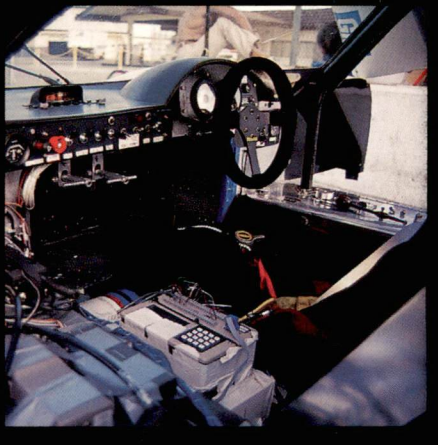
21X and 21XL Microloggers



CAMPBELL SCIENTIFIC, INC.
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21X and 21XL MICROLOGGERS

Rugged, Powerful Little Dataloggers

Significant Features

PORTABLE

Packaged smaller and lighter (including batteries) than the CRC Handbook of Chemistry and Physics.

BATTERY OPERATED

Scanning and processing all 16 single-ended channels every minute, the 21X's 8 alkaline D-cells last approximately 6 months; the 21XL's rechargeable batteries last approximately 2 months per charge. AC power or solar panels are used to trickle-charge the 21XL's batteries, extending operating life indefinitely.

SENSITIVITY AND MEASUREMENT SPEED

The 21X(L) has 14-bit precision on 5 software selectable ranges. Resolution is 0.33 microvolts at 37 milliseconds per channel with 100 nanovolt RMS input noise. At 2.5 milliseconds per channel, the input noise is 1.2 microvolt RMS.

SENSOR COMPATIBILITY WITHOUT EXTERNAL SIGNAL CONDITIONING

Linearized thermocouple measurements at 7.3 milliseconds per channel resolve to within 0.05°C. Bridge excitation voltages are selectable within a ±5 V range at 0.67 mV resolution. Resistance bridge measurements such as RTDs, load cells, pressure transducers, foil strain gages, and thermistors optimize accuracy using AC excitation and ratiometric techniques. AC excitation also minimizes polarization errors in soil moisture, salinity, conductivity, and RH sensors. Four pulse count channels accommodate magnetic pulse flow meters, photochopped or switch closure devices, and incremental shaft encoders.

EXPANDABILITY

Peripherals are available to expand the number of analog input, pulse count, analog output, and control channels.

INTERNAL PROCESSING

Programmable instructions include algebraic, statistical, and transcendental functions.

REMOTE PROGRAMMING AND DATA RETRIEVAL

Programs, parameters, and direct commands are entered from the 21X(L)'s keyboard or from an on-site or remotely located computer. Up to 19,296 data values can be stored in memory for transfer via the 21X(L)'s serial I/O to a display, printer, modem, storage module, or computer.

ANALOG AND DIGITAL CONTROL OUTPUTS

Two continuous analog outputs with 14-bit resolution supply voltage levels for strip chart recorders or proportional controllers. Six digital outputs can be set or reset based on time or measured value.

TRANSIENT PROTECTED

Spark gaps or transzorbs protect all panel connections from electrical transients.

OPERATION IN HARSH ENVIRONMENTS

Operating ranges are -25 to +50°C (-55 to +80°C on special order) and 0 to 90% relative humidity. A 21X(L) properly housed in an ENC 12/14 or ENC 16/18 enclosure is protected from excessive humidity and most contaminants.

Applications

Meteorology/Agriculture

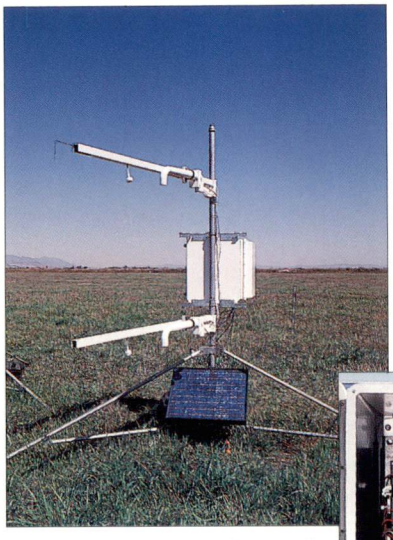
Meteorological conditions are monitored at Lake Louise, Alberta, Canada. Photograph courtesy of Claude Labine (CSC).

The 21X(L) is used in a variety of long-term climatological monitoring, meteorological research, and routine weather measurement applications. Typical meteorological measurements include wind speed and direction, precipitation, barometric pressure, solar radiation, air temperature, and relative humidity. The 21X(L) can measure wind speed and direction 5 times per second at 4 levels, computing the wind vector's average for each level without interruption. Standard deviations can also be calculated for wind direction, vapor pressure from wet/dry bulb temperature, and saturation vapor pressure from air temperature. For air quality applications, the 21X(L) automatically controls calibration sequences and computes conditional averages which exclude invalid data (e.g., data recorded during power failures or calibration intervals).

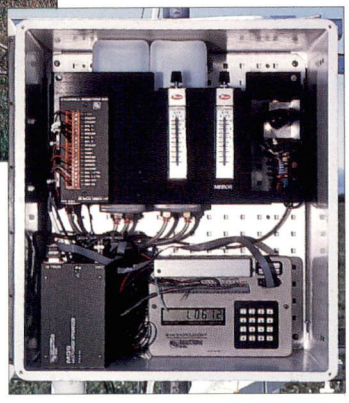
Cover Photos: At left: 21X Micrologger. From top right: *Hydrology* Oceanographic buoy measures wave height spectra, Bering Sea, Alaska, (photo courtesy of Brown & Caldwell); *Agriculture* Bowen Ratio systems, Lincoln, Nebraska; *Meteorology* Weather station installation, Peter Sink, Wasatch Mountains, Utah; *Automotive* GTP performance testing, Daytona Speedway, Florida.

Bowen Ratio Systems

The 21X is the center of Campbell Scientific's 023A Bowen Ratio system which calculates evapotranspiration (ET) by measuring air temperature, net radiation, soil heat flux, and dew point. The Bowen Ratio system measures air temperature at two heights with type E fine-wire thermocouples. A Q7 Net Radiometer measures net radiation and an HFT3 Soil Heat Flux Plate measures soil heat flux. To measure dew point, air samples from two heights are forced through mixing volumes and routed to a cooled mirror dew point hygrometer. Every 2 minutes the air drawn through the cooled mirror is switched from one height to the other with solenoid valves.



Bowen Ratio System with ASPTC Aspirated Thermocouples.



The 023A enclosure houses the 21X, hygrometer, and flow controller.

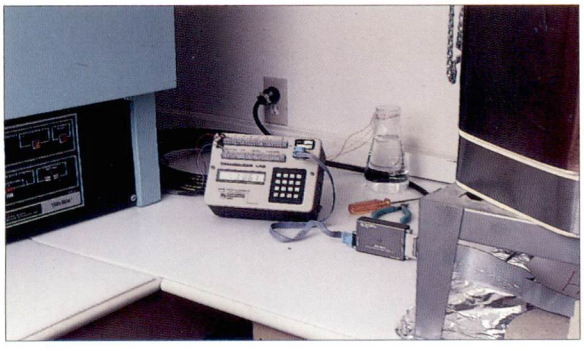
A related system is the 023/CO_2 Bowen Ratio System which uses a customer-supplied LI-COR 6262 analyzer for measuring water vapor and CO_2 concentrations.

Eddy Correlation System

Primary components include the CA27 Sonic Anemometer which measures wind and temperature fluctuations about their means, and the KH20 Krypton Hygrometer which measures rapid fluctuations in atmospheric water vapor. The 21X(L) uses the measurements to calculate atmospheric heat and vapor fluxes.

Laboratory Applications

Most sensors connect directly to the 21X(L)'s analog input channels without additional signal conditioning. The 6 control ports activate external relays, solenoid valves, or resistive loads based on time or measured values. The 21X(L)'s integrated keyboard/display allows lab personnel to edit the datalogger's program, display measurements or processed data, or access historical data. By connecting the 21X(L) through an SC32A interface to an IBM-compatible computer running PC208 software, up to 33 measured or calculated values can be displayed simultaneously.



The 21X monitors and controls laboratory experiments.

Vehicle Performance

The 21X(L)'s compact, integrated package fits on the passenger seat or car floor enabling a driver to easily access the keyboard and display. For passenger cars, trucks, buses, and other vehicles, the 21X(L) measures temperature, pressure, fuel flow, velocity, acceleration, engine RPM, force, displacement, and electrical system load. The linearization for K-type thermocouples extends from -50 to +1370°C, allowing measurements from ambient to catalytic converter temperatures. Strain gage transducers typically measure pressure, acceleration, and force. Pulse transducers that measure fuel flow, engine RPM, and velocity connect directly to the 21X(L)'s pulse count inputs.

A cross-country vehicle test system records performance data and vehicle position for transmission via cellular phone.

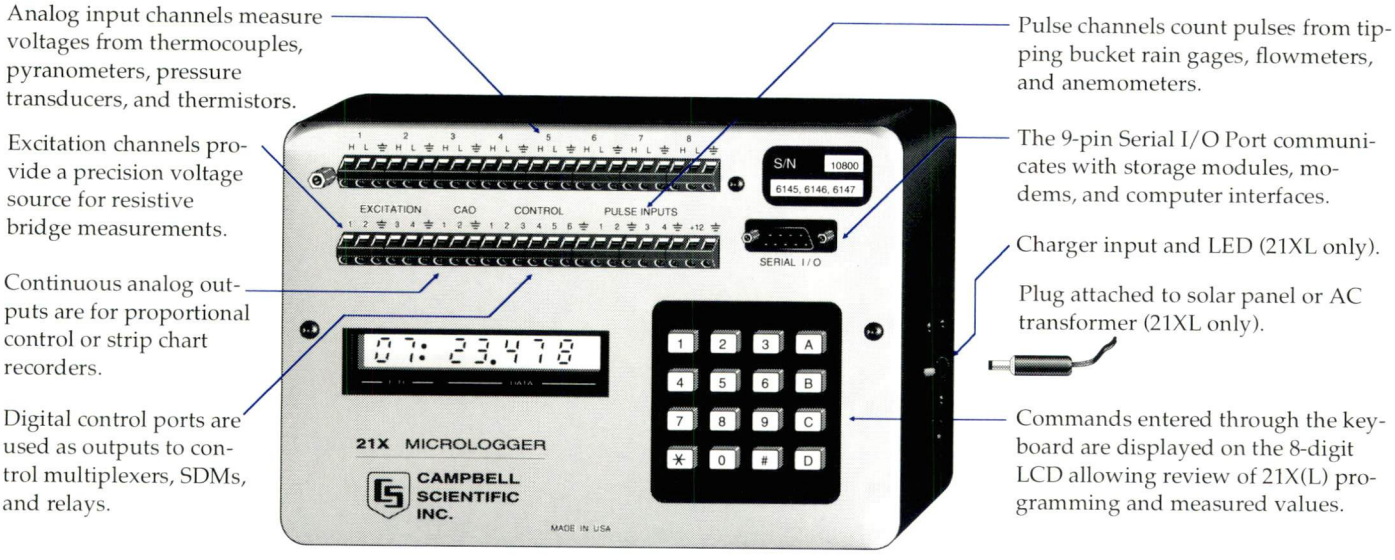
Hydrology

Hydrologic conditions of lakes, channels, and stilling wells can be monitored with the 21X(L).

In hydrologic applications, 21X(L) measurements include stage/water level, ion conductivity, and water quality. Stage/water level is measured with a DB1 Double Bubbler, a strain gage pressure transducer, or an incremental shaft encoder. Ion conductivity measurements use the AC excitation from one of the datalogger's four switched excitation ports. The 21X(L) can control water quality samplers as a function of time, water level thresholds, or rate of change.

System Descriptions

The 21X and 21XL are textbook-sized, battery-operated, precision dataloggers capable of operating in harsh environments. The name "MICROLOGGER" is descriptive of these MICRO-computer-based dataLOGGERs' MICRO-size, MICRO-power, and sub-MICRO-volt sensitivity. In one small box, they contain a micro-computer, clock, multimeter, calibrator, scanner, frequency counter, controller, and signal generator.



21X Versus 21XL

The 21X and 21XL Microloggers differ only in their power supply and battery base. The 21X's power supply is 8 D-cell alkaline batteries that have a 7 Ahr capacity; the 21XL's power supply is a 2.5 Ahr sealed rechargeable battery that is trickle-charged with AC power or a solar panel. (From here on, 21X will refer to both models unless stated otherwise.)

Standard Configuration

The 21X has 16 single-ended (8 differential) analog inputs, 4 pulse count inputs, 4 switched excitation outputs, 2 continuous analog outputs, and 6 digital control outputs. The standard instruction set contains 22 measurement and control, 39 data processing, and 9 program control instructions. There are 28 input, 64 intermediate, and 19,296 final data storage locations. The operating temperature range is -25 to +50°C. On special order, the 21X's electronics (excludes batteries) are tested and guaranteed to operate over the -55 to +80°C range.

Transient Protected

Spark gaps protect the input/output connections from electrical transients. The spark gaps are connected to a heavy copper bar located between the input terminal strips on the circuit board. Transzorbs protect the 12-volt power and charger inputs.

Channel Expandability

The following peripherals expand 21X measurement or control capability. Contact Campbell Scientific regarding the suitability of these peripherals for your application.

SYNCHRONOUS DEVICES FOR MEASUREMENT (SDM)

SDMs are addressable peripherals that expand control capabilities, analog output ports, and datalogger measurement capabilities. Up to 16 SDMs may be connected to three control ports on the 21X; the SDM-INT8 and SDM-SW8A also require analog channel 1H. SDM operation is controlled by datalogger instructions 101-104.

SDM-A04 Four Channel Continuous Analog Output Module provides four independent continuous analog outputs for proportional control or strip chart recording.

SDM-CD16AC Control Port Module has 16 relays (0-5 V) for control of external devices such as fans, pumps, and starter motors. A manual override switch is provided for each port.

SDM-INT8 Eight Channel Interval Timer expands the number of pulse count channels in the system and outputs processed timing data to the datalogger. Timing events are captured with ±1 microsecond resolution over a maximum range of 16.77 seconds. Output options include period, pulse width, frequency, counts, and interval time.

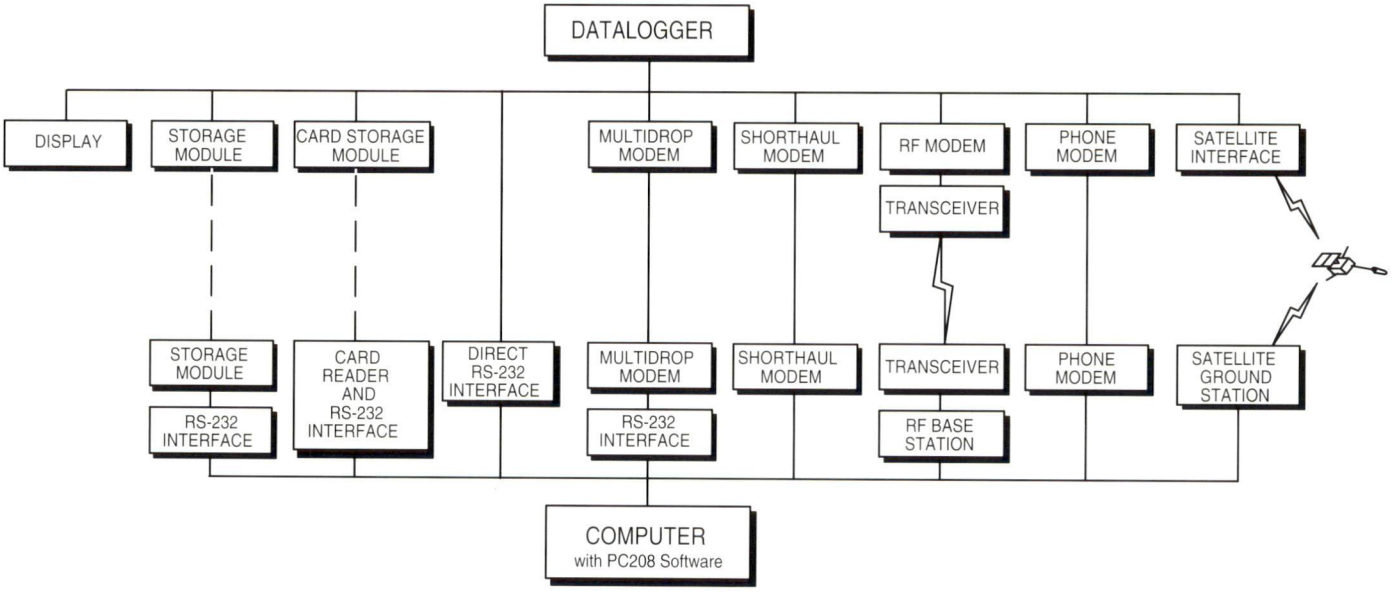
SDM-SW8A Pulse Counter is an 8-channel pulse count expansion for switch closure measurements up to 100 Hz. Channels can be individually configured for single-pole double-throw (SPDT), single-pole single-throw (SPST), or voltage pulse measurement. Output options include signal state, duty cycle, or counts.

MULTIPLEXERS

Multiplexers increase the number of sensors that can be measured by a 21X. The AM416 sequentially multiplexes sixteen groups of four lines at a time (a total of sixty-four lines). Compatible sensors include thermistors, thermocouples, potentiometers, load cells, strain gages, vibrating wires, and soil moisture blocks. The AM25T multiplexes 25 sets of two lines at a time. Compatible sensors include thermocouples and other low-level voltage sensors. Several multiplexers can be controlled by a single 21X.

Data Storage and Transfer

Up to 19,296 raw or processed data points can be stored in the 21X's memory. Data are transferred to a computer via telecommunications or on-site data retrieval options.



SOFTWARE

PC208 Datalogger Support Software supports telecommunications, programming, data transfer, and data processing functions. With an appropriate communication link, PC208 provides two-way communication between the 21X and an IBM-PC or compatible computer. Graph mode allows real-time graphical display of datalogger measurements.

DISPLAY

The 21X's keyboard/display provides on-site review of data values and program instructions. Annotated datalogger programs and labeled data values can be displayed on a DSP4 Heads Up Display or on the monitor of a computer.

STORAGE MODULES

Rugged, battery-backed RAM storage modules reliably store data over a -35° to +65°C (-55° to +85°C extended) temperature range. The SM192 or SM716 Storage Module (96K or 358K low-resolution data points, respectively) can remain connected to the 21X to store data continuously or be carried to the field to retrieve data from the 21X's memory. Up to two storage modules can be connected to one 21X. The SC532 Interface is used to transfer data and/or programs between the storage module and an MS-DOS computer. Consult Campbell Scientific if data upload to a non-MS-DOS computer is required.

CARD STORAGE MODULE

The CSM1 Card Storage Module and the MCR1 Memory Card Reader are read/write modules. The CSM1 can either remain with the 21X or be transported to the datalogger site. The MCR1 remains at the computer base station for module/computer communication. Battery-backed RAM memory cards are inserted into the CSM1 and MCR1 for data and/or program transfer. Currently available "credit-card-sized" RAM cards store 1 M bytes to 4 M bytes (524 K and 2 M low resolution data points, respectively). The system operates over a -40° to +50° range (extended range available) and was developed for use with the 21X by Campbell Scientific Limited, U.K.

DIRECT LINE OPTIONS

Direct Datalogger-to-Computer Interface

The SC32A RS-232 Interface supplies an optically isolated connection between the 21X and a computer over distances up to 50 feet.

Multidrop Modem

The MD9 Multidrop Interface links a central computer to over 200 dataloggers on a single coaxial cable. Total coax cable length can be up to three miles.

Short Haul Modems

The SRM-6A short haul modems provide local communication between the 21X and a computer with an RS-232 serial port. The modem transmits data up to 11.2 miles over four-wire unconditioned line (two twisted pairs).

RADIO FREQUENCY (RF) COMMUNICATION

Campbell Scientific's RF communication system uses an RF95 modem and a low-powered transceiver at the remote station(s), and a transceiver connected to an RF232 Base Station at the computer site. Up to 255 stations can be interrogated over a single UHF or VHF frequency.

TELEPHONE NETWORKS

Telephone communications via landline or cellular transceiver are supported. A user-supplied Hayes compatible modem is required at the base station computer. Remote RF or MD9 networks are also accessible by telephone.

The Datalogger Program

The 21X's ability to make measurements, calculations, logical decisions, and phone calls stems from its internal program. The 21X's program can be extremely powerful, yet is composed of simple instructions. Knowledge of a high level programming language, such as FORTRAN or BASIC, is not required.

PROGRAM DEVELOPMENT

A 21X program consists of a series of instructions designed to perform measurement, data processing, data storage, and logical control functions. To construct a program, the user selects application-specific instructions from a library of PROM-based instructions. These instructions, developed for data acquisition and control, allow the 21X to measure most sensor types without the need for external signal conditioning.

Program development can be accomplished with a prompt sheet and the keyboard. In addition, a prompt-driven, computer-based datalogger program editor (EDLOG) is available in Campbell Scientific's PC208 Datalogger Support Software.

Programs can be entered or edited on-site via the 21X's keyboard and display.

INSTRUCTION FORMAT

Each 21X program instruction is identified by a number. For example: Instruction 1 controls single-ended voltage measurements; Instruction 55 applies a 5th order polynomial to incoming data; Instruction 83 sets up an if/then statement; and Instruction 101 controls operation of an ~~SDM device~~ (SDM-INT8). The variety of instructions allows users to select measurement, processing, data storage and control sequences that precisely fit their applications.

The 21X's instructions can be grouped into four functional categories. A listing of the standard 21X instruction set follows; more detailed information is available in the 21X manual and prompt sheet.

INPUT/OUTPUT INSTRUCTIONS are primarily for sensor measurement, but also control and communicate with external devices. Some internal functions, such as control of the 21X's timer, are also classified as I/O instructions. Specific examples include:

- Single-Ended (SE) Volts
- Differential (DIFF) Volts
- Pulse Count
- Excite, Delay, SE Volts
- AC Half Bridge
- Full Bridge
- Three-Wire Half Bridge
- Excite, Delay, DIFF Volts
- Full Bridge with Measured Excitation
- Battery Voltage
- 107 Temperature Probe
- 207 RH Probe
- Thermocouple Temperature (SE)
- Thermocouple Temperature (DIFF)
- Platinum RTD Temperature
- Internal Temperature
- Time
- Signature
- Set Digital Ports
- Burst
- Excitation With Delay
- Timer
- Set/Control External Device (e.g. SDM's)

PROCESSING INSTRUCTIONS allow data reduction, entry of simple algorithms, or conversion of raw data into engineering units. In the following instructions, X, Y, and Z are Input Locations where incoming data values or processed results are temporarily stored; F refers to a fixed value (constant).

- Z = F
- Z = X
- Z = Z+1
- Z = X+Y
- Z = X+F
- Z = X-Y
- Z = X*Y
- Z = X*F
- Z = X/Y
- Z = SQRT(X)
- Z = LN(X)
- Z = EXP(X)
- Z = 1/X
- Z = ABS(X)
- Z = FRAC(X)
- Z = INT(X)
- Z = X MOD F
- Z = X^Y
- Z = SIN(X)
- Z = ARCTAN (X/Y)
- Spatial Maximum
- Spatial Minimum
- Spatial Average
- Scaling Array
- 5th Order Polynomial
- Saturation Vapor Pressure
- Wet/Dry Bulb Temp to Vapor Pressure
- Low Pass Filter
- Resistance from Bridge Output

OUTPUT PROCESSING INSTRUCTIONS process measured values collected over time.

- Sample
- Average
- Totalize
- Maximize
- Minimize
- Histogram
- Wind Vector
- Real Time
- High/Low Resolution
- Sample on Max or Min
- Redirect Output to Input Storage
- Standard Deviation

PROGRAM CONTROL INSTRUCTIONS allow logic based on time or data. They also control serial data output and 21X-initiated telecommunications.

- Subroutine
- Loop
- If X Compared to Y
- If X Compared to F
- If Flag/Port
- If Time
- If Case/Begin Case
- Else
- End
- Control Serial Data Output
- Initiate Telecommunications
- Send Serial Character

Once an instruction is selected, a set of associated parameters is queued in the datalogger's program memory. Each parameter controls a specific aspect of the instruction's operation. Depending on the versatility of the instruction, from 1 to 12 parameters are required. For example, the parameters associated with Instruction 2 (Differential voltage measurement) are:

1 - REPS - Defines the number of times an instruction executes (allows one instruction to measure several identical sensors).

2 - RANGE - Defines the full scale range of the voltage to be measured. Ranges are ± 5, 15, 50, 500, and 5000 mV. Fast (250 µs) and slow (16.67 ms) integration times are also selected with this parameter.

3 - INPUT CHANNEL - Defines the analog input channel that will make the first measurement.

4 - LOCATION - Defines the first Input Storage location.

5 - MULTIPLIER - Allows multiplication of data; for example, 1.8 is entered to convert a temperature measurement from °C to °F.

6 - OFFSET - Allows addition or subtraction of an offset value; for example, 32 is entered to complete the above temperature conversion to °F.

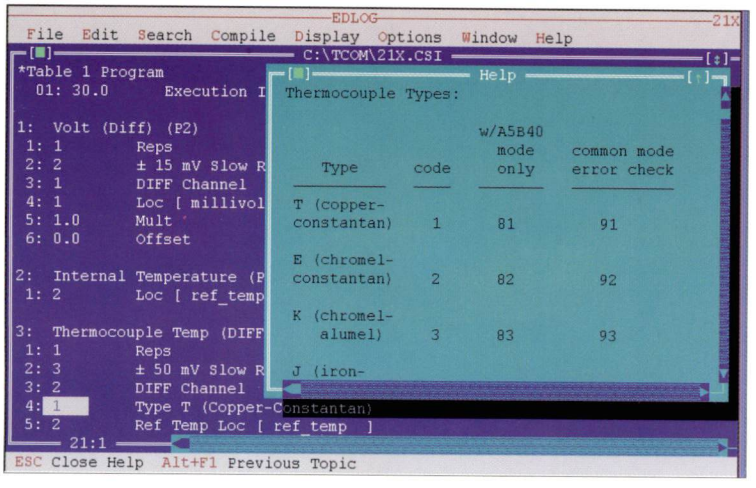
Once the parameters have been entered, the next instruction is selected. This procedure is followed until a specific program has been created. Following program entry, the datalogger checks for errors, then begins executing the program and acquiring data.

SCAN RATE, DATA STORAGE

The maximum rate at which the datalogger can execute its program is 80 times per second. (The maximum rate at which a single input can be measured is 1030 samples per second.) After measurement and analog-to-digital conversion, data are directed to Input Storage locations which hold the measurement value for viewing, subsequent processing, or until transfer to Final Storage. Data can be selectively stored based on user-defined events or intervals and need not be tied to scan rate. Each data point remains in Input Storage until written over by subsequent measured or processed values.

EDLOG

Datalogger program development is supported by PC208 software (EDLOG). Help screens are available to define all instructions and parameter options. Input locations can be annotated with alphanumeric labels so that computer-monitored data are labelled. Once the program has been created, it can be downloaded to the 21X directly, through telecommunications, or to a storage module for later transfer.



EDLOG simplifies 21X programming with annotated instructions, parameters, and labels.

SAMPLE PROGRAM

Every five minutes, the following program measures air temperature (°C) at six locations within a facility. Critical maximum temperature is 30°C (86°F); if any temperature exceeds that threshold, a control port trips a relay that activates an exhaust fan. The average temperature value measured by each thermistor is recorded hourly.

SENSOR CONNECTIONS

In this example, sensor signal leads are connected to 21X single-ended input channels 1 through 6; excitation leads are connected to excitation channel 1; and sensor grounds are connected to any ground terminal. Port 1 controls the exhaust fan.

		Program	Comments
	* 1	Table 1 Programs	*Executes the following program every 5 minutes.*
	01: 300	Sec. Execution Interval	
Measurement & Processing	01: P11	Temp 107 Probe	*Measures six Model 107 Thermistors and places the results in Input Locations 1-6.*
	01: 6	Reps	
	02: 1	IN Chan	
	03: 1	Excite all reps w/EXchan 1	
	04: 1	Loc [:TEMP #1]	
	05: 1	Mult	
	06: 0	Offset	
	02: P49	Spatial Maximum	*Analyzes the incoming data and places the highest temperature in Input Location 7.*
	01: 6	Swath	
	02: 1	First Loc TEMP #1	
	03: 7	Max Value Loc [:MAX TEMP]	
Exhaust Fan Control	03: P89	If X <=> F	*Compares that temp. against 30°C. If the measured temp. is higher, the exhaust fan is activated (or remains active),*
	01: 7	X Loc MAX TEMP	
	02: 3	>=	
	03: 30	F	
	04: 41	Set high Port 1	
	04: P94	Else	*else, if lower*
	05: P86	Do	*the exhaust fan is turned off or remains off.*
	01: 51	Set low Port 1	
	06: P95	End	
Data Output	07: P92	If time is	*The following data is output to Final Storage every hour:*
	01: 0	minutes into a	
	02: 60	minute interval	
	03: 10	Set high Flag 0 (output)	
	08: P77	Real Time	
	01: 110	Day,Hour-Minute	*date, hour, minute;*
	09: P71	Average	*average temp. measured by each sensor. (Each average is based on 12 measurements.)*
	01: 6	Reps	
	02: 1	Loc TEMP #1	
	10: P	End Table 1	

With PC208 software and an appropriate telecommunications link, a user can monitor real-time data or control the exhaust fan remotely. Data transfer to a computer can be selected as binary, comma-delineated or printable ASCII.

Specifications

The following electrical specifications are valid for an ambient temperature range of -25 to +50° C unless otherwise specified.

PROGRAM EXECUTION RATE

System tasks initiated in sync with real time up to 80 Hz. One measurement with data transfer is possible at this rate without interruption. A single input may be measured over short intervals at rates up to 1030 Hz using Burst Measurement.

ANALOG INPUTS

NUMBER OF CHANNELS: 8 differential or up to 16 single-ended. Each differential channel can be configured as two single-ended channels.

CHANNEL EXPANSION: Model AM416 Relay Multiplexer allows an additional 64 single-ended channels to multiplex into four 21X single-ended channels. Model AM25T allows an additional 25 differential channels to multiplex into a single 21X differential channel.

RANGE AND RESOLUTION: Ranges are software selectable for any channel. Resolution for a single-ended measurement is twice the value shown.

Full Scale Range (FSR)	*Resolution*
± 5000 millivolts	333 microvolts
± 500 millivolts	33.3 microvolts
± 50 millivolts	3.33 microvolts
± 15 millivolts	1.00 microvolt
± 5 millivolts	0.33 microvolts

ACCURACY OF VOLTAGE MEASUREMENTS AND ANALOG OUTPUT VOLTAGES:
Differential and positive single-ended:
±0.05% FSR (±0.025%, 0 to 40°C)
(e.g., ±0.05% FSR = ±5 mV for ±5000 mV range)
Negative single-ended:
±0.15% FSR (±0.1%, 0 to 40°C)

INPUT SAMPLE RATES: The fast A/D conversion uses a 0.25 ms signal integration time and the slow conversion uses a 16.666 ms signal integration (one power line cycle period). Differential measurements include a second sampling with reversed input polarity to reduce thermal offset and common mode errors. Input sample rates are the time required to measure and convert the result to engineering units.

Fast single-ended voltage:	2.4 ms
Fast differential voltage:	3.7 ms
Slow single-ended voltage:	18.8 ms
Slow differential voltage:	37.0 ms
Fast differential thermocouple:	7.3 ms

INPUT NOISE VOLTAGE:

Fast differential	---	0.82 microvolts RMS
Slow differential	---	0.1 microvolts RMS

COMMON MODE RANGE: ± 5 volts

DC COMMON MODE REJECTION: > 140 dB

NORMAL MODE REJECTION: 70 dB
(60 Hz with slow differential measurement)

INPUT CURRENT: 2 nanoamps maximum

INPUT RESISTANCE: 200 gigohms

SUSTAINED INPUT VOLTAGE WITHOUT DAMAGE: < ± 16 VDC

ANALOG OUTPUTS

NUMBER OF ANALOG OUTPUTS: 4 switched, 2 continuous

DESCRIPTION: A switched output is active only during a measurement and is switched off (high impedance) immediately following the measurement. Only one switched output can be active at a time. The 2 continuous outputs hold a preset voltage until updated by an analog output command.

RANGE: ± 5 volts

RESOLUTION: 0.67 millivolts

ACCURACY: Same as voltage input.

OUTPUT CURRENT:
Switched: 20 mA @ ± 5 V, 50 mA @ ± 2.5 V
Continuous: same @ +V, 5 mA @ −V

RESISTANCE AND CONDUCTIVITY MEASUREMENTS

ACCURACY: 0.0175% (±0.01%, 0 to 40°C) of full scale bridge output, limited by the matching bridge resistors. The excitation voltage should be programmed so the bridge output matches the full scale input voltage range.

MEASUREMENT TYPES: 6-wire and 4-wire full bridge, 4-wire, 3-wire, and 2-wire half bridge. Bridge measurements are ratiometric and dual polarity to eliminate thermal emfs. AC resistance measurements use a dual polarity 0.75 ms excitation pulse for ionic depolarization, with the signal integration occurring over the last 0.25 ms.

PULSE COUNTERS

NUMBER OF PULSE COUNTER CHANNELS: 4 eight-bit or 2 sixteen-bit; software selectable.

MAXIMUM COUNT RATE: 2550 Hz, eight-bit counter; 250 kHz, sixteen-bit counter. Pulse counter channels are scanned at 10 Hz maximum.

MODES: Switch closure, high frequency pulse, and low level AC:

SWITCH CLOSURE MODE
Minimum Switch Closed Time: 3 milliseconds
Minimum Switch Open Time: 4 milliseconds
Maximum Bounce Time: 1 millisecond open without being counted.

HIGH FREQUENCY PULSE MODE
Minimum Pulse Width: 0.002 milliseconds
Maximum Input Frequency: 250 kHz
Voltage Thresholds: Count upon transition from below 1.5 V to above 3.5 V
Maximum Input Voltage: ± 20 V

LOW LEVEL AC MODE
(Typical of magnetic pulse flow transducers or other low voltage, sine wave outputs).
Input Hysteresis: 11 mV
Maximum AC Input Voltage: 20 V RMS

Frequency Range:

Minimum AC Input (RMS)	*Range*
20 mV	1 Hz to 100 Hz
50 mV	0.5 Hz to 400 Hz
150 mV to 20 V	0.3 Hz to 1000 Hz

(Consult factory if higher frequencies are desired.)

DIGITAL CONTROL OUTPUTS

NUMBER OF DIGITAL CONTROL OUTPUTS: 6 (can be set or reset on command)

OUTPUT VOLTAGES (no load): high 5 volts ± 0.1 volt; low < 0.1 volt

OUTPUT RESISTANCE: 400 Ω

TRANSIENT PROTECTION

All input and output connections are protected using spark gaps connected directly to a heavy copper bar on the circuit card between the two input terminal strips. The 12 volt power input and charger inputs are protected with transzorbs.

CPU AND INTERFACE

PROCESSOR: Hitachi 6303

MEMORY: 24K ROM, 40K RAM. Standard 21X stores 19,296 low resolution data points in Final Memory.

DISPLAY: 8 digit LCD (0.5" digits)

PERIPHERAL INTERFACE: 9 pin D-type connector for storage module, modem, printer, card storage module, and RS-232 adapter. Baud rates selectable at 300, 1200, 9600 and 76,800.

CLOCK ACCURACY: ± 1 minute per month

SYSTEM POWER REQUIREMENTS

VOLTAGE: 9.6 to 15 volts

TYPICAL CURRENT DRAIN: 1.0 mA quiescent, 25 mA during processing, and 60 mA during analog measurement.

INTERNAL BATTERIES: The 21X is powered by 8 Alkaline "D" cells with 7 Ahr capacity. The 21XL's sealed rechargeable batteries have 2.5 Ahr capacity per charge. The 21XL batteries are recharged from an external 15 to 30 VDC source (e.g., solar panel, external battery, or included 110 VAC to 16 VDC wall transformer).

EXTERNAL BATTERIES: Any 12 volt battery can be connected as a primary power source; the external batteries provide backup while the internal batteries are changed.

PHYSICAL SPECIFICATIONS

SIZE: 8.2" X 5.7" X 3.3" (Input terminal strips extend 0.45" above the panel surface.)

WEIGHT: 6.2 lbs (with alkaline batteries)

WARRANTY

Three years against defects in materials and workmanship.

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