sample of the same phase (Figure 3.8). Since voltage samples are continually stored in a three location, *last in, first out* (LIFO), shift register, the first available voltage sample from the register is the one taken three samples (90° phaseshift) previous to the instant of the request for a Varh reading.

Each Varh measurement is added to a running accumulator. After the completion of 481 samples (approximately one second for 60 Hz supply or 1.2 seconds for 50 Hz supply), the reading of the accumulator is passed to the consumption routine where it is averaged, scaled, corrected, and added to the main registers.

## VAh Measurements (Extended Function Version)

The VECTRON meter measures RMS volt-amperes using arithmetic phase summation. This method ensures that the resulting VAh value contains as much of the harmonic information as possible.

Volt-ampere values are calculated by multiplying the RMS voltage value with the coincident RMS current value (see Figure 3.8) using the following formulas:

$$VA = V_{RMS} \times I_{RMS}$$

where

$$V_{RMS} = \sqrt{\frac{1}{N} \sum_{\Delta \rightarrow N} V_N^2}$$

$$I_{RMS} = \sqrt{\frac{1}{N} \sum_{\Delta \rightarrow N} I_N^2}$$

where N is the number of samples per second.

The voltage and current values from each phase are squared and stored in their respective accumulators. At the end of the 60th supply cycle, each accumulator contains the sums of the square of the voltages or currents for each phase. The contents of these accumulators are passed to the consumption routine where they are averaged (divided by 481) and the square root is taken, yielding the RMS voltage and RMS current for each phase.

Every second the RMS voltage and the RMS current for each phase are multiplied together to establish a VA-second value for each phase. These values are scaled and corrected.

The total VAhour value is calculated by adding the VA-second quantities for each phase and dividing the total by 3600. This value is added to the appropriate register

If apparent energy is selected as the extended function, the VECTRON can be programmed to calculate VA either vectorially or arithmetically on delta services. The vectorial calculation uses the following formula:

$$VA = \sqrt{Watts^2 + Vars^2}$$

Notes:



## **FCC WARNING STATEMENT**

**Note:** This equipment has been tested and found to comply with the limits for Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential/office installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- \* Reorient or relocate the receiving antenna
- \* Increase the separation between the equipment and receiver
- \* Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- \* Consult the dealer or an experienced Radio/RV technician for help

**CAUTION:** Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment



## 19.0 FAMILY APPROVAL

**19.1** A certificate holder may obtain family approval certification for a terminal equipment device, based on that certificate holder's previously certified equipment, provided that the proposed new equipment is nearly identical in design and construction to the previously certified device. In order to obtain a family approval certification, the following must be presented to the Department:

- (a) The model number, Industry Canada certificate number and certification number of the approved equipment;
- (b) a completed Terminal Equipment Certification/Testing Application and Agreement form. If more than one model is to be approved, the additional models may be shown on an attached list;
- (c) photographs and product literature if the new model(s) internal or external appearance differs from the previously certified models;
- (d) a drawing, sample or illustration of the product label, if this is not shown in (c);
- (e) a brief statement as to why the new product should qualify for family approval. This statement must be augmented with schematic diagrams and block diagrams. If modifications have been made to the circuitry, a test report verifying affected parameters may be required.
- (f) a description of the number and types of network interfaces;  
and
- (g) payment in accordance with TRC-49 section on Family Approval of Equipment Models.

## 20.0 MULTIPLE LISTING

**20.1** A terminal equipment device may be multiple listed to other distributors based upon the approval granted to the original certificate holder. In order to obtain a multiple listing certification, the following documentation must be presented to the Department:

- (a) The model number, Industry Canada certificate number and certification number of the approved equipment;
- (b) a letter from the original certificate holder authorizing the Department to use information on file to grant a multiple listing certification. The name/model number, certificate number and certification number for the subject equipment must be shown. The letter must also declare that the model to be multiple listed is identical in design and construction to the originally approved model;
- (c) a letter, from the proposed multiple listee, requesting the certification;
- (d) a Terminal Equipment Certification/Testing Application and Agreement form, completed by the proposed multiple listee;
- (e) a drawing, sample or illustration of the product label;  
and
- (f) payment in accordance with TRC-49 section on Multiple Listings.

0203

Manager Radio & Terminal Equipment Certification Section  
Industry Canada

Certification & Engineering Bureau

1241 Clyde Avenue

Ottawa, Ontario, Canada, K2C 1Y3

Tel (613) 952 - 3200

Fax (613) 952 - 1088

Called at 9:33 am - - application rec'd 3/2

- to call back by end of the week -

cannot do multiple until approved!

- application

\$ 200

\$ 45 - each certificate.

## **\* 19.0 FAMILY APPROVAL**

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