



**UTILITY
SYSTEMS
INC.**

A Magnetic Instrumentation, Inc. Company

Model 2002 Detailed Description

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1.0 General

The Model 2002 Digital Recorder is a state of the art data collection and analysis system. It is suitable for application in an electrical utility substation or plant environment to record fault data, extended disturbances, abnormal conditions, and normal conditions. The system will continually monitor all analog and event input signals. The system can be configured to create transient records, long-term records, and continuous records. Upon detection of a sensed fault or disturbance the system will automatically initiate and store pre-fault, fault, and post-fault data. The system will record continuous RMS, continuous frequency and dynamics power swing.

The Model 2002 Digital Recorder uses Windows 2000™ as its operating system and supports PC software and any Windows™ compatible modem. The recorder uses a Pentium-III, 1GHz processor, or better. The single board computer includes on board Ethernet. The computer contains 128MB RAM, 3.5" floppy drive, 40Gig hard drive, CD ROM Drive, 4 RS232 ports, 1 parallel port, 2 USB ports, and an internal 56K modem.

The system automatically converts fault files to COMTRADE format and manually or automatically uploads files to the Master Station. Distance to fault information is automatically calculated at the DFR. Information such as line name, fault type, duration and distance to fault are displayed at the recorder and automatically sent to the Master Station. The Master Station has the capability of automatically emailing a quick summary of all faults, including distance to fault information, to a list of email address.

The Model 2002 keeps a TRACE file (text file) that documents major activities of the recorder (time sync, diagnostic check, record a fault, rebooting, reinitializing, etc.) The unit continuously monitors major system parameters such as, PC voltages, power supply voltages, modem status, clock sync, disk free space, and automatically initiates an alarm if a problem is detected. The master station program is able to initiate and retrieve a diagnostic report from the digital fault recorder. An I/O board inside the DFR acts as a watchdog for the PC and will reboot the PC if a non-responsive condition exists.

Master Station software is supplied with each fault recorder. The Master Station software is capable of reading COMTRADE files. The Master Station software is capable of operating on a Master Station PC having a Windows 95, 98, NT, or 2000 operating system. The master station analysis software is also loaded on the fault recorder computer so fault analysis can be performed at the substation.

Real-time analog signals can be viewed at your master station with the built in pcAnywhere™ feature and scope program. Real-time trigger status and real-time event status can also be viewed with the this feature.

2.0 Recorder Details

2.1 Equipment Operating Voltage

- a. 125VDC standard, other input voltages available upon request (48VDC, 250VDC, 120VAC)
- b. Current draw dependent on number of channels
 - 8 analog, 32 events @ 125VDC = $3\frac{1}{4}$ A
 - 64 analog, 256 events @125VDC = $4\frac{1}{8}$ A

2.2 Analog Channels

- a. Groups of 8 channels w/dedicated DSP
- b. Each channel has Voltage 1, Voltage 2, Current, and common input
- c. Input type: AC (50, 60Hz), DC
- d. Input Ranges:
 - Voltage 1, 41V to 400V, $V_{in}/100$, R_{in} 111K Ω
 - Voltage 2, 0V to 40V, $V_{in}/10$, $R_{in}=11K\Omega$
 - Current, 15A Cont., 200A for 2 Seconds,
Built in $R_{shunt}=2m\Omega$
- e. Bandwidth DC to 5KHz Anti-aliasing LP filter, 9.6KHz Standard
Maximum Sampling Rate at 60Hz
- f. A/D Converter Capable Of 100Ks/Sec throughput
- g. Common Mode Rejection– 90db Typical
- h. Linearity– .01% FS Typical
- i. Temperature Error– 60ppm/ $^{\circ}$ C
- j. Accuracy– at least .25% FS
- k. Isolation– 3500Vrms Channel-to-System Ground, 3500Vrms Channel-to-Channel

2.3 Event (Digital) Channels

- a. Groups of 32
- b. Configure event recording for DFR, SER, or both
- c. Software debounce timer
- d. Auto trigger stop, temporization, and auto restart
- e. Trigger on rising edge, falling edge, or both
- f. Isolated channels or common return
- g. Standard input 125VDC, other input voltages available upon request (24VDC, 48VDC, 250VDC)
- h. Bandwidth 20MHz Minimum
- i. Isolation– 3500Vrms Channel-to-System Ground, 3500Vrms Channel-to-Channel

- 2.4 Analog Starting Sensors
 - a. The ability to start recording comes from analog triggers and event triggers
 - b. The recorder can be manually triggered
 - c. Auto trigger stop, temporization, and auto restart
 - d. Real time sampling, calculation and analysis
 - e. Each digital trigger can be set to trigger on rising edge, falling edge, or both.
 - f. Eight triggers per 8 analog channels
 - g. Multiple triggers per channel possible
 - h. Analog trigger types:
 - Over Voltage/Under voltage/Both over-under voltage
 - Over current
 - Over frequency/Under frequency/Both over-under frequencies
 - Positive sequence
 - Negative sequence
 - Zero sequence
 - Real/Reactive Power Rate of Change
 - Real Power Swing
 - Harmonic
 - THD (total harmonic distortion)

- 2.5 Time Synchronization Methods
 - a. IRIG-B input
 - b. 1PPS input
 - c. Micro-second time stamp capability
 - d. Optional built-in Oncore satellite clock
 - e. Custom programming available to work with specific satellite clock RS232 and 1PPS

- 2.6 Alarms
 - Fault Detected
 - On Line
 - Off Line
 - Printer Error
 - Clock Synch Loss
 - Disk Full
 - Communications Error
 - Power Good
 - Front panel indicators are all those listed above plus 3.3V DSP, 5V DSP, 5V PC, +12 PC, and -12V PC

- 2.7 Recording
 - a. Resolution– 16 bits ($\pm 32,767$ pts of A/D FS)
 - b. Sampling rate is the same for analog and digital
 - c. Transient:
 - Sampling Rates 19200, 9600, 4800, 2400, 1200 (Hz)
 - Maximum fault record lengths@ 9600Hz, 64 Analog, 256 Events is approx. 40 Sec.
 - Maximum record length=Pre-fault + fault limit + post-fault + post fault re-trigger
 - d. Long-Term (LT):
 - Sampling Rates of 240 and 600 (Hz)
 - Record lengths to 33 minutes
 - LT works simultaneously with transient recording
 - Also, a compressed long-term RMS file is generated each time a LT file is generated.
 - e. Continuous RMS
 - One RMS value calculated every X number of cycles, typically 2.
 - RMS value recorded for all channels, typically 30 days.
 - One new file generated each day.
 - f. Continuous Frequency Recording
 - Frequency calculated on 5000 samples.
 - Selectable sliding window, typically 2 cycles.
 - Frequency recorded for all channels, typically 30 days.
 - One new file generated each day.
 - g. Dynamic Swing Recording
 - Real and Reactive power rate of change calculated from the continuous data. Real Power Swing calculated from the continuous data. If limits are exceeded a record is generated and stored.
- 2.8 Computer Features
 - a. Pentium III 800 MHz w/Ethernet, 128MB RAM
 - b. 40GB HDD or greater
 - c. 3.5" Floppy drive
 - d. 48X CD Drive
 - e. (4) RS232 Ports, (1) Parallel Port, (2) USB Ports
 - f. Windows 2000™ Professional OS
 - g. 56K Internal Hardware Modem
- 2.9 Environmental
 - a. Operating temperature 5 to 50 °C
 - b. Humidity up to 95% non-condensing

- 2.10 Physical
 - a. Modular Configuration 19" Rack Mount
 - Computer Chassis 1 $\frac{3}{4}$ "H x 19 $\frac{3}{8}$ "D.....21Lbs
 - Primary Chassis 8 $\frac{3}{4}$ "H x 17 $\frac{3}{8}$ "D...29Lbs, up to 16 analog, 64 events
 - Add-on Chassis 8 $\frac{3}{4}$ "H x 17 $\frac{3}{8}$ "D....24Lbs, up to 16 analog, 64 events
 - b. Portable Unit 10.5"H x 19 $\frac{3}{8}$ "D x 19"W57Lbs, with up to 16 analog channels and 64 digital channels.

- 2.11 Common Cabinet Configurations (Other Cabinets Available)
 - a. Standard 90"H x 22"W x 24"D, contains space for 48 analog channels, 64 digital channels, States sliding link analog terminal blocks, States sliding link power and alarm terminal blocks, Weidmuller digital terminal blocks, light, light switch, convenience receptacles, ground bars, complete wiring, optional front panel test switches, optional computer monitor, optional sliding keyboard and mouse drawer, fully tested and calibrated, completely turnkey.
 - b. Standard 90"H x 36"W x 24"D contains space for 48 analog channels, 64 digital channels, Weidmuller sliding link analog terminal blocks, three analog terminal blocks per channel (V,I,C), Weidmuller sliding link power and alarm terminal blocks, Weidmuller digital terminal blocks, light, light switch, convenience receptacles, ground bars, complete wiring, optional test switches built into front of cabinet, optional computer monitor, optional sliding keyboard and mouse drawer, fully tested and calibrated, completely turnkey.
 - c. Other cabinets, free standing panels, and terminal block styles available
 - d. All analog channel wiring is rated 12AWG SIS 600V. All event wiring to be in shielded cable. Each event cable will contain wires for 8 event inputs.
 - e. Outside of cabinet is primed and electrostatically painted gray.
 - f. All cabinets to have an information tag containing:
 - manufacture name, serial number, input voltage, number of analog and event channels, weight, and manufactured date.

- 2.12 Calibration
 - a. Internal accuracy of components is very high, calibration generally not necessary.
 - b. Automatic internal calibration, can be done from master station.
 - c. External calibration:
 - Start scope program
 - Place signal on channel
 - Observe waveshape and RMS value
 - Enter the value you want the DFR to read
 - Correction factor automatically stored in a file called cal.inf
 - d. No potentiometers to turn

- 2.13 Memory
- a. The fault recorder hard drive size is 40GB, or greater, for data storage and communication software. Each 8 channels has 16MB of SDRAM for pre-fault storage.
 - b. Optional non-volatile solid-state flash drive available for holding operating system and programs. CDRW or DVD removable disk media available for fault data.
- 2.14 Printing
- The fault recorder is capable of supporting a printer and automatically printing selected reports and waveforms.
- 2.15 Communication & Data Transfer
- The equipment is capable of transmitting recorded analog faults and digital events to one or more master stations for review and analysis. **Data being transmitted is in the universal COMTRADE format (standard format C37.111-1999), not in a company specific proprietary format.** The recorder has the capability to provide data via dial-up modem or Microsoft compatible networking (LAN, WAN) using TCP/IP Protocol.

If the communications link is broken, during the transfer of a fault record from the fault recorder to the master station, partially transferred data is viewable by the master station software. When communications is re-established, transfer of the interrupted fault record will begin where it left off, not at the beginning.

Other information that will be transferable from the DFR to the Master Station are:

- a. Calibration Record with analog and digital settings
- b. Configuration settings
- c. Automatic or manual transfer of a quick summary of faults
- d. Automatic or manual transfer of complete fault data (COMTRADE FORMAT)
- e. Automatic or manual transfer of distance to fault, type of fault (AB, AC, BC, AG, BG, CG, ABC), duration of fault, faulted line name.
- f. Diagnostics information
- g. Trace files
- h. Line group settings
- i. Continuous frequency and RMS information (selectable time slice).

3.0 Master Station Data Analysis Software (DAS)

Two single user master station licenses are provided with each digital fault recorder. One licensed copy of pcanytwhere™ is provided with each digital fault recorder. Master Station software automatically works in conjunction with pcAnywhere™ to enable an operator to have a virtual presence at fault recorder. Master Station Software is compatible with a PC operating Windows® 95, 98, NT or 2000. Software is compatible with any Windows compatible modem.

3.1 General Features

- a. Two licensed copies of the DAS software.
- b. If the DFR has a permanently installed monitor, keyboard, and mouse then the DAS is also loaded on the DFR so analysis can be done at the DFR site.
- c. If the DFR does not have permanently installed monitor, keyboard and mouse, then the second copy of the DAS can be loaded on a laptop for direct com. through the DFR RS232 port.
- d. Capability of creating a header file (report) for each fault.
- e. Pull down menu to select the desired DFR to log into.
- f. Capability of viewing real-time waveforms and RMS values for any analog channel.
- g. Capability of viewing real-time event and trigger status.
- h. Line groups can be setup for calculating distance to fault and convenient graphics analysis viewing.
- j. Virtual channels can be setup for line groups.
- k. Capability of viewing two COMTRADE records simultaneously.

3.2 Communications and File Transferring

- a. Automatically read incoming COMTRADE files in Binary or ACSI format
- b. Communicate with up to 999 digital fault recorders.
- c. Automatically receive incoming calls from recorders sending quick summary fault information or complete fault data or both.
- d. Automatically email a quick summary report to a list of email address.
- e. Automatically poll recorders at a specific time of day and pull back quick summary information only or a quick summary and complete fault data or always a quick summary and only data if logic filter is true.
- f. Manually start or stop auto polling at any time of day.
- g. Manually poll recorders and retrieve quick summary information only or complete fault data.
- h. Retrieve or send calibration records, DFR configuration records, and line group records.
- i. Automatically save incoming fault records to 1 archive drive and 2 backup drives. Drives selectable through a browser.
- j. View fault records saved to the archive drive or backup drives.
- k. Set up Boolean Logic Filter, to filter data being sent in from fault recorder.
- l. Capability to send a test run, diagnostic, trace file, reinitialize, or reboot command to the fault recorder.
- m. Capability of communicating with the fault recorder with pcAnywhere

3.3 Graphics Features

- a. Viewing channels in sequence
- b. Viewing channels per user selection and saving as favorite
- c. Viewing line groups with panels setup as (Vabc, Iabc, and N) or (VaIa, VbIb, VcIc, and N) or (VaIa and N) or (VbIb and N) or (VcIc and N) and automatically view calculated active power, reactive power, power factor, phase A, B, and C impedance.
- d. View continuous frequency, and continuous RMS graphs (30 days)
- e. View power graphs
- f. View two COMTRADE records simultaneously
- g. Measure harmonics, phase angle difference, delta time, delta cycles, mathematically add, and subtract
- h. Calculate positive sequence, negative sequence, and zero sequence.
- i. Invert displayed waveshapes
- j. Turn digital data on or off.
- k. Delete digital traces from graphics viewing screen
- l. Cut, copy, paste, delete, and add waveforms to any viewing panel.
- m. Measure RMS, Magnitude, Peak, DC, Max, Min, Max-Min, and Average values.
- n. Change graph scaling, change cursor type, zoom in, zoom out, zoom previous.
- o. Automatically export data to Microsoft excel®
- p. View frequency or RMS plot for any time slice in last 30 days
- q. Vector analysis

3.4 Printing

- a. Print screen
- b. Print graph shown on screen
- c. Print all waveforms, y-scale selectable, waveforms per page selectable, print sequence of events and triggers w/line on for normal, sequence of events and triggers w/line on for abnormal, print all events and triggers w/line on for normal, print all events and triggers w/line on for abnormal.
- d. Print quick summary table
- e. Print sequence of events for a specific fault record
- f. Print calibration record
- g. Print line group record
- h. Auto print at master station computer
- i. Auto print at digital fault recorder
- j. All print functions can be print previewed

4.0 Extended Recording

a. Long-Term Recording

The Model 2002 also has the ability to generate two additional files when the system is triggered. The two files are the long-term oscillograpy file and the long-term RMS file. The long-term sampling rate can be set at 0Hz(disable) 240Hz, 600Hz, or 1200Hz. The long-term oscillograpy record can have a length up to 32min (16min pre-fault and 16 post-fault). Calculating the RMS value of two or more cycles and creating one data point, over and over, creates the long-term RMS envelope file. When the long-term feature is enabled, three records are generated each time the recorder is tripped (transient record, long-term oscillograpy record, and RMS envelope record.

b. Continuous Frequency Recording (30 days)

To create a 30-day frequency file the long-term recording must be on. Before the long-term file is deleted, if no triggers, a single frequency data point is calculated on 5000 data samples. Sliding out the two oldest cycles and sliding in two new cycles calculates additional frequency data points. A single frequency data point is calculated every two cycles. The sliding window can be two or more cycles. The frequency data points for a single day are written to the same file. Each day a new frequency file is created. After 30 days, the oldest file is overwritten. A sample frequency file name is 20021105.frq (year, month, day, extension). The amount of memory used for 32 analog channels, 600Hz long-term sampling, is about 5GB.

The Master Station Software allows a user to get a frequency file and prompts the user with a "From" and "To" choice (day, hr, min., sec.). The maximum file size sent to the master is approximately 1MB. The smaller the time slice requested the more resolution. For example, a 10-minute request will still have maximum resolution. Each frequency data point represents 2 cycles. A 30-minute request will have 10 data points in one second (100ms steps at 600Hz). If a time slice is large, 2 days, frequency data points are evenly skipped to ensure the requested data stays within 1MB. In a file such as this, the jump from one frequency data point to another might be several seconds. After viewing the large time slice, a smaller time slice can be requested for more detailed resolution.

c. Continuous RMS Recording

To create a 30-day RMS envelope file the long-term recording must be on. Before the long-term file is deleted, if no triggers, a single RMS data point is calculated every two cycles. A new RMS data point calculated every two cycles, or more cycles. The data points for a single day are written into a file. Each day a new RMS file id created. After 30 days the oldest file is overwritten. A sample RMS file name is 20021105.rms (year, month, day, extension).

The Master Station Software allows a user to get a continuous RMS file just like the continuous frequency file discussed above.

d. Dynamic Swing Recording

Real Power Swing calculated from continuous RMS information.
Separate record created if swing limit exceeded.

5.0 Options

- a. Modular Unit, Mount In Your Cabinet/Panel
- b. Distributed Architecture (150' Copper or 1500' Fiber Optic Chassis to Chassis)
- c. Turn-Key Cabinet Configuration With:
 - Analog & Event Sliding Link Terminal Blocks
 - Test Switches
 - Convenience Lights and Receptacles
 - Complete Wiring
 - Optional Built-In Monitor and Sliding Keyboard w/Mouse and Mouse Pad
- d. Purchase in portable configuration w/carrying handles and coupling plates that ties computer chassis and primary chassis together.
- e. Model CT-1001 For Current Channels 1A=.1V or 1A=25Mv
- f. GPS Satellite-Controlled Clock
- g. Master Station Multi-User License
- h. Cabinet Environment Control AC or Heat
- i. AC Back-up Power
- j. DC Back-up Power
- k. Extended Warranty

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