



Software solutions for a complex environment



CEMSuite Hardware Manual Ver. 1.03

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1.1 REVISION HISTORY

Revision	Revision Date	Summary of Changes
V1.01	19/12/08	New Manual
V1.03	11/05/10	Format Change

1.2 APPROVALS

This document requires the following approvals:

Name	Title
R. Grant	Managing Director
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3 INTRODUCTION

The CEMSuite package can access data from up to five data sources: a Data Storage Unit (DSU), an analyser with a serial output, an Adam RS485 network (analogue inputs and outputs), a DCS or PI historian system and a Davis weather station (local RS232). Normally, the DSU is connected to the PC and the others data sources are connected to the DSU. However, a DSU may not always be present and all the inputs can be connected to a personal computer via standard serial ports, using RS232 to RS485 converters where necessary. The RS485 standard is suitable for cable distances of up to 1.2 km, but this may be extended easily using repeaters.

CEMSuite provides a suite of software programs that operate on a typical personal computer. These are listed with summaries below:

CEMComm	A data communications program used to acquire data from one or more data sources and store it to hard disk thus making it accessible to other CEMSuite programs. This normally operates from a Data Storage Unit (DSU) except on simple systems where a DSU is not present.
CEMForm	Typical data analysis (normalisation and averaging) to provide real time and historical data analysis. Also acts as the interface to other data export programs to provide outputs from processed data.
CEMPort	General report production. Non-specialist reports to summarise the emission data into daily, weekly, monthly, quarterly or yearly time periods. Also may be used to export the emission data into a spreadsheet compatible format (e.g. comma separated variable – CSV), and to check on any excursions above alarm levels.
WIDReport	Specialist Waste Incineration Directive report that provides the data in a dedicated format suitable for submission to the authorities.
CEMPower	Specialist Power Generation report that provides the data in a dedicated format suitable for submission to the authorities. Covers reports required under the Large Combustion Plant Directive.
CEMQual	Specialist program to analyse and report drift and validity of analyser calibration, based entirely upon the European standard EN14181. MCERTS Certified
CEMServer	Operates in background to copy the data from the DSU and provide averaged data for trending and reporting for all programs (later systems only – late 2008). Multi socket is a module operating within CEMServer and operates in background and is used only for multi DSU applications. It receives the real time data from up to 8 DSUs and provides a single point for subsequent programs to access (later systems only – late 2008).
CEMBus	Provides an interface to access data from and export data to either; Modbus, Profibus or other data protocols. It picks the processed data up from CEMForm and the real time raw data from CEMComm.
CEMCFG	Configuration program for all programs.
DBUtils	Basic program for direct data table editing.

4 NETWORK LAYOUTS

Most systems will require an Adam 5000 unit located within the data gathering network; this connects to the DSU by means of a two wire RS485 connection. However, due to site conditions more than one ADAM 5000 may be required or a combination of Adam 5000 and Adam 4000 units.

Depending upon the site layout and for ease of cabling, connections will be made in either a 'Star' or 'daisy-chain' layout – or a combination of both. These are described within this section. Ideally, for each spur (other than the first) a repeater should be used to prevent signal problems. However, for short cable runs (<100m) that use only a few Adam units (three per measurement point), repeaters should not be required.

4.1 CABLE NOTES

Typical cable specs are:

1. **RS485 Comms cables:** twisted pair, minimum 0.5 mm², with an overall screen.
2. **Analogue input and output cables:** multicore paired cables with an overall screen.
3. **Relay outputs:** relays rated at 110V 0.5 A maximum, cable to suit this voltage and current.
4. **Power cables:** low power three core – 2 for AC power (110 or 240 V) and 1 earth. Cable specification as required by site, typically steel wired armoured.
5. **CAT5 E:** Cable used to carry Ethernet signals. Max distance 100m

4.1.1 STAR NETWORKS

Star shaped networks are suitable for most applications; a DSU (Data Storage Unit) is mounted close to the logging computer, and each interface unit is connected directly to this by a separate cable. See the next section for a description of these units. Although this configuration is not recommended for use with high-speed networks, at a baud rate of 9600 (the default for all equipment items) no problems have yet been experienced with star configurations each with over 1km of cable. However, to ensure that difficulties are not encountered, isolated RS485 repeaters should be installed at the PC end of each spur. Not only do these units isolate each spur, they overcome any potential difficulties with reflections and interference. 'Daisy-chain' networks for small systems, each RS485 unit can be connected in a daisy-chain configuration from the PC via the 232/ 485 converter – this is the preferred method of connection for multiple RS485 units.

4.1.2 COMBINATION NETWORKS

A combination of daisy chain and star network layouts may also be used.

4.2 EQUIPMENT TYPES

Envirosoft will supply a selection of the following equipment items for a logging system. These are described briefly below and are examined in more detail within the next section.

4.2.1 DATA STORAGE UNIT/OUTPUT CONTROLLER

The DSU is a mini-itx form computer system assembled by Envirosoft which has two functions:

- a) To store all incoming data from the analysers, sensors and digital inputs and upload that data to the host PC
- b) To enable very fast communications between itself and all elements of the emissions monitoring system

4.2.2 DIGITAL/DIGITAL (RS232 TO RS485) CONVERSION UNIT

The Digital/Digital conversion units convert the RS232 from the PC to RS485 for the two networks. They may also contain input and output Adam units to enable measurements within the control room to bring into the system. RS485 repeaters may be used to simplify the cabling on site and provide more than one RS485 network line.

4.2.3 INTERFACE UNITS

These are stainless steel enclosures, mounted in the field at the location of the analysers. Fitted as standard with an DSU and usually an Adam 5000 unit, power supply and an RS232 to 485 converter their function is to receive analyser serial and current outputs and relay outputs.

4.2.4 CALIBRATION GAS CONTROLLER

This device controls the input of calibration gases to the two analysers at predetermined intervals. It consists of a fibreglass enclosure containing a backplane, and a series of solenoid valves. The solenoid valves are controlled by the CEMCal program and are activated by an ADAM 5069 power relay module.

4.3 DAVIS WEATHER STATION

A full description of this product and details of installation and connection are provided in the Davis documentation. Brief descriptions of the hardware and installation are included in this manual.



4.3.1 RS232 CONNECTION

A Vantage Pro Davis weather station may be connected to the system to provide meteorological measurements. This has a RS232 connection that should be connected to the serial port of the computer as defined from the CEMCfg program – see the CEMCfg manual. Connections are straightforward and provided with the weather station; should the RS232 cable require extending, a four core cable should be used with an RJ11 plug one end and a socket the other. RS232 is only rated to a few metres; practical experience, however, suggests that it is usually OK up to at least 15 metres.



4.3.2 CONSOLE MOUNTING

The Vantage pro console provides much useful information and should be located in a visible location. Also when deciding upon where to install, the system should be tested for radio reception (assuming it is a wireless weather instrument). Full details are provided in the Davis documentation.

Power for the console is supplied from a plug top transformer; find a suitable power supply within 3 metres of the proposed location.

Three type 'D' batteries provide memory backup in the event of power loss. Although not essential, it is good practice to fit these.

4.3.3 SENSOR MOUNTING

The remote sensor should be mounted in an open area away from the influence of buildings and other obstructions for the wind measurements. Details of selecting the location are provided in the Davis documentation.

5 CEMSERVER

5.1 MULTI DSU SYSTEM

We term the system that communicates between the DSU and the PC as CEMServer and can comprise up to three modules FTPSync, Multisocket and CEMComm.

5.1.1 FTP SYNC

FTPSync connects to each DSU in turn via FTP (File Transfer Protocol) and downloads all the historic data on first start up. It will re-sync the historic data after midnight each day. Also every minute it downloads a file that contains roughly the last 20 minutes of data and then combines this with the rest of the day's data.

FTPSync then processes the raw data into minute averages and combines the minute averages from all the DSUs into a master data set for use with CEMForm, and the rest of the reporting packages.

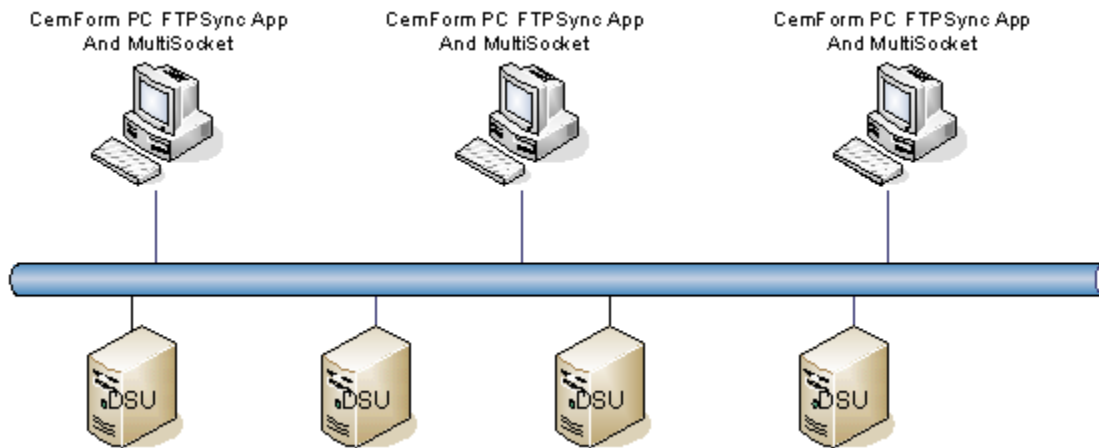
5.1.2 MULTISOCKET

MultiSocket connects to each DSU via TCP sockets (on a user definable port) and then takes the incoming socket data and combines it into a single output stream which it sends out on a server socket which multiple copies of CEMForm can connect to.

At 29 Minutes past each hour, it sends the system time to each DSU connected to it to make sure the entire system is synchronised with the same time. However, if the DSU time drifts by more than one minute, MultiSocket will re-synchronise the time straight away.

5.1.3 CEMCOMM

CEMComm is a multi protocol data collection application. It is able to connect and read data from many different analysers, and other such devices, and store this data locally on the DSU's hard disk for collection later by the FTPSync program. Also, on every write to the hard disk, it pushes the current live data via a TCP socket connection to all software that requires the data.



5.2 SINGLE DSU SYSTEM

A single DSU system would just consist of the following CEMServer Applications:
CEMComm & FTPSync.

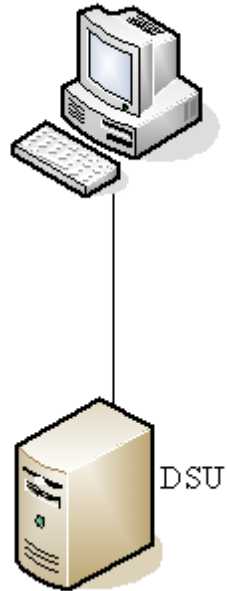
5.2.1 FTPSYNC

FTPSync connects to one DSU via FTP and downloads all the historic data on start up, and then re-syncs it after midnight. Also, every minute, it downloads the last 20 minutes of data and combines it with the rest of the current day's data. FTPSync then processes all the raw data into minute averaged data for use within CEMForm and the rest of the reporting packages.

5.2.2 CEMCOMM

CEMComm would operate in the same way as described in the Multi-DSU description.

CemForm PC FTPSync App



6 ADAM 5000 BASED SYSTEMS

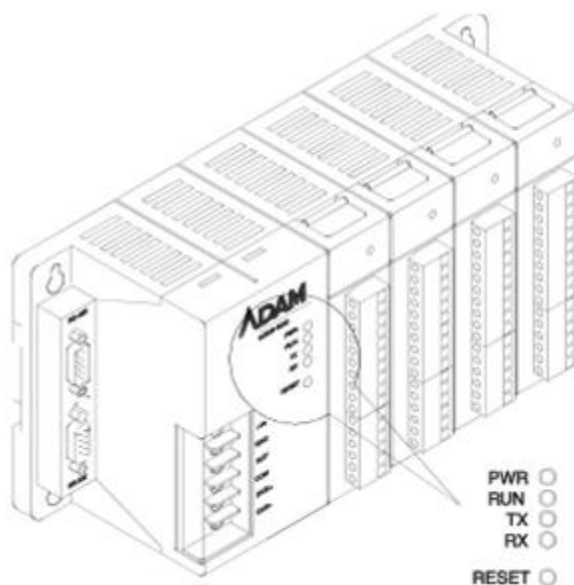
6.1 INTRODUCTION

The ADAM-5000 series is a data acquisition and control system which can control, monitor and acquire data through multi-channel I/O modules. It is extensively used by Envirosoft as part of their data acquisition systems to capture and re-transmit data. Depending on the number of modules required, we use a four or 8 channel system.

A typical Envirosoft system would consist of the analyser feeding up to 8 analogue signals and 16 digital signals to an Adam 5000. The Adam unit would then export the data via an RS 485 serial stream to the DSU which would store the data raw and then export on via an Ethernet link to a PC running CEMSuite.

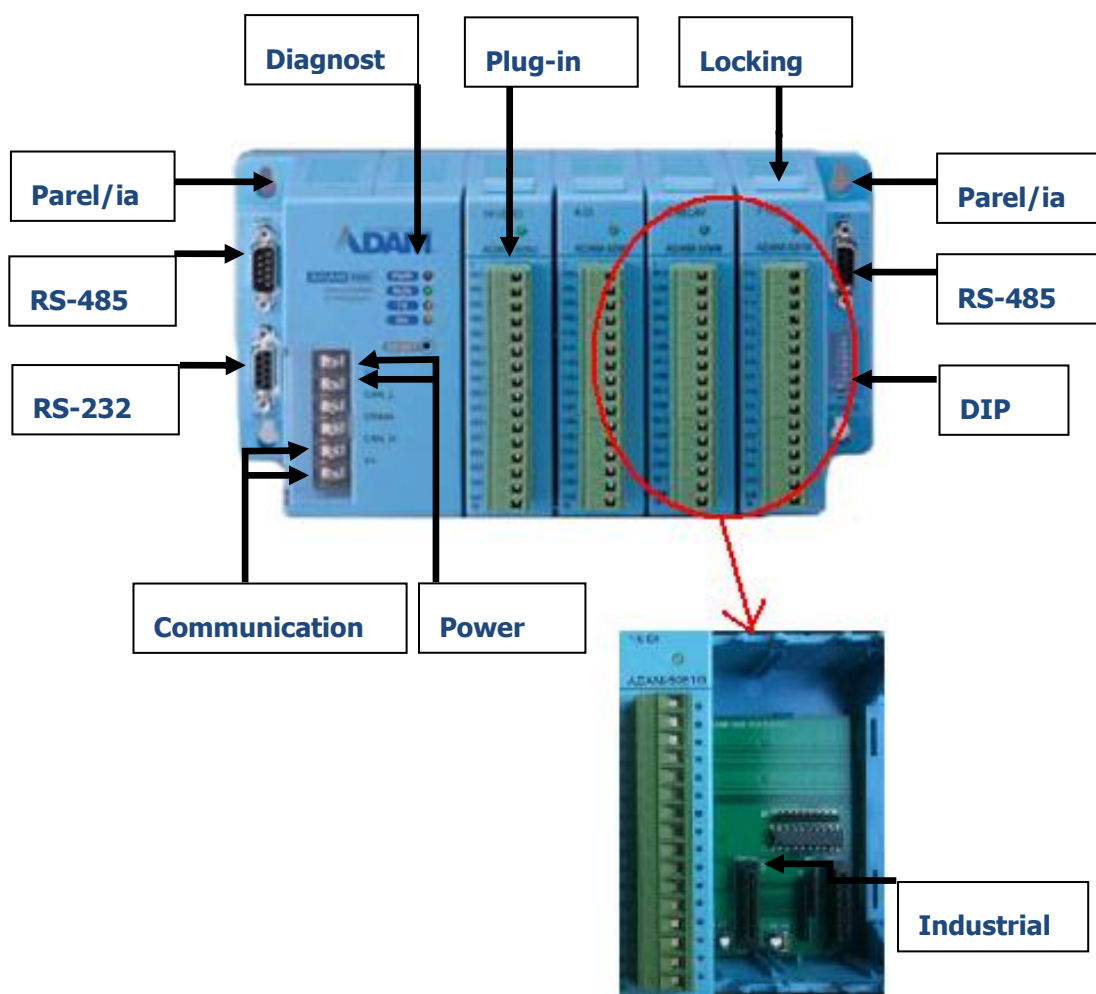
Encased in rugged industrial grade plastic bases, the system provides intelligent signal conditioning, analogue I/O, digital I/O, RS-232 and RS-485 communication. The ADAM-5000/485 can handle up to any 4 combinations of I/O modules (64 I/O points), while the ADAM-5000E can handle up to 8 combinations of I/O modules (128 I/O points). The systems communicate with their controlling host over a multi-drop RS-485 network.

The ADAM-5000 system consists of two major parts: the system kernel and I/O modules. The system kernel includes a CPU card, power regulator, 4-slot base (or an 8-slot base), built-in RS-232 communication port, and a pair of built-in RS-485 ports.



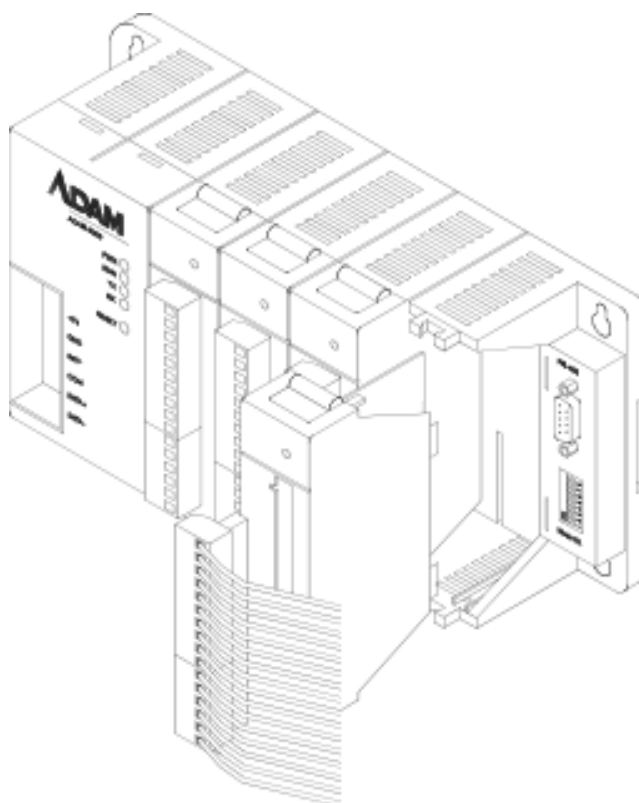
There are 4 LEDs (indicated as PWR, RUN, TX and RX) to provide visual information on the general operation of the ADAM-5000 system. The LEDs also indicate the error status when the ADAM-5000 system performs the self test. Besides the LED indicators, the system also offers software diagnosis via the RS-232 port.

Electrical noise can enter a system in many different ways. It may enter through an I/O module, a power supply connection or the communication ground connection. The ADAM-5000 system provides isolation for I/O modules (3000 V). The 3-way isolation design prevents ground loops and reduces the effect of electrical noise to the system. It also offers better surge protection to prevent dangerous voltages or spikes from harming your system. The system also provides a Watchdog timer to monitor the microprocessor. It will automatically reset the microprocessor in ADAM-5000 system if the system fails.



6.2 INSERTING I/O MODULES

When inserting modules into the system, align the PC board of the module with the grooves on the top and bottom of the system. Push the module straight into the system until it is firmly seated in the backplane connector. Once the module is inserted into the system, push in the retaining clips (located at the top and bottom of the module) to firmly secure the module to the system.

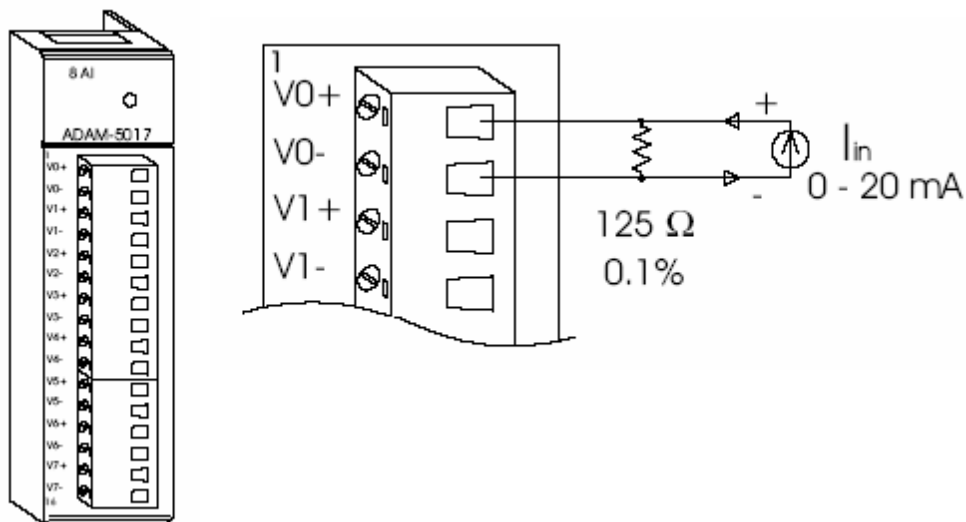


6.3 ADAM 5017 ANALOGUE INPUT CHANNEL

The ADAM-5017 is a 16-bit, 8-channel analogue differential input module that provides programmable input ranges on all channels. It accepts mill volt inputs ($\pm 150\text{mV}$, $\pm 500\text{mV}$), voltage inputs ($\pm 1\text{V}$, $\pm 5\text{V}$ and $\pm 10\text{V}$) and current input ($\pm 20\text{ mA}$, requires 125 ohms resistor). The module provides data to the host computer in engineering units (mV , V or mA).

Its opto-isolated inputs provide $3,000\text{V}$ isolation between the analogue input and the module, protecting the module and peripherals from damage due to high input line voltage.

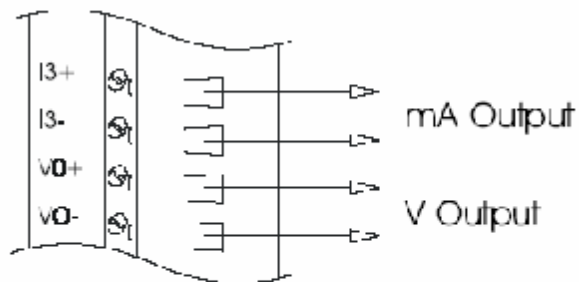
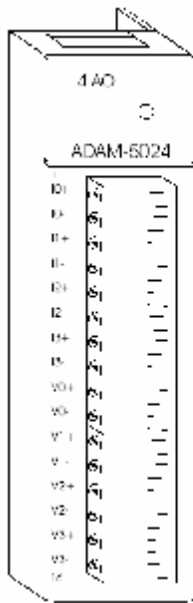
Additionally, the module uses analogue multiplexers with active over-voltage protection. The active protection circuitry assures that signal fidelity is maintained even under fault conditions that would destroy other multiplexers. This module can withstand an input voltage surge of 70 V-p with $\pm 15\text{ V}$ supplies.



6.4 ADAM 5024- 4 CHANNEL ANALOGUE OUTPUT MODULE

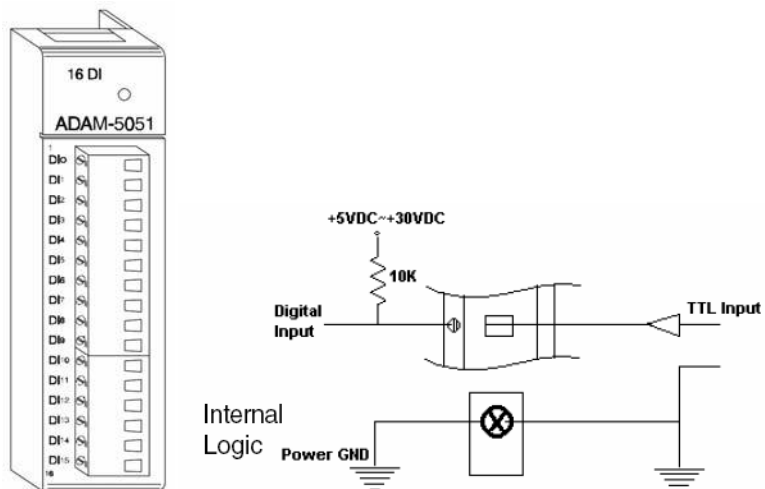
The ADAM-5024 is a 4-channel analogue output module. It receives its digital input through the RS-485 interface of the ADAM-5510 system module from the host computer. The format of the data is engineering units. It then uses the D/A converter controlled by the system module to convert the digital data into output signals.

The analogue output can also be configured as current or voltage through the software utility. The module protects your equipment from ground loops and power surges by providing opto-isolation of the D/A output and transformer based isolation up to 500 V.



6.5 ADAM 5051 SERIES DIGITAL INPUT MODULE

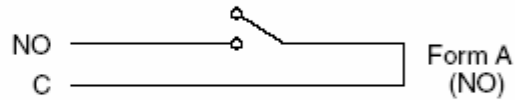
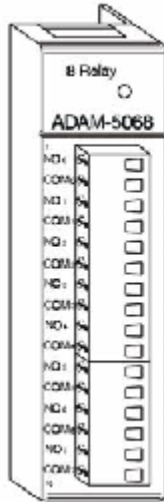
The ADAM-5051 provides sixteen digital input channels.



Points:	16
Digital Inputs:	Logic level 10: +1V max Logic level 1: 3.5 to 30V Pull Up Current: 0.5 mA 10K OHM resistor to +5V
Power Consumption:	0.3W
Indicator:	ADAM 5051 D only

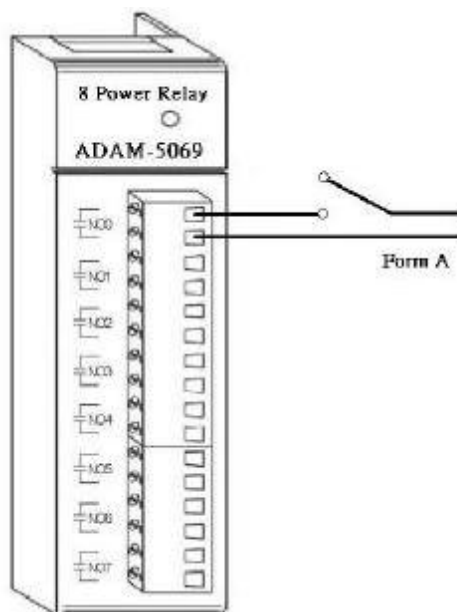
6.6 ADAM 5068 RELAY OUTPUT MODULE

The Adam 5068 relay module provides 8 relay channels of form A.



Connectors:	1 X Plug-in screw terminal
LED Indicator :	On: Active Off: Non-active
Power consumption:	2.2W (Max)
Breakdown Voltage:	750VAC (50/60 Hz)
Channels:	8 x form A
Contact rating:	AC: 250V @ 5A DC: 30V @ 5A
Insulation resistance:	1GΩ @ 500VDC
Relay On time:	5 ms
Relay Off Time:	5.6 ms

6.7 ADAM 5069 RELAY OUTPUT MODULE



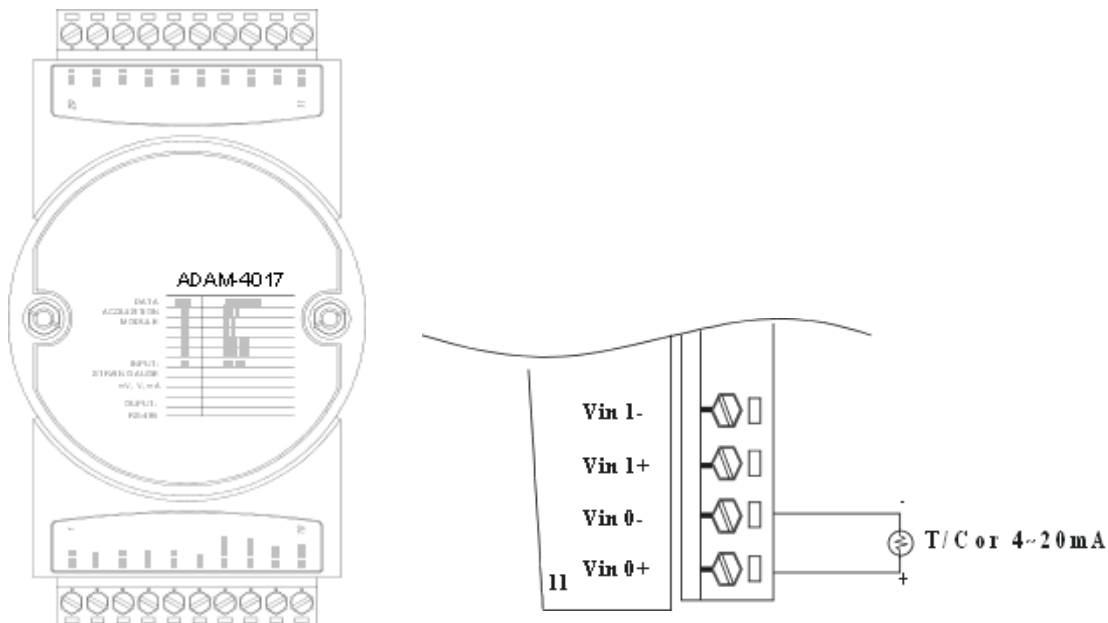
Connectors	1 X Plug-in screw terminal
LED Indicator	On: Active Off: Non-active
Power consumption	2.2W (Max)
Breakdown Voltage	750VAC (50/60 Hz)
Channels	8 x form A
Contact rating	AC: 250V @ 5A DC: 30V @ 5A
Insulation resistance	1GΩ @ 500VDC
Relay On time	5 ms
Relay Off Time	5.6 ms

7 ADAM 4000 COMPONENTS

In smaller systems or when we require additional functionality in our systems we use standalone ADAM 4000 intelligent computer interface modules. Some are similar to their ADAM 5000 counterparts whilst others have discrete functions.

7.1 ADAM 4017

The ADAM-4017 is a 16-bit microprocessor-controlled sigma-delta A/D converter used to convert current inputs into digital data. The digital data is then translated into engineering units. When prompted by the host computer, the module sends the data to the host through a standard RS-485 interface.

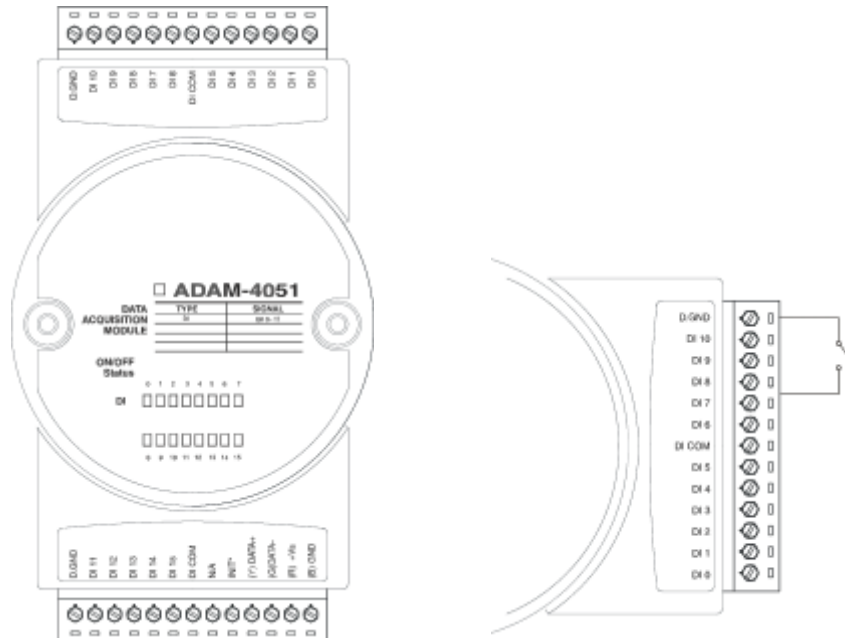


- Channels: six differential, two single-ended
- Accepts:
- Millivolt inputs: ± 150 mV and ± 500 mV
 - Volt inputs: ± 1 V, ± 5 V, and ± 10 V
 - Current input: ± 20 mA (requires a 125Ω resistor)

The module forwards the data to the host computer in engineering units (mV, V, or mA)

7.3 ADAM 4051

The ADAM 4051 is a 16 channel digital input module built with 2500V optical protection, which accepts 10-50 V input voltages to fit various digital signals.



7.4 ADAM 4068

The ADAM-4068 Relay Output Module provides eight channels, four of Form A and four of Form C. This module is used for ON/OFF control or low-power switching applications.

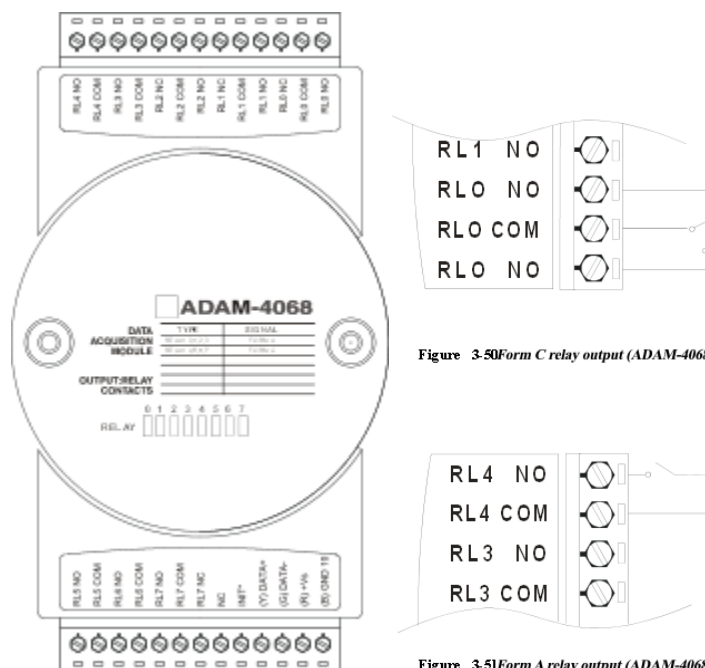


Figure 3-50 Form C relay output (ADAM-4068)

Figure 3-51 Form A relay output (ADAM-4068)

8 DATA STORAGE UNIT/DATA CONTROLLER

8.1 DSU

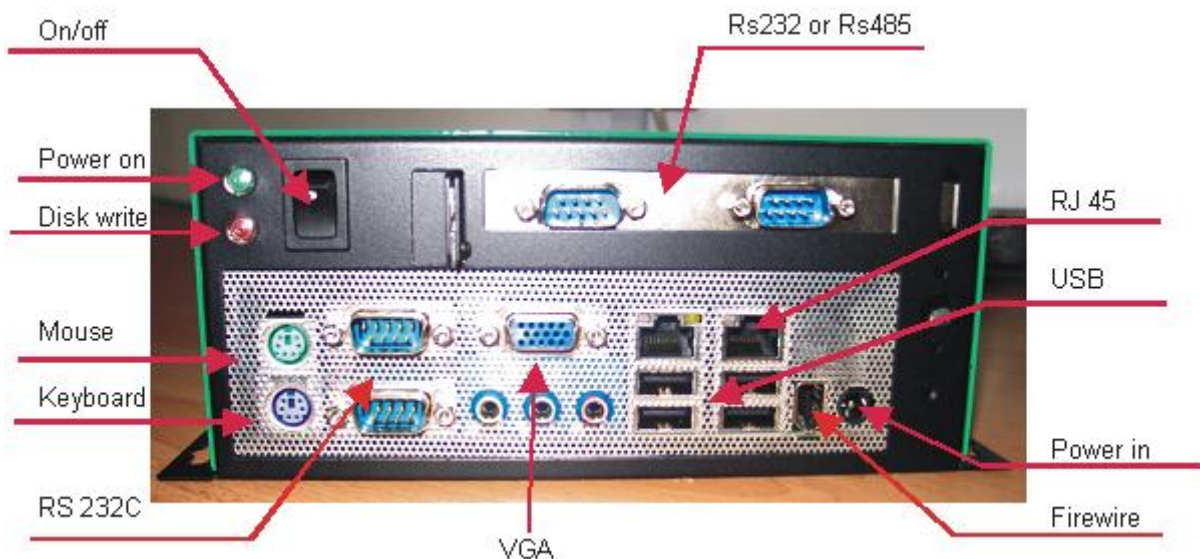
The DSU is a mini-itx form pc assembled into an enclosure by Envirosoft and includes a 160 GB hard drive. It accepts 12 to 24V power and has a range of input and output ports. The DSU's primary function is to gather data from analysers directly or via an ADAM 5000 unit, to store it and send it on to the PC. The only difference between DSU and output controller is the Envirosoft software onboard. The operating system is Windows XP embedded

Its power requirements are 12 -24 VDC (see power supply), auto-switching and it can operate in environment from 0 - 60°C.





8.1.1 REAR PANEL



8.1.2 DSU FEATURES

The DSU/DC system board is equipped with 2 onboard 232c serial ports and Envirosoft also provide 2 off RS-232c or RS-485 asynchronous communication ports with 16C550A-compatible UARTs that can be used with modems, serial printers, remote display terminals, and other serial devices. These extra ports are located on a plug-in card along the top of the back plane.

The DSU system board is equipped with two onboard RJ45 LAN ports. These ports provide an Ethernet output to the PC and Modbus TC/IP comms to a DCS system.

The DSU is normally mounted in a control room or equipment room reasonably close to the PC, due to the limited reach of Ethernet. The ADAM 5000 unit exports data to the DSU using RS 485 and should be within 1 km of the DSU.

8.2 POWER SUPPLY

Envirosoft usually supply the PULS MiniLine ML50.102 , 12-14 V/50W for use with our systems. It is normally mounted on DIN rail and is selected for its robustness and reliability.

Input voltage range	100 – 240V AC
Operating temperature	10 to 70°C
Output voltage	12-15VDC (without jumper)



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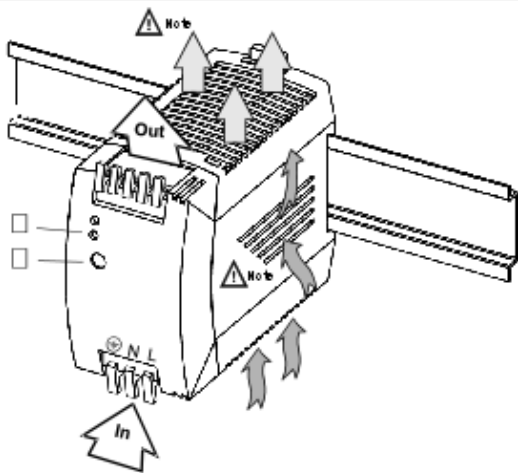


Fig. 1

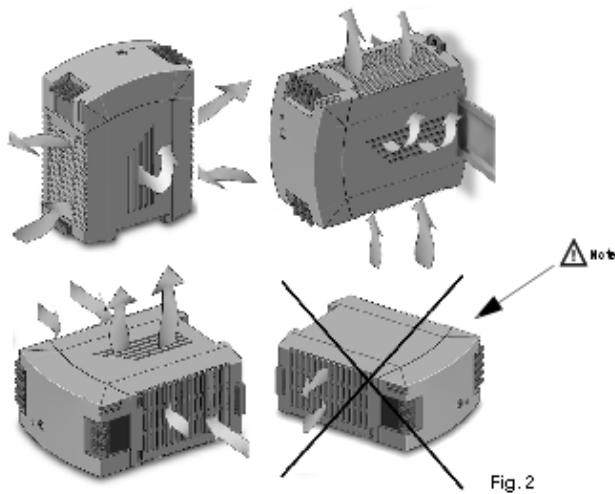


Fig. 2

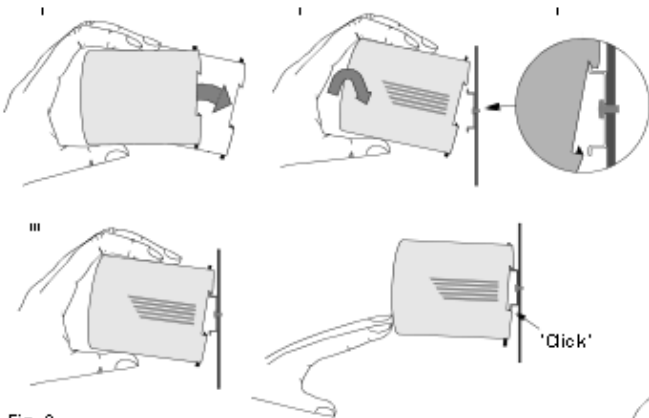


Fig. 3

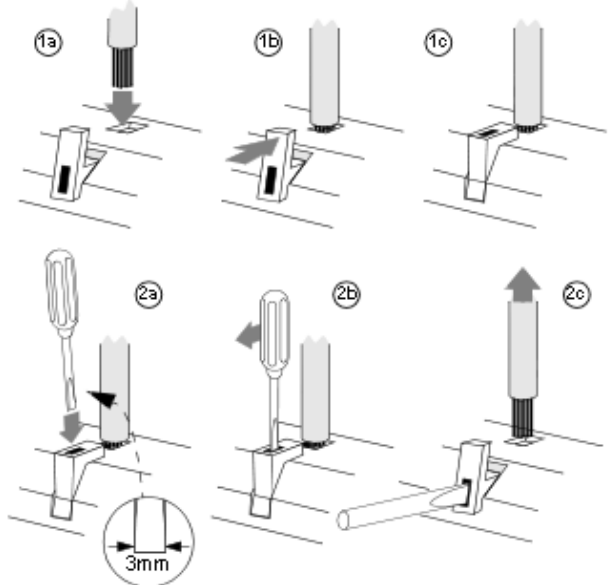
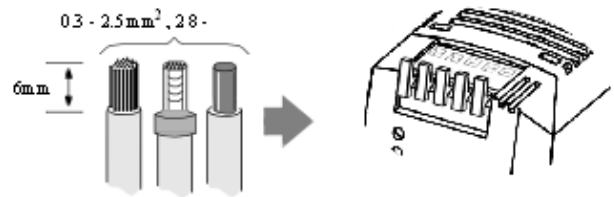
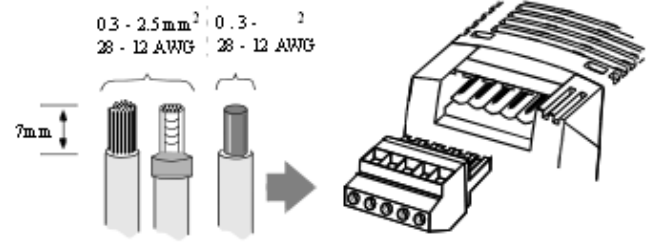


Fig. 4

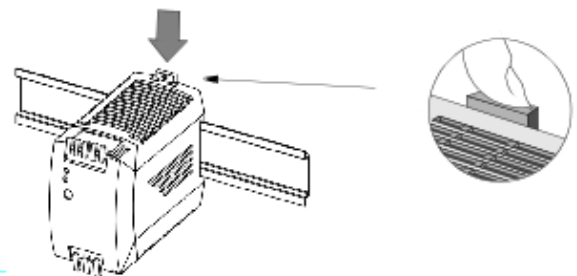


Fig. 5