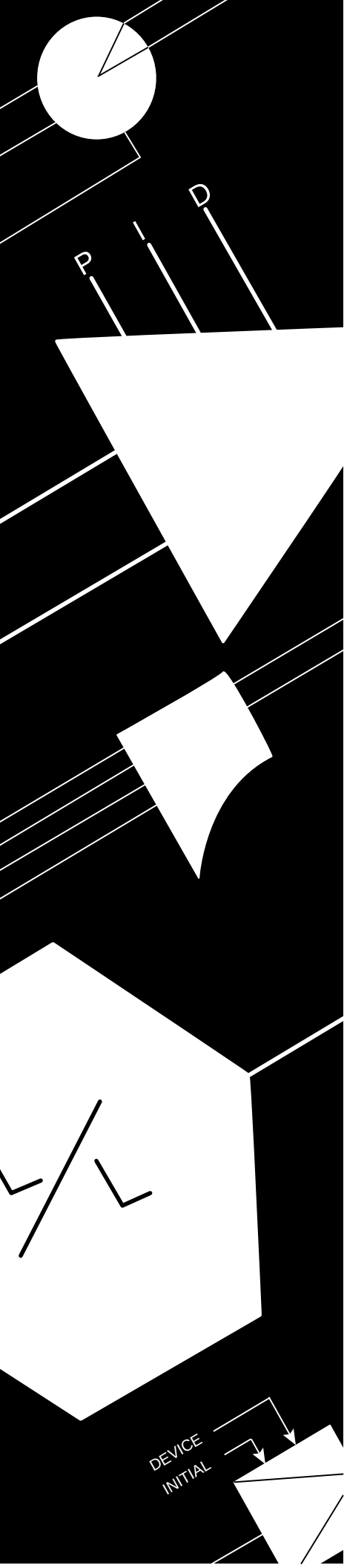

An Introduction to: ACCOL

(Formerly known as "The ACCOL Textbook")

Bristol Babcock

D4056 Issue: January, 2001

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Who Should Read This Manual?

This manual is intended for use by new ACCOL users. It describes the basic concepts in ACCOL, and provides examples of the major structures used by the ACCOL programmer.

It assumes familiarity with the following subjects:

- Use of personal computers, including clicking with a mouse, using dialog boxes, list boxes, menus, etc.
- Windows 98 or Windows NT operating system.

As a minimum, users should have the following additional manuals available, when reading *this* manual:

- *ACCOL II Reference Manual* (document# D4044) which contains detailed descriptions of all ACCOL modules.
- *ACCOL Workbench User Manual* (document# D4051) which contains detailed instructions on using ACCOL Workbench to create an ACCOL load.
- *Network 3000 Communications Configuration Guide* (document# D5080) which contains an overview of communications using Bristol Babcock networks, and a guide to troubleshooting communication problems.

> NOTE
>
> This book should not be considered a substitute for 'hands-on' experience with ACCOL Workbench and Network 3000 controllers.
>
> New users should strongly consider attending one or more training courses offered by Bristol Babcock. Contact our Training Department at the number listed on page ii for more information.

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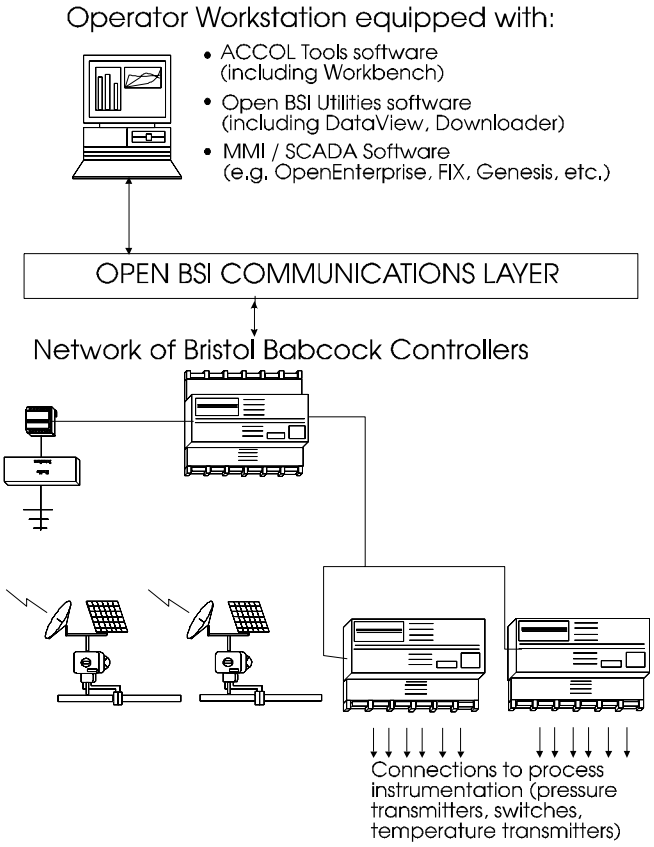
Chapter 1 - Introduction: What is ACCOL?

What is ACCOL?

ACCOL is an acronym which stands for **A**dvanced **C**ommunications and **C**ontrol-**O**riented **L**anguage. The initial concept for ACCOL was developed at Bristol in the early 1970s, and has since become the standard software programming language for Bristol Babcock Network 3000-series devices. Several newer generations of the language have been developed since then.

The current versions of the ACCOL language, as well as the **ACCOL Tools** software, which is used to create programs in the language, have incorporated numerous features and improvements suggested by our customers, and are markedly different from the initial version. All are rooted in the initial concept of ACCOL, however, which was to create a high-level programming language which used a 'modular' approach for monitoring and control of process control applications.



What is Network 3000?

Network 3000 is the name for a product family of Bristol Babcock digital **remote process controllers**, and auxiliary equipment, which includes the DPC 3330, DPC 3335, RTU 3310, and RTU 3305 remote process controllers, as well as GFC 3308-series flow computers[1] and the EGM 3530-xx TeleFlow™ / RTU 3530-xx TeleRTU series[2] flow computers and RTUs. Network 3000-series controllers are utilized in a wide variety of measurement and control applications throughout the water, waste water, and natural gas pipeline industries.

These controllers collect data from field instrumentation such as pressure transmitters, flow meters, electrical contacts and switches. The incoming data is received through connection points on **process I/O boards** in the controller.[3] Based on the incoming data,

---

[1] *Network 3000 controllers are often referred to as simply '33xx controllers' because of the '33' in the model number.*

[2] *3530 TeleFlow and TeleRTU units only support a subset of ACCOL modules and features. Task slip counts and rate information, communication statistics, and crash blocks are not available. See the ACCOL II Reference Manual (D4044) and contact Bristol Babcock Application Support for more information.*

[3] *The term 'I/O' is an abbreviation for input/output and refers to data coming in, and going out, of a particular device. The 'Process I/O board' is an electronic device (board/card) in the controller through which data comes in and out from field instrumentation (the process).*

the controllers can execute pre-programmed instructions to control a process.

For example, in response to data collected from field instruments, the controller can issue commands to open valves when a certain pressure is reached, or to start compressors or pumps if a flow rate decreases below setpoint. All of these pre-programmed instructions are written using ACCOL.

In addition to directly controlling a process, a Network 3000 controller can serve as a **node** in a communications network. Each controller (node) can thus share its data with other controllers.

Data is sent to the network through one or more of the controller's **communication ports**. If controllers are located near each other, network connections can be 'hard-wired' with cables. Controllers which are far away can communicate through dial-up modems using either dedicated phone lines or the public telephone system. For some applications, radio or satellite links may be appropriate.

Typically, one or more PC workstations is also connected to the network. These workstations generally include **ACCOL Tools** software to allow for ACCOL programming, as well as **Open Bristol System Interface (BSI) Utilities** software. The Open BSI Utilities are a collection of programs which facilitate communication with the controller network by the ACCOL Tools, and by third-party applications. Open BSI Utilities also allow an operator to collect and view data from the network, and to monitor the status of network communications. Separate utilities may be purchased which allow scheduled data collection, and file export capability to third-party applications such as Microsoft Excel spreadsheets or data bases such as Microsoft Access.

Often, the PC workstations are also equipped with **Supervisory Control and Data Acquisition (SCADA)** or **Human-Machine Interface (HMI)** software packages which allow the presentation of data to an operator in the form of graphical displays, trends, and printed logs or reports. The PC workstation can use one of several different packages for this purpose including Iconics Genesis software, Intellution® FIX® software, or Bristol Babcock's own OpenEnterprise software.

Chapter 1 - Introduction: What is ACCOL?

How Are the Controllers Programmed?

ACCOL programming is done using a set of software programs referred to as the **ACCOL Tools**. The most important program in the ACCOL Tools software set is **ACCOL Workbench**. ACCOL Workbench, is a Windows-based tool which combines the necessary functions for ACCOL program generation, with the cut, paste, search, and replace capabilities of a text editor.

The ACCOL programmer uses ACCOL Workbench to construct an **ACCOL source file**.[4] The ACCOL source file consists of **ASCII** text, and has a file extension of (.ACC).

When editing the source file, the programmer selects from a large set of pre-programmed ACCOL software **module** templates and **control statements** which can be inserted in the source file. These modules and statements perform common mathematical, communication, and process control functions.[5]

Each module receives a series of input values, upon which it performs certain calculations. It then generates a series of output values which may be used by other modules. For example, the PID3TERM module generates outputs which allow proportional, integral, and derivative control over an input value.

```
* PID3TERM
 INPUT                    ;ANALOG_SIGNAL_OR_VALUE
 SETPOINT                 ;ANALOG_SIGNAL_OR_VALUE
 DEADBAND                 ;ANALOG_SIGNAL_OR_VALUE
 PROPORTION               ;ANALOG_SIGNAL_OR_VALUE
 INTEGRAL                 ;ANALOG_SIGNAL_OR_VALUE
 DERIVATIVE               ;ANALOG_SIGNAL_OR_VALUE
 RESET                    ;ANALOG_SIGNAL_OR_VALUE
 TRACK                    ;LOGICAL_SIGNAL
 OUTPUT                   ;ANALOG_SIGNAL
 ERROR                    ;ANALOG_SIGNAL
```

Each module includes a set of **module terminals** which are used to specify the inputs and outputs of the module. The name of an ACCOL **signal** or, in some cases, just a numerical value, is entered on the required module terminals. **Signal**s are software structures which allow data to be passed between modules.[6] Each signal has a specific name which should reflect the type of data it holds. For example, if a signal is used to store the level of water in water tank number 3, the signal should have a name such as TANK3.WATER.LEVL. Each signal name, as well as certain characteristics associated with the signal such as its initial value, engineering units, etc. must be defined in the ACCOL source file. A typical ACCOL source file includes several hundred signals; however, depending upon the complexity of the system, thousands of signals may be used.

---

[4] *The ACCOL source file can also be edited directly with any ASCII text editor. AccolCAD software, available separately from Bristol Babcock, can also be used to generate the ACCOL source file. Notes For Older Network 3000 Products: Different methods for program generation exist for older model controllers; these units use an older DOS-based set of ACCOL Tools which include the ACCOL II Batch Compiler (ABC) and ACCOL II Interactive Compiler (AIC). These older tools are not discussed in this manual.*

[5] *There are numerous modules and control statements to choose from. For information on particular modules and control statements see the ACCOL II Reference Manual (document# D4044).*

[6] *For users familiar with other high-level programming languages such as BASIC or 'C', signals can be thought of as 'variables'. In some industries, they are referred to as 'tags'.*

By entering the same signal name on terminals of different modules, a connection between the modules is established, and the modules are said to be 'wired' together.[7] In this way, the output of one module serves as the input to another module; allowing data values to be shared between modules.

```
*TASK 2 RATE: 1.000000 PRI: 1 REDUN: 0
10 * C OBTAIN FLOW VALUE FROM ANALOG PROCESS I/O BOARD
20 * ANIN
    DEVICE                              1
    INITIAL                             1
    INPUT                     1         F201.FLOW.IN
    ZERO                      1         F201.FLOW.ZERO
    SPAN                      1         F201.FLOW.SPAN
30 * C SMOOTH OUT INPUT FLUCTUATIONS WITH LEAD/LAG MODULE
40 * LEAD/LAG
    INPUT                               F201.FLOW.IN
    DERIVATIVE                          F201.DERIV.
    INTEGRAL                            F201.INT.
    RESET                               LEADLAG.RESET.SIG
    OUTPUT                              F201.FLOW.LL
50 * C COMPARE NEW VALUE WITH OPERATOR SETPOINT
60 * COMPARATOR
    MODE                                COMP.MODE.
    INPUT                               F201.FLOW.LL
    SETPOINT                            F201.FLOW.SP
    DEADBAND                            F201.FLOW.DB
    OUTPUT_1                            F201.FLOW.HIGH
```

The programmer combines the appropriate modules and control statements together into functional blocks called **ACCOL Task**s. ACCOL tasks provide a way to divide up the source file, and make it more manageable. Although an ACCOL source file can theoretically include more than 100 tasks, most ACCOL programmers find that using a few tasks, say less than ten, is most efficient. Each ACCOL task executes at a user-defined rate, and with a user-defined priority. In this way tasks which perform critical process control operations can take precedence over tasks which perform less important calculations.

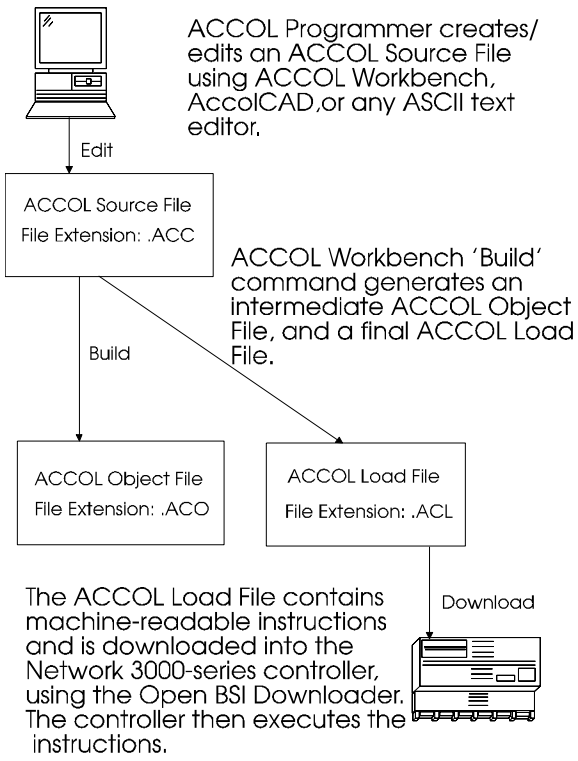
The ACCOL source file may include other structures which allow for data storage and management, such as **signal lists** and **data arrays**. These subjects will be discussed later in this manual.

[7] *The modules, terminals, signals, and the connections between them all exist in the software program which executes in the controller. There are no physical modules to be wired together. Unless otherwise noted, whenever these terms are used in this book, they refer to software structures in the ACCOL, not physical hardware devices.*

Chapter 1 - Introduction: What is ACCOL?

Once the ACCOL source file has been completed, it must be translated into a format which is compatible with the Network 3000 series controller. To perform this translation, the ACCOL programmer initiates an ACCOL Workbench 'build' command. If there are no errors in the ACCOL source file, the 'build' command generates an intermediate ACCOL Object File[8] (.ACO), and a final ACCOL Load File (.ACL).

All of the modules and statements originally entered in the ACCOL source file, are stored as machine-readable instructions in the ACCOL Load file. The ACCOL Load file, generally referred to as simply the **ACCOL load**, may then be **downloaded** into the **memory** of the Network 3000-series controller.[9]



Once in memory, the controller will begin executing each of the machine-readable instructions in the ACCOL load, in order to perform whatever measurement and control duties are required for its particular application.

[8] *The ACO file is useful only for certain ACCOL Tools, it may NOT be edited by the user.*

[9] *Downloading is performed using the Open BSI Downloader.*

Chapter 2 - What Are Signals?

What Are Signals?

Signals are the primary vehicle by which data is passed from module to module in the ACCOL load. They are similar to 'variables' in other programming languages. The ACCOL programmer uses signals to specify the inputs to, and outputs from, ACCOL modules. By placing an ACCOL signal name on a module terminal, that terminal is said to be 'wired' to that signal. Placing that *same* signal name on another terminal establishes a connection between the modules; the value of a signal on an output terminal of one module serves as an input to another module, and so on.

This section will describe the five different types of signals: logical, logical alarm, analog, analog alarm, and string. A special set of signals created by the system, called **system signals** will also be discussed. Before covering these topics, however, it's important to discuss signal naming conventions, and signal characteristics.

Signal Naming Conventions

Every signal has a unique name. Signal names are divided up into three parts as shown below:

base_name.extension.attribute

The signal *base_name* can be from 1 to 8 characters in length, and must begin with a letter.[1] The remaining characters can be any mixture of numbers and letters.

The signal *extension* can be any mixture of 0 to 6 letters or numbers.

The signal *attribute* can be any mixture of 0 to 4 letters or numbers.

Note the presence of periods '.' between the base name and extension, and between the extension and attribute. These serve as separator characters between each part of the signal name, and are always required. If the signal contains no attribute, the signal name should include an ending period, i.e. '*base.extension*.' and if neither an extension, nor an attribute is used, the signal name should have two ending periods, i.e. '*base*..' Here are some examples of valid ACCOL signal names:

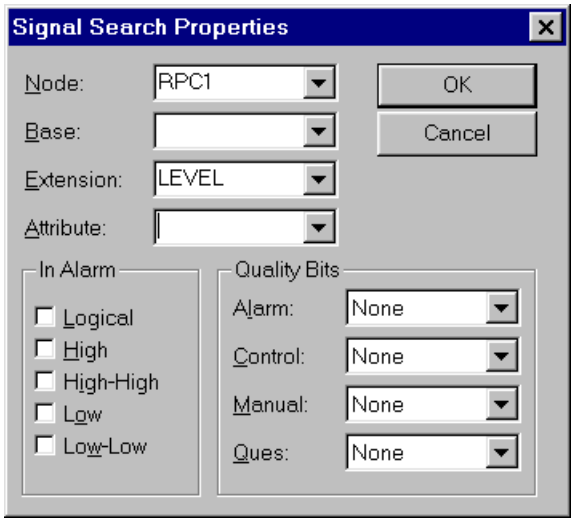
STATION1.TEMP.DEGC
PUMP4.STATUS.
TANK3..LEVL
POWRFAIL..
PUMP3425.STATUS.FAIL

[1] *The only exception to this rule is for **system signals**. All system signals have a base name beginning with the character '#'. System signals are created by the ACCOL Tools, and are used for specific 'housekeeping' duties. The ACCOL programmer can use system signals, but cannot create them.*

Chapter 2 - What Are Signals?

The reason signals are divided up into three parts is that it allows a greater level of organization for signals.

In the figure, at right, the Open BSI DataView utility is being used to search for all signals which share the common extension 'LEVEL'. The same type of search could be conducted based on base names or attributes.



Characteristics Common to All Signals

Every ACCOL signal has a set of characteristics associated with it. Depending upon the type of signal (logical, logical alarm, analog, analog alarm, or string) the characteristics may vary, however, every signal, no matter which type, shares the characteristics described below:

Initial State or Value

This is the starting value, as specified in the ACCOL source file, which this signal will have when the ACCOL load is initially downloaded into the Network 3000 controller. The signal will maintain its initial state or value, until such time as it is changed, either manually, through the intervention of an operator, or via control instructions in the ACCOL load.

Manual Inhibit/Enable Flag

The manual inhibit/enable flag is a status value, associated with the signal, which determines whether or not an operator can change the value of the signal. The value of a manually enabled signal can be altered by an operator. When a signal is manually inhibited, however, an operator cannot change the signal's value, without first manually enabling the signal.

Control Inhibit/Enable Flag

The control inhibit/enable flag is a status value, associated with the signal, which determines whether or not the execution of ACCOL control logic (modules, tasks, etc.) can change the value of the signal. The value of a control enabled signal can be altered by

ACCOL control logic. When a signal is control inhibited, however, control logic cannot change the signal's value. This flag is sometimes referred to as 'AUTO/MANUAL'.

Base name Text

Every signal has a base name. If desired, a descriptive text message may be associated with the base name. The full text of this message is only visible in those SCADA/HMI packages which are specifically equipped to display it. The base name text for a particular base name is *shared by all signals with the same base name.*

For example, if the base name COMPRSR2 has descriptive text of 'COMPRESSOR NUMBER 2', and the ACCOL source file contains two signals with a base name of COMPRSR2:

COMPRSR2.POWER.STAT and
COMPRSR2.RUN.TIME,

then both those signals will share the common base name descriptive text of 'COMPRESSOR NUMBER 2'.

Base name text can be defined in the *BASENAMES section of the ACCOL source file, -OR- it can be defined via a separate string signal. (String signals will be discussed later in this section.)

ACCOL supports six levels of security access (1 to 6), with 6 being the highest level. Each level has, associated with it, a security code. Any operator using Open BSI Utilities, or certain ACCOL Tools must sign-on with one of these security codes. Once signed on, the operator is then allowed access to system functions which accept a security level *less than or equal to* his or her security level. For example, an operator with security level 4 has access to functions requiring level 1 to 4, but is prohibited from accessing functions requiring security level 5 or 6.

Read Priority

The **Read Priority** value specifies the minimum security level an operator must sign on with, in order to view (i.e. read the value of) this signal.

Write Priority

The **Write Priority** value specifies the minimum security level an operator must sign on with, in order to change the value of (i.e. write to) this signal.

Chapter 2 - What Are Signals?

Additional signal characteristics vary depending upon the signal type, and will be described, below:

Logical Signals

Logical signals can only have two possible values: ON or OFF.[2]

Logical signals are therefore used for data which can only have two possible states. For example, if a valve is either OPENED or CLOSED, its value can be stored in a logical signal. Similarly, if a pump is either ON or OFF, a logical signal could be used to store its value. Logical signals are also useful in the creation of Boolean logic expressions.

Logical signals have the following characteristics: (in addition to those described under *Characteristics Common to All Signal Types*).

ON/OFF Text — In certain on-line tools (in Open BSI, for example) the state of a logical signal is shown as 'ON' if the signal is ON, and 'OFF' if the signal is OFF. A signal's ON/OFF text may be changed, however, to better represent the signal's function. For example, it may be desirable to edit this text in the source file so that the ON text is 'ACTIVE', and the OFF text is 'FAILED'. Both the ON text and OFF text may be up to six characters in length.

LOC/GLB Flag — Certain HMI/SCADA packages will only collect data from signals which are alarms, or are specified as global signals 'GLB'. These packages will ignore signals specified as local 'LOC'. This flag, therefore, allows the user to designate whether or not such packages should collect data from this signal.

RBE Flag — Report by Exception (RBE) is a method of data collection, used by certain HMI/SCADA packages, which will cause data from signals to be collected only if the signal value changes. This minimizes the amount of message traffic in the system. By default, signals are NOT RBE signals.

Logical Alarm Signals

Logical Alarm Signals are similar to logical signals, except that when they change state, they generate an **alarm message**.[3] These signals are used to store data which is more

[2] *The controller stores an OFF as the number '0' and an ON as the number '1'.*

[3] *Alarm messages are immediately transmitted out of the controller's slave port, to the next highest node in the network, until they reach whatever device is used to notify the operator of the alarm (PC Workstation, printer, etc.)*

critical to the operation of a process, for example, a logical alarm signal might be used to indicate that a pump or compressor has failed.

Logical alarm signals have the following characteristics: (in addition to those described under *Characteristics Common to All Signal Types*).

ON/OFF Text See description under *Logical Signals*.

RBE Flag See description under *Logical Signals*. NOTE: In general, alarm signals should NOT be designated as RBE signals.[4]

Alarm Priority Alarm signals can also be further classified based on the severity of the alarm condition. This severity level is called the **alarm priority**. There are four possible priority levels, which will be discussed in ascending level of importance. The choice of which signals should have a given alarm priority is entirely at the discretion of the programmer.

Event - Signals specified as event alarms are used to indicate normal, everyday occurrences.

Operator Guide - Signals specified as operator guide alarms are used to indicate everyday occurrences as well, however, they are slightly more important than events.

Non-Critical - Signals specified as non-critical are used to indicate problems which, while not serious enough to cause damage to a plant or process, require corrective action by an operator.

Critical -Signals specified as critical are used to indicate dangerous problems which require immediate operator attention, and corrective action.

Alarm Type The type of an alarm specifies under what conditions the signal enters an alarm state. There are three possible choices:

Alarm ON - with this choice, an alarm message is generated when the signal turns ON, and a 'return to normal' alarm message is generated when the signal turns OFF.

[4] *Alarms are always reported before RBE change reports, therefore, if a signal is collected both as an alarm, and as an RBE change, there is a possibility that an <u>older</u> RBE message could arrive after an alarm message, thereby overwriting newer data with older data. Because of this interaction of the two data collection methods, it is recommended that alarm signals NOT be designated as RBE signals. For more information on Report by Exception, see the ACCOL II Reference Manual (document# D4044).*

Alarm OFF - with this choice, an alarm message is generated when the signal turns OFF, and a 'return to normal' alarm message is generated when the signal turns ON.

Change of State - with this choice, an alarm message is generated anytime the signal changes state from ON to OFF, or from OFF to ON.

Alarm Inhibit/ Enable Flag The alarm inhibit/enable flag is a status value, associated with the signal, which determines whether or not alarm messages will be transmitted. Setting this flag to 'Enable' allows transmission of alarm messages to occur. Setting this flag to 'Inhibit' prevents the transmission of alarm messages from this signal.

Analog Signals

Analog signals are used to store numerical data. Examples of such data might include, temperature readings, pressure readings, or flow totals. The numerical data is stored as 4-byte floating point numbers in IEEE format.[5] The non-zero numerical value of an analog signal can range from:

$$\pm 1.175494 \times 10^{-38} \text{ to } \pm 3.402823 \times 10^{38}$$

Analog signals have the following characteristics: (in addition to those described under *Characteristics Common to All Signal Types*).

LOC/GLB Flag Certain HMI/SCADA packages will only collect data from signals which are alarms, or are specified as global signals 'GLB'. These packages will ignore signals specified as local 'LOC'. This flag, therefore, allows the user to designate whether or not such packages should collect data from this signal.

RBE Flag Report by Exception (RBE) is a method of data collection, used by certain HMI/SCADA packages, which will cause data from signals to be collected only if the signal value changes. This minimizes the amount of message traffic in the system. By default, signals are NOT RBE signals.

RBE Deadband Analog signals which have been designated as RBE signals may

[5] *See Appendix B for more information on working with floating point numbers.*

have an associated **deadband**.[6] The deadband represents a range, above and below the last reported value of the signal, in which changes to the signal will not be reported. If the signal goes out of this range, for a period of time long enough to be detected by an RBE scan, then an exception has occurred, and the change will be reported.

Units Text Units text specifies the engineering units for this particular signal. Up to six characters of units text may be defined. Typical examples of units text include: 'HOURS', 'FEET', 'INCHES', and 'PSIG'.

Analog Alarm Signals

Analog Alarm Signals are similar to analog signals, except that when the signal value exceeds certain pre-defined alarm limits, an alarm message is generated. These signals are used to store data which is more critical to the operation of a process, for example, an analog alarm signal might be used for temperature or pressure readings of critical system components.

Analog alarm signals have the following characteristics: (in addition to those described under *Characteristics Common to All Signal Types*).

Units Text See description under *Analog Signals*.

RBE Flag See description under *Analog Signals*. NOTE: In general, alarm signals should NOT be designated as RBE signals.[7]

RBE Deadband See description under *Analog Signals*.

Alarm Enable/ Inhibit Flag See description under *Logical Alarm Signals*.

Alarm Limits and Deadbands An analog alarm signal generates an alarm message when the value

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[6] *The concept of deadbands is explained in more detail in the discussion of alarm limits for analog alarm signals, later in this section.*

[7] *Alarms are always reported before RBE change reports, therefore, if a signal is collected both as an alarm, and as an RBE change, there is a possibility that an older RBE message could arrive after an alarm message, thereby overwriting newer data with older data. Because of this interaction of the two data collection methods, it is recommended that alarm signals NOT be designated as RBE signals. For more information on Report by Exception, see the ACCOL II Reference Manual (document# D4044).*

of the signal exceeds a pre-defined **alarm limit**. Up to four alarm limits may be defined; every analog alarm signal must have at least one limit defined, or else the signal will never generate an alarm message.

The four alarm limits are the high alarm limit, the high-high alarm limit, the low alarm limit, and the low-low alarm limit. Each of these alarm limits can be specified in the ACCOL source file as either a constant, or as an ACCOL signal. In general, specifying an ACCOL signal provides more flexibility, because it allows the limit to be changed dynamically, either by the operator, or through logic in the ACCOL load.

In addition to the alarm limits, there are two **deadband**s: the low deadband and the high deadband. A deadband represents a range just above or below the alarm limit (depending upon whether it's a high or low alarm) in which the signal remains in an alarm state, despite the fact that its value no longer exceeds the alarm limit. Without the deadband, if the signal's value rapidly fluctuates above and below the alarm limit, the signal would constantly be going in and out of an alarm state, thereby flooding the system with alarm and return to normal messages. A properly defined deadband helps prevent this situation.

Deadbands can be defined in the ACCOL source file as either constants, or as signals.

When the value of an analog alarm signal passes one of its alarm limits, an alarm message is generated.[8]

In the case of a high, or high-high alarm, the alarm condition does not clear (i.e. generate a 'return to normal' alarm message) until the value of the signal goes below the alarm limit, *minus* the value of the high deadband.

In the case of a low, or low-low alarm, the alarm condition does not clear until the value of the signal rises above the alarm limit, *plus* the value of the low deadband.

An example of alarm limits and deadbands is illustrated in the figure on the opposite page. In this example, we are showing a plot of the value of a signal measuring Celsius

[8] *In order for alarm limits to function properly, the high-high limit must be a higher number than the high limit, the high limit must be a higher number than the low limit, and the low-low limit must be a lower number than the low limit. In addition, deadbands should always be entered as positive numbers.*

temperature, as it fluctuates over time. The four alarm limits and two deadbands are shown in the figure. The normal range for this signal is temperatures between 40^0 C and 70^0 C. Temperatures outside of this range are considered to be alarm conditions.

Starting from the left of the graph, the value of the signal increases until it reaches 70^0 C, the high alarm limit (see Item 1). At this point a high alarm message is generated, and the signal is considered to be in a 'high alarm' state.

The value of the signal continues to increase. When it passes the high-high alarm limit of 90^0 C a 'high-high' alarm message is generated (see Item 2). At this point, the signal is considered to be in a high-high alarm state.

The value of the signal then starts to decrease. Although the value passes below 90^0C, it is still considered to be in a 'high-high' alarm state because there is a 10^0 high deadband in effect (deadbands are shown as shaded areas on the graph.) When the signal value falls lower than 80^0 C point (90^0 C high alarm limit minus the high deadband of 10^0 C) the signal is no longer in a 'high-high' alarm state (See Item 3). It is still however in a 'high' alarm state.

As the value of the signal decreases below 70^0 C, it remains in a 'high' alarm state until its value falls below 60^0 C (70^0 C alarm limit, minus a 10^0 C high deadband). (See Item 4). At this point, the signal is in its normal range, and a 'return-to-normal' alarm message is sent.

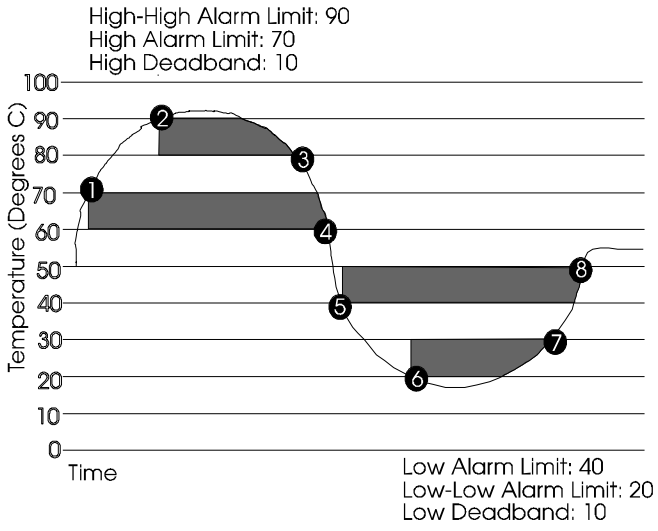
Then, however, the value of the signal continues to drop. When it reaches 40^0 C, a 'Low Alarm' message is generated (See Item 5).

The signal remains in a 'Low Alarm' state until the signal value drops to 20^0 C. (See Item 6). This causes a 'Low Low Alarm' message to be generated.

The signal remains in a 'Low-Low Alarm' state until the signal rises above 30^0 C, (20^0 C low-low alarm limit plus low deadband of 10^0 C). (See Item 7). The signal is still in a 'Low Alarm' state, however.

Once the signal rises above 50^0 C (40^0 C low alarm limit + low deadband of 10^0 C), it has left the low-alarm state, and a 'return to normal' alarm message is sent (See Item 8).

As long as the signal remains in the normal range (between 40 and 70^0 C), no more alarm messages will be generated.



String Signals

The last type of signal is the string signal. The value of a string signal is a message consisting of up to 64 characters of ASCII text. These messages are called **character strings**, because they are a bunch of characters tied together. For example, a string signal called STATION.TAG.NAME may have a value of 'ELM STREET COMPRESSOR STATION'.

String signals are typically used to provide readable status messages. Some SCADA/HMI packages are also equipped to display these messages.

A less common use of string signals is to hold the base name descriptive text for *another* signal. Normally a signal's base name descriptive text is defined in the source file as a constant; if a string signal name is entered instead, the base name descriptive text can be changed on-line.

The Calculator Module (which will be discussed in the section *Modules*) also supports certain functions for string manipulation including checking the length of a string, comparing the value of two strings, and concatenating (putting together) two strings.

String signals have the following characteristics: (in addition to those described under *Characteristics Common to All Signal Types*).

String Length The length (number of characters) of the message (including spaces). No string may be longer than 64 characters.

Chapter 2 - What Are Signals?

System Signals

Every ACCOL load contains a series of **system signals** System signals are created automatically by the system, and are distinguished from other ACCOL signals by the presence of a pound sign '#' at the beginning of the base name.

For example, the system signal #TIME.000. indicates the current Julian date and time. The system signal #NODEADR.. indicates the local address of the controller (as set via hardware or software switches).

There are numerous other system signals which are used for 'housekeeping' such as holding task characteristics, and error information.

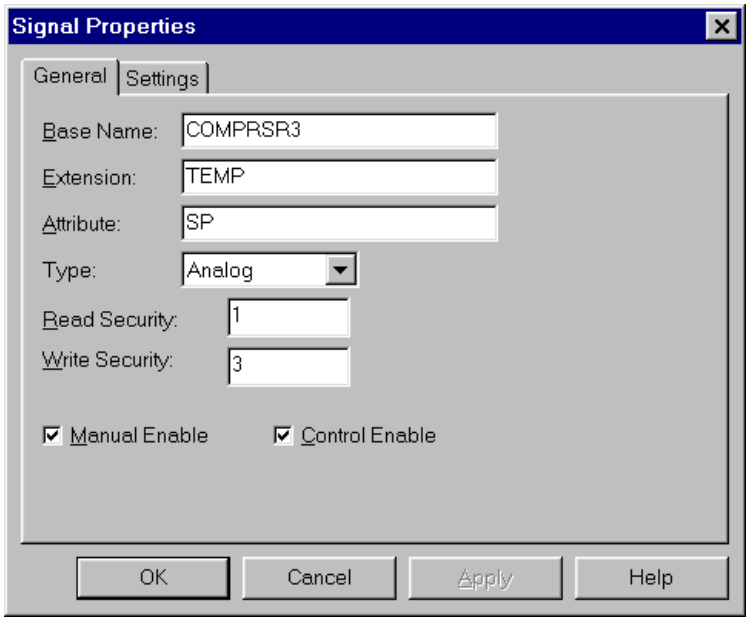
The ACCOL programmer cannot create or delete system signals, but can make use of them on module terminals, or in equations.

For more information on system signals, see the *ACCOL II Reference Manual* (document# D4044).

How Are Signals Created?

All signals must be defined in the '*SIGNALS' section of the ACCOL source file (.ACC). Base name descriptive text for the signals is defined in the '*BASENAMES' section of the file.

Instructions for defining signals and base name text are included in the *ACCOL Workbench User Manual* (document# D4051).

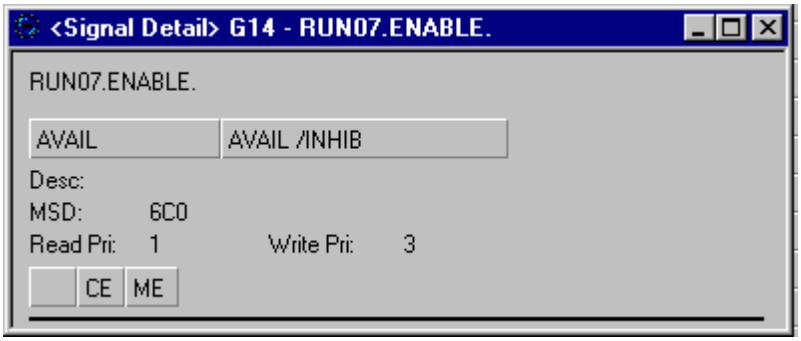


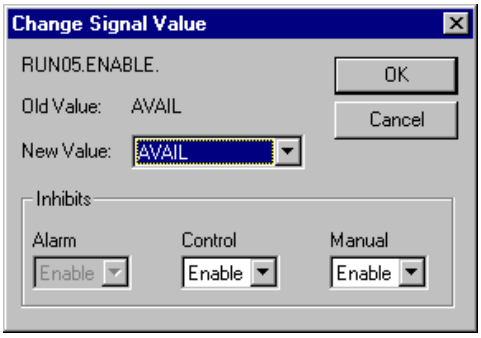
Chapter 2 - What Are Signals?

How Does the Operator View Signal Values?

There are several different ways to view signal data in a running Network 3000 series controller.

- While running the Open BSI DataView utility, users can call up signals by a signal search, by the full signal name, or through lists. Signal values may also be changed via dialog boxes. See the *Open BSI Utilities Manual* (document# D5081) for details.





- Signal data can be exported to DDE compliant applications such as spreadsheets and word processors using the Open BSI DDE Server program. See the *Open BSI Collection/Export Utilities Manual* (document# D5083) for details.

- Users with Bristol Babcock's Universal Operator Interface (UOI) software can configure text-based menus and logs to include signal data. See the *UOI Configuration Manual* (document# D5074) for details.

- If you are using an HMI/SCADA software package such as OpenEnterprise, Enterprise Server, Intellution® FIX®, Iconics Genesis, etc., signal values may be used to drive the color and appearance of graphic symbols on screen displays, trend lines, etc. See the documentation accompanying the HMI/SCADA software for details.

Chapter 3 - What Are Modules?

What Are Modules?

Modules are pre-programmed structures which are used to perform mathematical, communication, and process control functions.[1] Within ACCOL Workbench, the programmer chooses from a library of modules, and inserts the selected modules into one or more ACCOL **task**s in the source file.[2,3]

Each module has a series of **terminal**s which represent its inputs and outputs. The programmer 'wires' these terminals in software, by typing an ACCOL signal name next to the terminal. By placing the same signal name on terminals of different modules, the programmer establishes a connection for data flow between the modules. In this way, data flows from an output terminal of one module, to an input terminal of another module, and so on.[4]

How Do Modules Execute?

When a module executes, it reads its input terminals, performs any necessary calculations, and then updates its output terminals.

Except for certain special modules in Task 0 (discussed later in this manual) modules do NOT execute unless the line of the **task** on which they are defined executes, therefore the output terminals of a module do NOT change at any time except when the module is executing.

What Kinds of Modules Are Available?

There are over 80 different ACCOL modules. We will discuss a few broad categories of available modules here. A full description of each module is included in the *ACCOL II Reference Manual* (document# D4044).

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[1] *If you are familiar with other programming languages, you can think of a module as a sub-routine, or procedure.*

[2] *The pre-programming instructions for each module reside in **firmware**, a special kind of encoded software that resides in the remote process controller. When you install new versions of ACCOL Tools software, which include new modules, you may also need to install an upgrade to the controller firmware, in order to use the new modules or features. For some controller models, the firmware is referred to as the **PROM set**, because it resides in Erasable Programmable Read only Memory (EPROM) chips. In other controllers, the firmware is installed into a FLASH memory area. See the hardware manual of your controller for more information.*

[3] *The method for inserting modules into a task will be discussed in greater detail later.*

[4] *The terminals of a module are only updated with data when the module executes.*

Chapter 3 - What Are Modules?

Natural Gas Modules

There are several modules available which implement natural gas industry calculations, including those described in *American Gas Association* reports. Among these modules are AGA3ITER, AGA5, AGA7, AGA8GROSS, AGA8DETAIL, FPV and ISO5167.

```
10 * AGA8DETAIL
       ENABLE            ;LOGICAL_SIGNAL
       PRIORITY          ;ANALOG_SIGNAL_OR_VALUE
       FLOW_TEMP         ;ANALOG_SIGNAL_OR_VALUE
       STAT_PRESS        ;ANALOG_SIGNAL_OR_VALUE
       BASE_TEMP         ;ANALOG_SIGNAL_OR_VALUE
       BASE_PRESS        ;ANALOG_SIGNAL_OR_VALUE
       LIST              ;ANALOG_SIGNAL_OR_VALUE
       ARRAY             ;ANALOG_SIGNAL_OR_VALUE
       COLUMN            ;ANALOG_SIGNAL_OR_VALUE
       ERROR             ;ANALOG_SIGNAL
       STATUS            ;ANALOG_SIGNAL
       Z_FLOWING         ;ANALOG_SIGNAL
       Z_BASE            ;ANALOG_SIGNAL
       FPV               ;ANALOG_SIGNAL
```

Input/Output (I/O) Modules

Most every ACCOL source file includes some I/O modules, since these modules are necessary to send and receive data through the controller's process I/O boards. The most commonly used include the analog input (ANIN), analog output (ANOUT), digital input (DIGIN) and digital output (DIGOUT).

```
20 * ANOUT
DEVICE                DEVICE_ID
INITIAL               CHANNEL
OUTPUT        1       ;ANALOG_SIGNAL_OR_VALUE
ZERO          1       ;ANALOG_SIGNAL_OR_VALUE
SPAN          1       ;ANALOG_SIGNAL_OR_VALUE
TRACK         1       ;LOGICAL_SIGNAL
RESET         1       ;ANALOG_SIGNAL
```

Mathematical Modules

These modules implement a variety of different arithmetic and logical functions. Among those available are the AVERAGER, COMPARATOR, INTEGRATOR, DIFFERENTIATOR, TOT/TRND, MUX, and DEMUX modules.

```
30 * INTEGRATOR
       INPUT          ;ANALOG_SIGNAL_OR_VALUE
       RESET          ;LOGICAL_SIGNAL
       ZERO           ;ANALOG_SIGNAL_OR_VALUE
       SPAN           ;ANALOG_SIGNAL_OR_VALUE
       OUTPUT         ;ANALOG_SIGNAL
```

Chapter 3 - What Are Modules?

Communication Modules

These modules support data transmission through the controller's **communication ports**. Among the most commonly used modules are MASTER, SLAVE, EMASTER, LOGGER, CUSTOM, IP_CLIENT, and IP_SERVER.

```
40 * MASTER
       REMOTE        ;ANALOG_SIGNAL_OR_VALUE
       POINT         ;ANALOG_SIGNAL_OR_VALUE
       MODE          ;ANALOG_SIGNAL_OR_VALUE
       INTYPE        ;ANALOG_SIGNAL_OR_VALUE
       OUTTYPE       ;ANALOG_SIGNAL_OR_VALUE
       INDEX         ;ANALOG_SIGNAL_OR_VALUE
       INLIST        ;ANALOG_SIGNAL_OR_VALUE
       OUTLIST       ;ANALOG_SIGNAL_OR_VALUE
       STATUS_1      ;ANALOG/LOGICAL_SIGNAL
       STATUS_2      ;ANALOG_SIGNAL
```

Process Control Modules

These modules implement algorithms which are useful for process control applications including PID loop control (PID3TERM), LEAD/LAG, SCHEDULER, SEQUENCER, and STEPPER.

```
50 * PID3TERM
  INPUT                ;ANALOG_SIGNAL_OR_VALUE
  SETPOINT             ;ANALOG_SIGNAL_OR_VALUE
  DEADBAND             ;ANALOG_SIGNAL_OR_VALUE
  PROPORTION           ;ANALOG_SIGNAL_OR_VALUE
  INTEGRAL             ;ANALOG_SIGNAL_OR_VALUE
  DERIVATIVE           ;ANALOG_SIGNAL_OR_VALUE
  RESET                ;ANALOG_SIGNAL_OR_VALUE
  TRACK                ;LOGICAL_SIGNAL
  OUTPUT               ;ANALOG_SIGNAL
  ERROR                ;ANALOG_SIGNAL
```

Calculator Module

One module which deserves special mention is the CALCULATOR module. If you are unable to find a module which suits your needs, you may often be able to create the needed module yourself by entering statements in a Calculator Module. This module supports a wide range of arithmetic operators (add, subtract, multiply, divide, square root, SIN, COSINE), logical operators (IF, ELSE, AND, INCL OR, EXCL OR), and other operators related specifically to signals, and strings.

```
60 * CALCULATOR
  10 :IF((TANK7.WATER.LEVL>12)&(DRAIN.ENABLE.ON))
  20    OPEN.DRAIN.VALV=#ON
  30 :ENDIF
```

How Are Modules Placed in the ACCOL Source File?

Modules are inserted inside **ACCOL Tasks** in the ACCOL source file. ACCOL Tasks are discussed in the next section. For information about inserting modules in them, see the *ACCOL Workbench User Manual* (document# D4051).

Chapter 4 - What Are ACCOL Tasks?

What Are ACCOL Tasks?

An ACCOL **task** is a series of modules and control statements which execute sequentially as a functional block. Task execution occurs at a user-specified rate and priority.

ACCOL tasks provide a way to organize the ACCOL source file into smaller, more manageable pieces. For example, at a compressor station for a natural gas pipeline, there are critical flow, temperature and pressure calculations, as well as I/O operations; these might fit well in one high priority task. Less critical calculations, such as daily flow totals, and averages, might be separated out into a lower priority task. Communication through master modules may be handled through yet another task.

Each ACCOL task is assigned a unique number. ACCOL supports over 100 tasks, however, most users find that using a few tasks is most efficient.

Communication Between Tasks

Data is transferred from one task to another in the same way that data moves from module to module, via signals.

To send a value of an output terminal in one task to the value of an input terminal in another task, simply 'wire' the same signal name on both terminals.

Other ACCOL structures, such as data arrays, signal lists, etc., are also shared among all tasks.

Task Rate

The task rate specifies how often the controller will initiate execution of this task.[1]

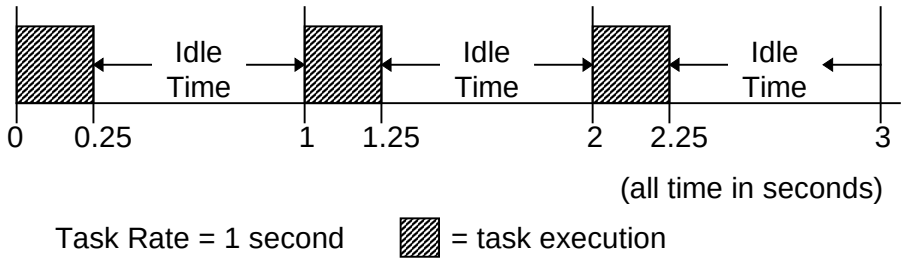
The task rate is specified in units of seconds, and is defined in the ACCOL source file, and may be modified on-line through the #RATE.*nnn* system signal (where *nnn* specifies the task number). The task rate can be as fast as 0.02 seconds (20 milliseconds), or as slow as 5400 seconds (90 minutes). Setting the task rate to 0 stops execution of the task.

In the timing diagram, on the next page, an ACCOL load with a single task has a task rate set at 1 second. Each second, the task is scheduled to start executing, and it

[1] *If the time it takes to execute the task is longer than the rate specified, the next execution of the task will NOT be started on schedule. It must wait until the previous execution of the task has completed. This delay is called* ***slippage****, and is recorded as a slip count error in the system signal #RCNT.nnn where nnn is the task number.*

completes execution (in this case) in 0.25 seconds.[2] For the remaining time, the controller is not executing any tasks, and is said to be idle.

In this situation, with only one task in the load, the task rate could safely be set faster, to say, 0.3 seconds, thereby minimizing the idle time.



Since an ACCOL load can have many tasks, be aware that each task must share execution time. Some tasks may have critical calculations which require frequent updates. To efficiently use the system, tasks should be scheduled to run as frequently as needed, but not so fast as to cause slippage of the execution time.

For example, in the timing diagram, above, with a 1 second task rate, the controller is idle for 0.75 seconds out of every 1.00 second. Therefore, if other tasks are added to the load, and the sum of their execution times is always less than 0.75 seconds, they could also all have 1 second task rates.

Continuous Tasks

If desired, a task may be set to run continuously. by specifying 'C' as its task rate, when creating the ACCOL source file off-line, or setting the appropriate #RATE.*nnn* signal to a value of '-1' when operating on-line. Care must be taken, however, to ensure that continuous tasks are given a priority lower than any other task, or to use WAIT statements to stop execution of the continuous task. If these precautions are NOT taken, any tasks with a lower priority than the continuous task WILL NEVER execute.

Task Priority

Each task is assigned a priority. **Task priority** can range from 1 to 64, with 64 being the highest priority, and 1 being the lowest. If a task performs operations which are critical to the safe operation of a process, it should be assigned a high priority. Tasks which perform less important calculations may be assigned a lower priority.

Task priority can be changed on-line via the #PRI.*nnn* system signal (where *nnn* corresponds to the task number).

---

[2] *The time it takes to execute a task may be measured using the system signals #RTTIME.000 and #RTTIME.001.*

Chapter 4 - What Are ACCOL Tasks?

ACCOL uses a technique called **pre-emptive multi-tasking**. This means that multiple tasks execute concurrently, however, higher priority tasks are given priority over lower priority ones.

If two or more tasks are scheduled to execute at the same moment, the one with the higher priority will be executed first. As time becomes available, the task with the next highest priority will be executed, and so on. If two tasks share the same priority, they will be executed on a rotating basis.

If a high priority task is required to run, and a lower priority task has not finished execution, execution of the lower priority task will be suspended to allow the higher priority task to run. The lower priority task can only resume execution when higher priority tasks have finished.

If you have a continuous task (described earlier), it must have the lowest priority relative to all other tasks, or it must be stopped by WAIT statements (WAIT FOR, WAIT DELAY, etc.) or else NO OTHER TASKS WILL EXECUTE.

System Tasks

Another consideration when setting task priority is to avoid conflicts with **system tasks**. A system task is a task in the system firmware, which performs some function during the execution of the ACCOL load. A table of system task priorities is included in the 'Task' section of the *ACCOL II Reference Manual* (document# D4044). Never assign an ACCOL task a priority that is higher than one of the system tasks which will be used in your ACCOL load, or the system task may be unable to run when it is needed.

Redundancy Frequency

If you are using a **redundant** pair of Network 3000 controllers, then a redundancy frequency of 1 should be specified.[3] If you are NOT using redundant controllers, a redundancy frequency of 0 should be specified.

Task 0 - The Special Task

Every ACCOL load has a task numbered 0. Task 0 is a special task which does not execute at a specified rate. Instead, it is used to hold certain modules which do NOT

[3] *In general, a redundancy frequency of 1 should be specified for redundant units. For additional information on redundancy frequency, see the 'Redundancy Concepts' section of the ACCOL II Reference Manual (document# D4044).*

execute on their own, except when activated by other ACCOL modules. The following are non-executing modules, which are appropriate for use in Task 0:

AUDIT
EASTATUS
EAUDIT
RBE
REDUNDANCY
RIOSTATS
SLAVE

All other modules should be placed in tasks which execute at a specified rate.

Task Control Statements

Normally, the modules in a task execute in sequential order. **Task Control Statements** can be inserted in the task to modify the flow of execution.

Modules can be conditionally skipped using IF/ENDIF/ELSE/ELSEIF statements. Modules can be repeatedly executed using FOR/ENDFOR statements.

The entire task can wait for a particular event to occur, or time to elapse, using WAIT statements.

The task can even suspend its execution with a SUSPEND statement. The task can then only be re-started by a RESUME statement in a *different* task.

In the simple example task, shown, below, only one of the two single-line calculator modules will execute; which one is chosen depends upon the hour of the day determined in the IF statement:

```
**TASK 2 RATE: 0.500000 PRI: 1 REDUN: 0
10 * C SIMPLE TASK TO TURN ON LIGHTS IN A ROOM
20 * C BETWEEN 4:00 PM AND 6:00 AM
30 * IF ((#TIME.005.>16)|(#TIME.005.<6))
40 * CALCULATOR ROOM.LIGHT.=#ON..
50 * ELSE
60 * CALCULATOR ROOM.LIGHT.=#OFF..
70 * ENDIF
```

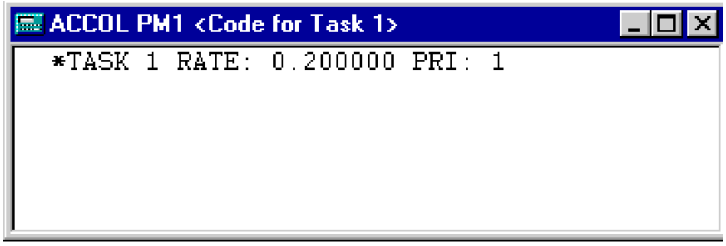
The following is a list of sections in the *ACCOL II Reference Manual* (document# D4044) which contain details on control statements.

ABORT
BREAK
CONTROL STATEMENTS

IF/ENDIF/ELSE/ELSEIF
FOR/ENDFOR
GOTO
RESUME
SUSPEND
WAIT DELAY
WAIT DI/RWAIT DI
WAIT FOR
WAIT TIME

How Are ACCOL Tasks Created?

Each task has a separate *TASK section in the ACCOL source file. Tasks are inserted in the file within ACCOL Workbench. For information on doing this, see the *ACCOL Workbench User Manual* (document# D4051).



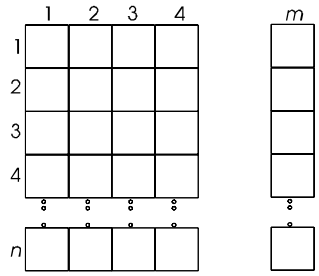
Chapter 5 - What Are Data Arrays?

What Are Data Arrays?

Data arrays are essentially tables. They are organized in rows and columns, and each array element (cell) can hold a single piece of data.

Arrays can be one dimensional (1 column by *n* number of rows):

-OR- two dimensional (*m* columns by *n* number of rows).



A particular array includes either all analog data, or all logical data; data types cannot be mixed within the same array.[1]

Arrays are identified by a number from 1 to 255. There can be up to 255 logical arrays, and 255 analog arrays. Both types of arrays can share the same numbers; for example, there can be a logical array #1, as well as an analog array #1. All arrays are accessible by any ACCOL task in the ACCOL load.

Each array is classified as either **Read-Only** (RO) or **Read/Write** (RW).

- Data entries for a Read Only array are made directly in the ACCOL source file. They may be changed using ACCOL Workbench in either off-line or on-line mode; but cannot be changed via DataView or other access methods. The data entries may, however, be viewed by operators, and referenced by ACCOL modules.

[1] *In some applications, Julian Date/Time information can be stored in an array, via system signals. This data is treated as analog information.*

- Read/Write Array entries, conversely, can only be specified on-line, either by an operator entering values, or by the execution of ACCOL logic.

Modules Which Are Commonly Used With Arrays

Although many ACCOL modules use arrays, some are specifically designed for array access or array data manipulation.

- **Storage Module**

  This module allows data to be read from a data array and stored in a **signal list** or read from a signal list and stored in a data array.

- **Function Module**

  This module can use an array as a look-up table. The first row and first column of the array must each include values in ascending order. These values will be used as indices, to look up values from among the remaining array elements. Interpolation can be performed by the module if row and column indices are not exact.

- **Stepper Module**

  This module is used in applications which can be divided up into a specific set of steps, and where each step requires a certain set of signal outputs. Each row of the array represents required signal outputs for a step in the sequence.

- **Encode Module**

  Function 8 of the Encode Module allows array rows (or columns) to be shifted within the array, in a specified direction. This simplifies array manipulation in a variety of applications.

- **Calculator Module**

  Individual array elements (cells) can be read using Calculator equations. In addition, array elements in read/write arrays can be changed using Calculator equations. See the 'Calculator' section of the *ACCOL II Reference Manual* (document# D4044) for details.

All of these modules are discussed in detail in the *ACCOL II Reference Manual* (document# D4044).

Chapter 5 - What Are Data Arrays?

Typical Applications For Read Only Arrays

Because read only arrays cannot be changed, they are typically used to store reference information, which the ACCOL logic will refer to later.

Steam Table

One possible application for a read only analog array is to store a steam table. In the figure, shown below, a portion of a steam table is shown in an array format. The first column represents absolute pressure, and the top-most row represents a range of temperatures. The remaining array elements represent enthalpy in units of BTUs per pound of steam.

0	360	380	400	420	450
80	1211.0	1221.5	1231.5	1240.3	1255.7
85	1210.0	1220.5	1230.7	1239.7	1255.1
90	1209.0	1219.8	1230.0	1239.1	1254.5

A user could configure a Function Module to access the array. The Function Module uses the values in row 1 and column 1 to locate appropriate array cells. For example, if the Function module ROW terminal is 85, and the Function module COLUMN terminal is 400, the Function module OUTPUT terminal will have a value of 1230.7. If the ROW and COLUMN values fall between the values in the rows and columns, an interpolation will be performed. For example, if the ROW terminal is 85, and the column terminal is 390, a value halfway between the 380 COLUMN value of 1220.5 and the 400 COLUMN value of 1230.7 will be calculated, resulting in an OUTPUT value of 1225.6.

For details on how to configure the Function Module, see the *ACCOL II Reference Manual* (document# D4044).

Output Statuses For A Water Filter Backwash Sequence

One possible use of a logical read only array would be to hold the status values to be used for each step of a water filter backwash sequence in a water treatment plant.

For example, let's say that a simple water treatment plant has three valves and three pumps which are used as part of a backwash sequence. The details of the sequence are presented in the table on the next page. (Note: This sequence has been greatly simplified for purposes of explaining the Stepper Module; the details of an actual backwash sequence are longer and more complex.)

Chapter 5 - What Are Data Arrays?

Device:	Influent Valve	Influent Pump	Wash Pump	Drain Valve	Effluent Valve	Effluent Pump
Step 1	CLOSED	OFF	OFF	CLOSED	OPENED	ON
Step 2	CLOSED	OFF	OFF	CLOSED	CLOSED	OFF
Step 3	CLOSED	OFF	OFF	OPENED	CLOSED	OFF
Step 4	CLOSED	OFF	ON	OPENED	CLOSED	OFF
Step 5	CLOSED	OFF	OFF	CLOSED	CLOSED	OFF
Step 6	OPENED	ON	OFF	CLOSED	OPENED	ON

The details of this sequence can be stored in a logical array of ON/OFF status values. The ACCOL programmer creates an array, as shown below, where each column corresponds to a specific device (pump, valve, etc.,) and each row represents a specific step of the backwash sequence. The programmer enters in each element of the array a 1 for ON (open, start, etc.) or a 0 for OFF (close, stop, etc.).

0	0	0	0	1	1
0	0	0	0	0	0
0	0	0	1	0	0
0	0	1	1	0	0
0	0	0	0	0	0
1	1	0	0	1	1

The Stepper Module executes the rows in an order specified by the ACCOL programmer, for a specified duration. When a particular step (row) is activated, the proper status commands for that step are retrieved from the array, and output to logical signals in order to drive the action of the valves, pumps, etc.

For details on how to configure the Stepper Module, see the *ACCOL II Reference Manual* (document# D4044).

Chapter 5 - What Are Data Arrays?

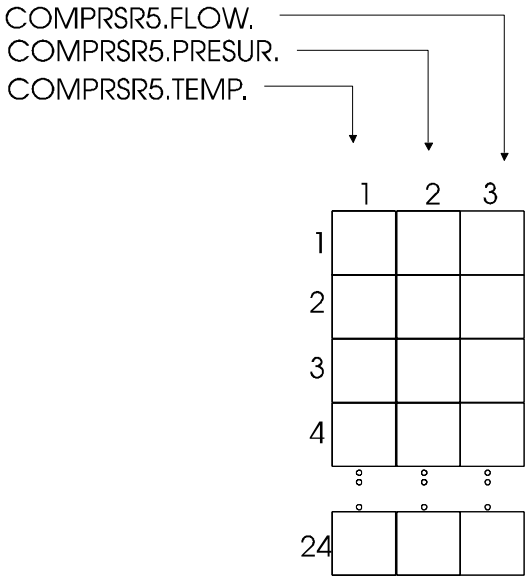
Typical Applications for Read/Write Arrays

Read/Write arrays are used for data which changes during execution, either via ACCOL logic, or via operator intervention.

Storing Hourly Totals or Averages

One common usage would be for storing hourly flow, temperature, and pressure totals for a natural gas pipeline compressor station.

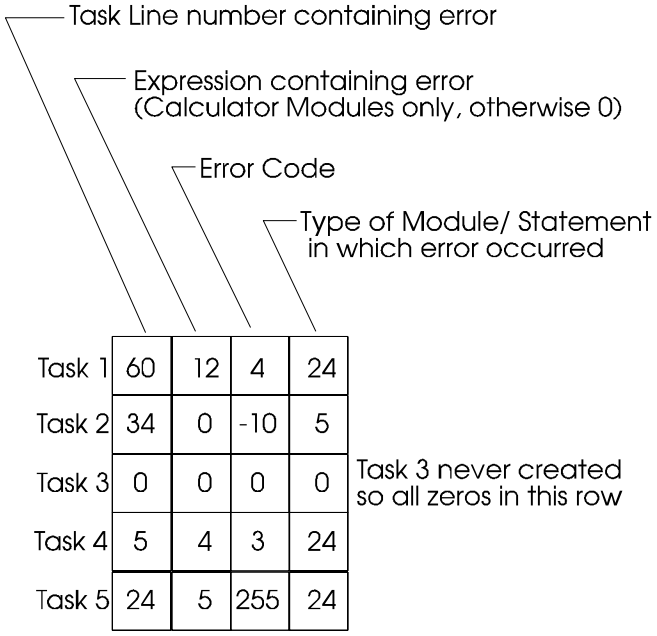
For this example application, the programmer has created three analog signals named COMPRSR5.PRESUR., COMPRSR5.TEMP., and COMPRSR5.FLOW. which contain the current pressure, temperature, and flow totals, respectively, for this compressor station.



Each of these signals is 'wired' to one of the INPUT terminals of the Storage Module. Every hour, the value of these signals will be copied, using the Storage Module, into the next available row of a 3 column by 24 row read/write analog array. For information on using the Storage Module, see the *ACCOL II Reference Manual* (document# D4044).

Detecting Task Execution Errors

Sometimes an ACCOL programmer configures structures which result in illegal operations. For example, entering a calculator equation which attempts to divide a value by zero. Such errors, are detected by the firmware. In order for the user to view the error code, however, an analog read/ write error array must be defined.



The number of the array must be specified using the #ERARRAY.. system signal. The array itself must have four columns, and as many rows as the highest numbered task in the system. Each row represents an ACCOL Task, the columns associated with that row

contain data about which type of module or equation in the task caused the error, and the error code. Note that if there are multiple errors, only the most recently detected error will be displayed for each task.

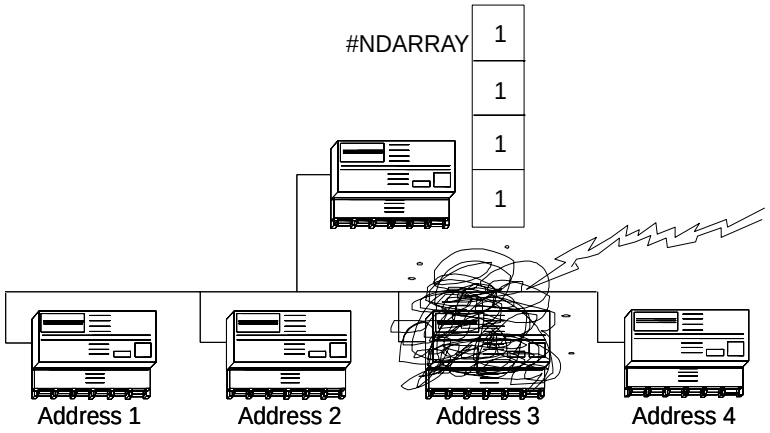
For a full description of how to configure the error array, as well as a description of what each error code means, see the #ERARRAY.. portion of the 'System Signals' section in the *ACCOL II Reference Manual* (document# D4044). ACCOL Workbench, when operating in on-line mode, can also display the meaning of the error code.

Node Array For Tuning On/Off Polling to Selected Network 3000 Nodes in a BSAP Network

One important use for a Read/Write Logical Array is to set up a node array for turning ON/OFF communication requests to slave nodes of this controller.

The number of the logical array to be used is specified by the system signal #NDARRAY..

The ACCOL programmer creates a number of rows equal to the highest slave address. For example, if the ACCOL program we are creating is for a controller which is master to 4 slave controllers, a four row by one column logical read/write array should be created.



Normally, the operator or ACCOL logic should leave each element set to ON, so that communication with slave nodes can occur. If, for whatever reason, one or more slave nodes are taken out of service (failure, maintenance, repairs, communication problems) then polling for them should be turned off using the #NDARRAY. This prevents unnecessary communication attempts by the master to a non-existent node.

In the figure, shown above, the third slave node has been struck by lightning and so has failed. The master controller (which contains the node array) will continue attempts to communicate with it, until, the third element in the #NDARRAY (corresponding to address 3) is changed from ON to OFF by the operator, as shown at right.

#NDARRAY	
	1
	1
	0
	1

For a full description of how to configure the node array, see the #NDARRAY portion of the 'System Signals' section in the *ACCOL II Reference Manual* (document# D4044).

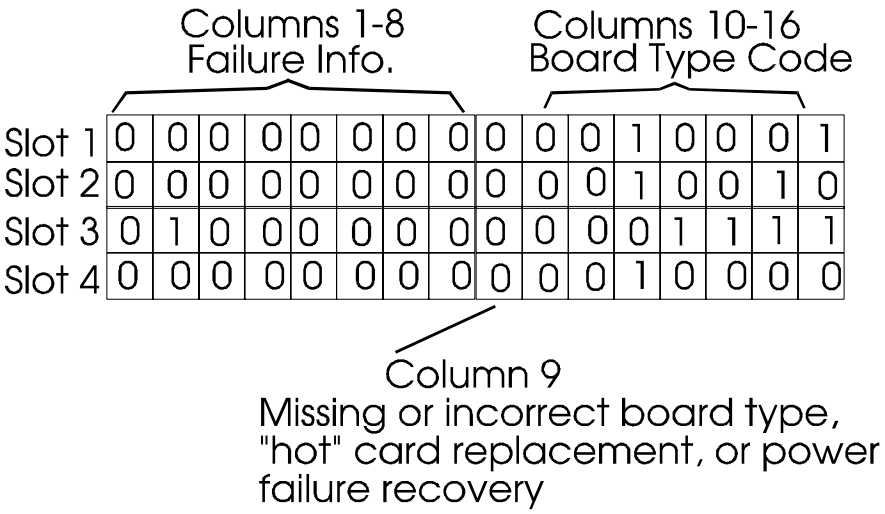
Detecting Process I/O Board Diagnostic Failures

If a failure is detected in one of a controller's process I/O boards, the resulting error code can be stored in a Read/Write Logical Array.

The array must be specified using the #DIAG.002 system signal, and must have as many rows as the number of process I/O board slots in the controller. The first eight columns display the error code, in binary with OFF and ON represented as 0 and 1, respectively. Additional columns display more information.

In the figure, below, the analog input board in slot 3 is experiencing an amplifier gain failure.

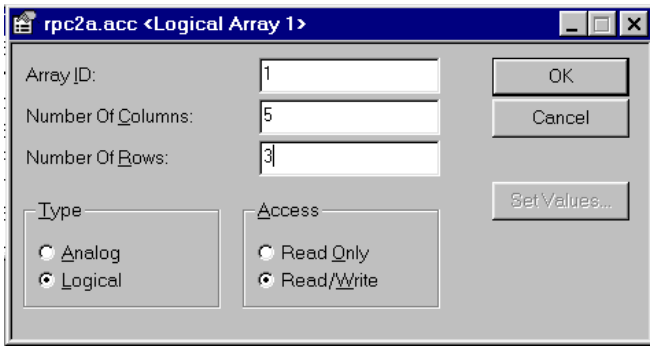
A full description of how to configure and interpret entries in this array is included in the #DIAG.002 portion of the 'System Signals' section of the *ACCOL II Reference Manual* (document# D4044).



Chapter 5 - What Are Data Arrays?

How Are Data Arrays Created?

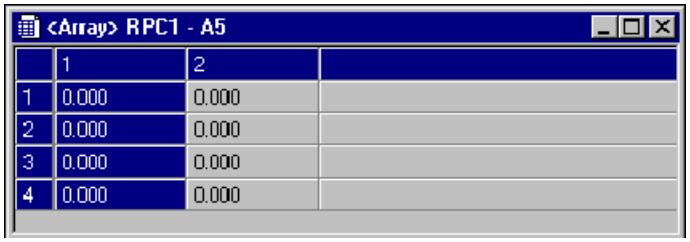
Data arrays are inserted into the ACCOL source file using ACCOL Workbench. For information on creating arrays, see the *ACCOL Workbench User Manual* (document# D4051).



How Does the Operator View Data Array Values?

There are several different ways to view data array values in a running Network 3000 series controller.

- While running the Open BSI DataView utility, users can call up the array for viewing on the screen. Individual entries can also be edited if this is a read/write array. See the *Open BSI Utilities Manual* (document# D5081) for details.



- Users with Bristol Babcock's Universal Operator Interface (UOI) software can configure text-based menus and logs to include data array values. See the *UOI Configuration Manual* (document# D5074) for details.

- While running the Open BSI Data Collector or Open BSI Scheduler, users can retrieve array data, and store it in files for export to third-party HMI applications. See the *Open BSI Collection/Export Utilities Manual* (document# D5083) and the *Open BSI Scheduler Manual* (document# D5082), respectively, for details.

Chapter 6 - What is Process I/O?

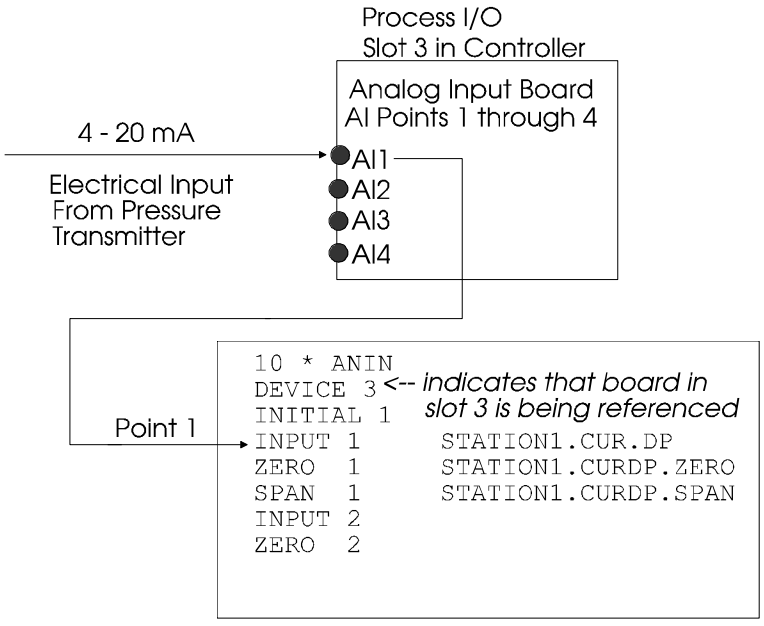
What is Process I/O?

Field instrumentation devices such as flowmeters, pressure transmitters, and electrical contacts collect data from a process (such as a pump control station, a compressor station, a factory assembly line, etc.). **Process I/O** boards are the way this data is transmitted to the Network 3000 controller. Among the most commonly used process I/O boards are Analog Input boards, Analog Output Boards, Digital Input Boards, and Digital Output Boards.

For most controller models, process I/O boards are installed in slots in the controller. Some controller models have a fixed set of process I/O boards in certain slots or multi-function boards which encompass more than one slot; others allow any valid board type in any slot. In addition, the number of slots in a controller varies from model to model. For example, the DPC 3330 supports 6 or 12 slots; the DPC 3335 supports 10 slots. For a full list of process I/O options, see the 'Process I/O' section of the *ACCOL II Reference Manual* (document# D4044), or the hardware manual accompanying the controller.

Data from the instrumentation is transmitted in the form of electrical impulses. These impulses are sent through wires to a termination block.[1] The termination blocks are wired to process I/O boards in the Network 3000 controller. The process I/O board converts the electrical impulses from the instrumentation into signal data which can be used by modules in the ACCOL load.

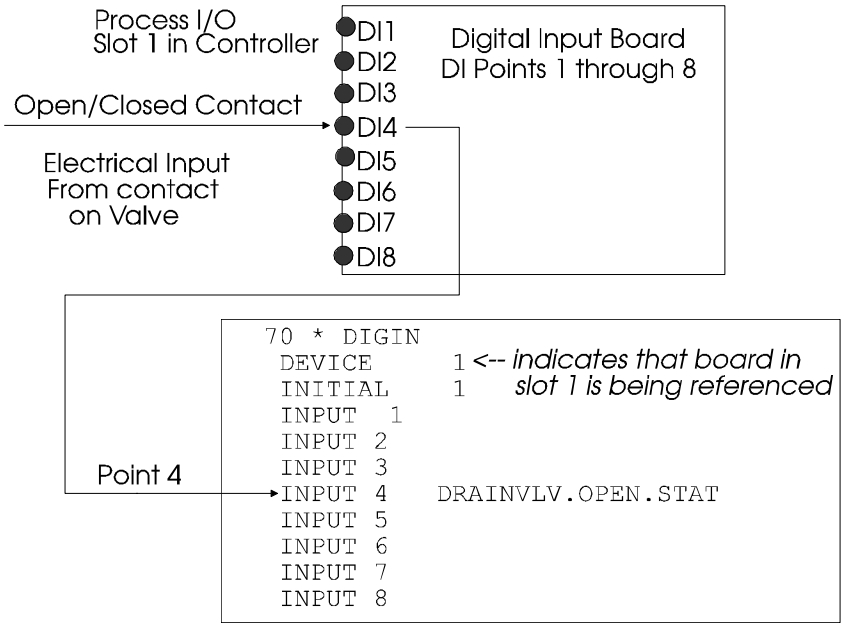
For example, if analog pressure data is transmitted to one of the I/O **points** on an Analog Input process I/O board, a 4 milliamp current flow to the board may represent the 0% of scale pressure, and a 20 milliamp current flow to the board may represent 100% of scale pressure. An ANIN (Analog Input) Module in the ACCOL load reads this I/O point and translates the data into an analog signal.



[1] *In this instance we are talking about actual hardware and wires; not software.*

Chapter 6 - What is Process I/O?

Similarly, if an electrical contact on a valve is used to indicate that the valve is open or closed, a closed contact (0 volts) may indicate a closed valve, and an open contact (24 volts) may indicate an open valve. These voltages are read by a Digital Input process I/O board. A DIGIN (Digital Input) Module in the ACCOL load reads the I/O point on the board, and converts it into an ON/OFF status of a logical signal.

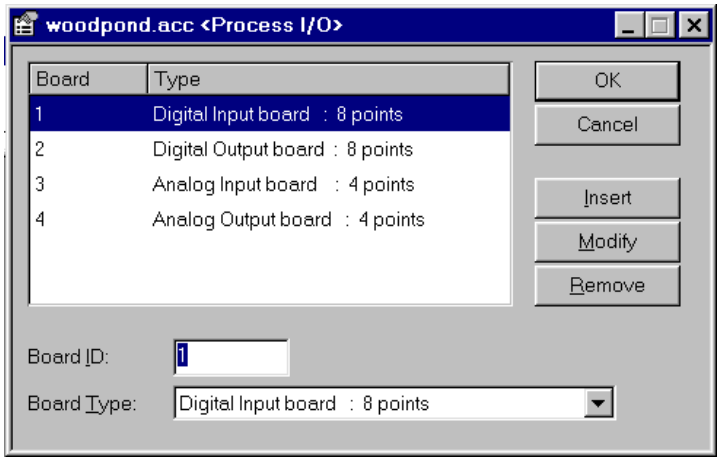


What Is Remote (Process) I/O?

Some controllers support the use of external racks of process I/O boards. These units, called RIO 3331 Remote I/O Racks, allow the process I/O boards to be in a physically separate location from the controller which uses them. Usage is similar to any other process I/O boards, except that communication is only available at synchronous baud rates, and the numbering scheme used to define the boards is somewhat different. For more information on this topic, see the sections in the *ACCOL II Reference Manual* (document# D4044) which discuss the Remote I/O Modules.

How Are Process I/O Boards Defined?

Before process I/O data can be obtained from the process I/O boards in the controller, the boards must be defined in the *PROCESS-I/O section of the ACCOL load. ACCOL Workbench allows this definition to be performed through the dialog box shown at right.



For details on how to use this dialog box, see the *ACCOL Workbench User Manual* (document# D4051).

Chapter 6 - What is Process I/O?

How Are Process I/O Boards Referenced?

Process I/O boards are referenced within the ACCOL Task via process I/O modules such as ANIN, ANOUT, DIGIN, DIGOUT, etc.

Each process I/O module includes a DEVICE terminal, which specifies the slot which this module will reference. If this value is left at the default of 0, this module will be unable to access the board, and a device error will be generated.

Each process I/O module also includes an INITIAL terminal, which specifies the number of the first I/O point on the board which this module will reference. Usually, this is 1. In most cases, a single module should be used to reference all I/O points on the entire board.

Once the I/O point data has been converted to signal data, by the Process I/O module(s), the resulting signal can be 'wired' (in software) to the terminal of other ACCOL modules.

How Are Communication Ports Used?

Although it is *possible* to use a Network 3000 controller as a stand-alone unit, controlling a process directly without operator intervention, most applications require communication with other devices.

For example, operators may need to interact with the process by viewing data or entering setpoints from an operator workstation. Data may also need to be logged on an attached printer. Depending upon the complexity of the process, data from one controller may need to be shared with other controllers (nodes) in the network. In some applications, a Network 3000 controller may need to communicate with a third-party device, for example a Modbus device. All of these methods of communication must utilize one or more of the controller's **communication port**s.

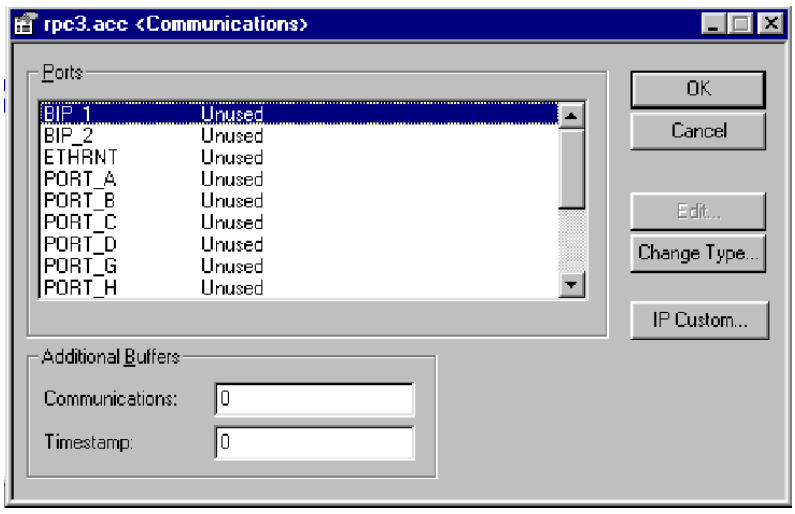
The number of ports available varies depending upon the model of the controller. The Communication Ports section of the *ACCOL II Reference Manual* (document# D4044) contains a description of each type of port, and each available configuration option.

NOTE: The discussion of communication ports in this chapter is limited to the BSAP (Bristol Synchronous / Asynchronous Protocol) ports (Master, Slave, etc.) The subject of using Internet Protocol (IP) ports is beyond the scope of this manual. See the Network 3000 Communications Configuration Guide (document# D5080) for more information.

How Are Communication Ports Defined?

Communication Ports are defined in the *COMMUNICATIONS section of the ACCOL source file. ACCOL Workbench provides a dialog box for editing this section, shown at right.

See the *ACCOL Workbench User Manual* (document# D4051) for information on configuring these ports.



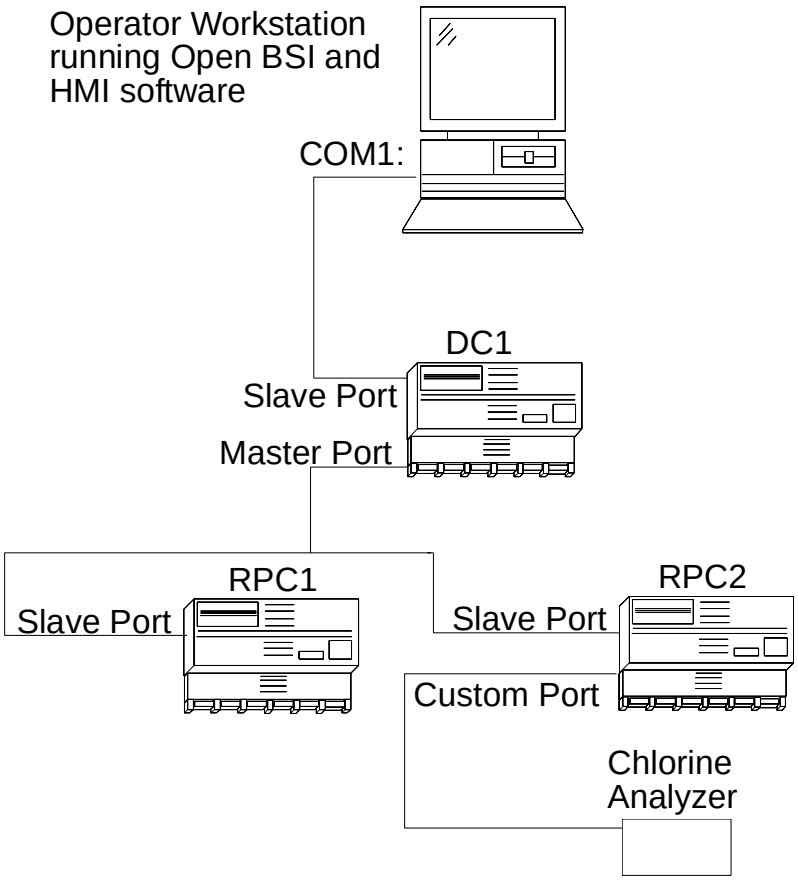
Chapter 7 - How Are Communication Ports Used?

Examples of Communication Port Usage

The fictitious Bristolville Water Treatment Plant has two Network 3000 controllers "RPC1" and "RPC2" to monitor various processes throughout the plant, and a third Network 3000 controller named "DC1" at the top of the network.

"RPC1" controls the levels of a water tank. "RPC2" operates some chlorination pumps. Both "RPC1" and "RPC2" will have a Slave Port configured for 19,200 baud operation. "RPC2" also has a Custom Port configured so that it can send and receive data from a chlorine analyzer unit which communicates using the Modbus protocol.

"DC1" serves as a **data concentrator** or communications interface at the top of the network. Any Network 3000 controller with a Master Port connected to one or more slave nodes can serve as a data concentrator. While a data concentrator is not usually required, it is useful in many systems to make decisions based on inputs from several slave nodes:



RPC1 and RPC2 can each control their own areas of operation; DC1 can monitor both to issue control commands to them. DC1 also acts as a communication pass-through device, and handles its own local I/O.

"DC1" will need a Master Port, to collect data from "RPC1" and "RPC2", and a Slave Port, to send that data to an operator workstation, running Open BSI, and an HMI software package. A node such as "DC1", which is on the level directly below the operator workstation, is called a **top-level node**. Open BSI supports multiple top-level nodes on a single PC port, or over multiple ports.

DC1 Port Config

```
*COMMUNICATIONS
      PORT_B  SLAVE  9600
      PORT_C  MASTER 19200  2 1
```

RPC1 Port Config

```
*COMMUNICATIONS
      PORT_A  SLAVE  19200
```

RPC2 Port Config

```
*COMMUNICATIONS
      PORT_A  SLAVE  19200
      PORT_C  CUSTOM 9600 PARITY_E  SBIT_1  BIT_8  PARAM:  8  1  1
```

The figure, above, shows the Communication Port definitions in each of the three Network 3000 controllers, DC1, RPC1, and RPC2.

In addition to configuring the ports, and any necessary structures in ACCOL, each node must be defined in the Network Definition (NETDEF) files and Open BSI communications must be configured on the PC. This subject is discussed in the *Open BSI Utilities Manual* (document# D5081).

Chapter 8 - What Should I Know About Memory?

What Should I Know About Memory?

Depending upon the application your controller will be used for; you might not need to know anything about memory, other than there is a finite amount of it in the controller, and the more structures you put in your ACCOL load, the more memory of this finite amount gets used.

If you are using more than the default memory configuration, or you are using certain ACCOL structures (Storage Modules, Audit Trail Alarms/Events, custom port applications) then you *do* need to know a little more about memory.

The next section describes a little about what memory is. If you are comfortable with the basic concepts of Network 3000 memory, you can skip to the section called *'What Configuration Needs To Be Performed?'*.

Background - What is Memory?

As a Network 3000-series controller runs its ACCOL load, the CPU (central processing unit) of the controller executes each instruction in the ACL file. These instructions, and the data associated with them, are read from, and/or written to, physical locations within computer chips in the controller. These physical locations are referred to as **memory**. They are similar to memory you might have in your personal computer at home.

The amount of memory in your Network 3000 controller varies depending upon the model of controller, and the purchased memory options. The amount of memory needed for your ACCOL load varies depending upon the types of modules, control statements, and structures included in the source file.

Information in memory is stored as a series of 0's and 1's; each '0' or '1' is referred to as a **bit**. These bits are grouped together into chunks of 8 which are called **bytes**.[1] Each byte can hold a character of data. A group of 1024 bytes is referred to as 1K. 1024K is referred to as a Megabyte or 1MB.

Types of Memory in the Controller

The size of your ACCOL load file is limited by the amount of **RAM**[2] in the controller.

RAM in a 186-based controller, or a 386EX Real Mode controller is divided into two parts: **base memory** and **expanded memory**. All of these controllers have 64K (65,536

[1] *Two bytes together are referred to as a **word**.*

[2] *RAM is an acronym for random access memory. It simply means memory that can be read from and written to.*

bytes) of **base memory**, and then some amount of **expanded memory**.[3] The expanded memory is used to hold certain kinds of ACCOL structures which CANNOT fit in the base memory.

RAM in a 386EX Protected Mode controller is NOT divided up into base and expanded; instead, it is treated as one large memory area. Each Protected Mode controller has at least 512K of RAM, but can be configured for as much as 4.5 MB.

Normally, when you **download** your ACCOL load file into the Network 3000 controller, it is transferred directly into RAM, and on completion of the download, the controller begins to execute the instructions (modules, control statements, etc.) in the ACCOL load.

Execution of the ACCOL load will continue, without interruption, unless the Network 3000 controller loses power, or fails (which is referred to as a **watchdog** condition), or it is manually reset by the operator, by activating the reset switch.

In the first case (power failure), the ACCOL load, and its data, will remain in RAM for as long as the unit's backup battery functions. If the battery remains good, when primary power is restored, the unit will resume execution of the ACCOL load from the point where it lost power. This is referred to as a **warm start**.

The second and third cases (watchdog failure, or manual reset) are referred to as **cold start** conditions. In a cold start, any accumulated data (calculations, etc.) is lost. In addition, the ACCOL load file, itself, will only be retained if it has been previously "burned into" **EPROM**, or downloaded into **FLASH**.

EPROM stands for Erasable Programmable Read Only Memory. An EPROM chip can be placed in a device called a PROM burner, and the ACCOL load file can be 'burned into' the chip. If your unit has an EPROM chip with the ACCOL load 'burned in', the ACCOL load file (though no accumulated data) will still be present in the controller after a cold start condition. With the exception of the RTU 3305, and the 3530-xx series, all 186-based controllers support the use of EPROMs.

Similarly, if your ACCOL load was originally downloaded into **FLASH** memory, prior to the cold start condition, accumulated data will be lost, but the load file will still be present after the cold start. The RTU 3305, 3530-xx series, as well as 386EX Real and Protected Mode units support the use of FLASH memory.

For more information on these subjects, consult the section on Downloading in the *ACCOL II Reference Manual* (document# D4044).

[3] *The amount of expanded memory available varies depending upon the type of controller.*

Chapter 8 - What Should I Know About Memory?

What Configuration Needs To Be Performed?

The *MEMORY section of the ACCOL source file may need to be modified, depending upon what kind of controller you are using, and which structures are included in your ACCOL load.

For 186 and 386EX Real Mode users, the amount of expanded memory installed in the controller must be specified.

For 386EX Protected Mode users, the total amount of RAM must be specified if it is different from the default of 512K.

If certain ACCOL structures are used, the ACCOL programmer must also explicitly allocate memory for them. It's not important at this point that you understand what all these structures are used for; just remember that if you do include them in your ACCOL load, they require some memory configuration. These structures are:

- Audit Trail/EAudit Module Alarm Event Buffers[4]
- Storage Rows (when using Historical function of the Storage Module)
- Templates (used by OpenEnterprise, and Enterprise Server users ONLY)[5]
- Custom Memory area (used by certain custom port applications)
- Global Storage area (used by certain user-specific applications)[6]

For 186-based units other than the RTU 3305 and EGM 3530 / RTU 3530 series, the user can optionally choose to specify that certain structures be placed in expanded memory, in order to free up space in the 64K base memory area[7], these structures are:

- Signals
- Read-Only data arrays
- Read/Write data arrays
- Signal Lists
- Calculator Module equations
- AGA8, AGA8Detail, AGA8Gross module calculations

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[4] *For 386EX Protected Mode users, alarms and events are specified separately; for other users they are combined together as events.*

[5] *Not all controller types are equipped to hold templates.*

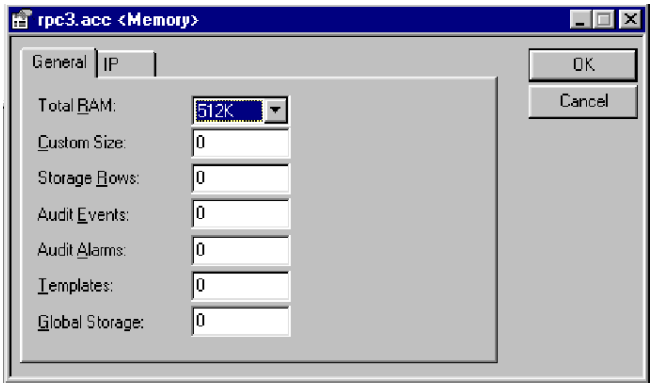
[6] *The Global Storage area is only available for 386EX Protected Mode units.*

[7] *For the RTU 3305, there is no choice between base and expanded for these structures; they are automatically stored in expanded memory. For the EGM 3530 or RTU 3530, any choice of 'BASE' you make in ACCOL Workbench is ignored; the system will automatically place most structures in the expanded memory area.*

Chapter 8 - What Should I Know About Memory?

How is the Configuration Performed?

Memory configuration is performed in ACCOL Workbench through the dialog box shown at right. (The fields in the dialog box vary depending upon which version of ACCOL Workbench you are using.)



For more information about this dialog box, see the *ACCOL Workbench User Manual* (document# D4051).

Chapter 9 - What Are Signal Lists?

What Are Signal Lists?

Signal Lists are a convenient way to organize a group of signals. Signals are referenced by their position in the list. Any mixture of analog, analog alarm, logical, logical alarm, or string signals, can be included in a given list. Signal lists are shared among all tasks in the ACCOL file. A typical signal list is shown below:

```
*LIST 1
 1  PUMP1.RUN.NOW
 2  PUMP1.SPEED.SP
 3  PUMP2.RUN.NOW
 4  PUMP2.SPEED.SP
```

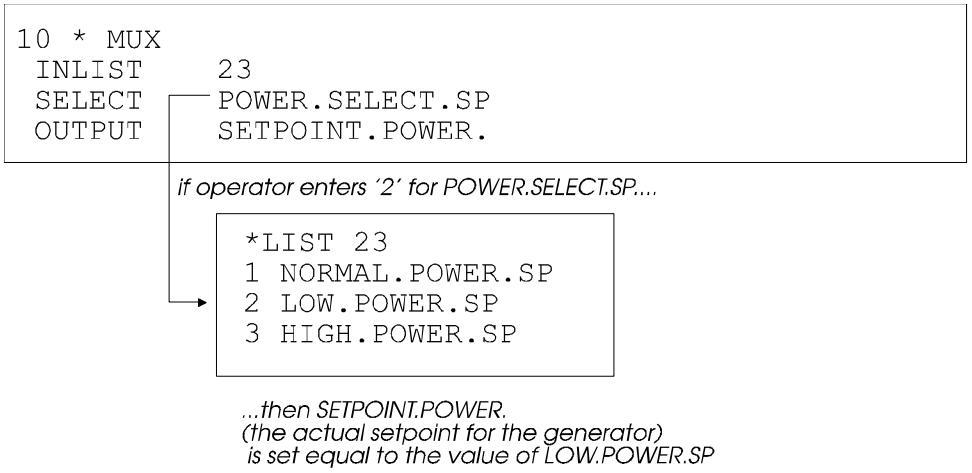
Signals lists are referenced by modules specifically designed to access them. AUDIT, EAUDIT, MASTER, EMASTER, SLAVE, MUX, EMUX, DEMUX, and EDEMUX are among the most common modules which use signal lists.

For information on the number of signal lists supported in ACCOL, and the maximum size of signal lists, see the *ACCOL II Reference Manual* (document# D4044).

Using a MUX module to select a signal from a signal list

Suppose a power generator has three different settings, one for normal power demand, one for low power demand, and a third for high power demand.

Each of these settings has a setpoint, stored using the following signals: NORMAL.POWER.SP, LOW.POWER.SP, and HIGH.POWER.SP. A signal list is created containing these three signals. The actual setpoint value is transmitted to the generator using an analog output signal named SETPOINT.POWER.



Chapter 9 - What Are Signal Lists?

In order to allow for an operator to select which of these setpoints should be used for the generator at a given time, the operator can select the desired setpoint, from the signal list, using a signal called POWER.SELECT.SP. This signal specifies the position in the signal list which be chosen as the setpoint.

The MUX module uses the POWER.SELECT.SP signal to choose which of the three setpoints should be output to the SETPOINT.POWER. signal.

For example, if the operator chooses '2' for the value of POWER.SELECT.SP, then the second signal in the list, called LOW.POWER.SP will be used as the setpoint.

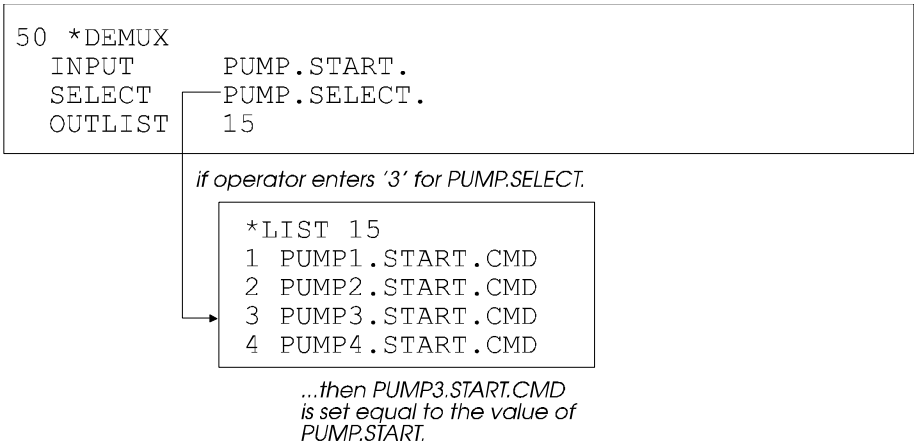
For more information on the MUX Module, see the *ACCOL II Reference Manual* (document# D4044).

Using A DEMUX Module to Choose Which Signal In A List Should Receive An Input Value

Suppose a water pumping station has four different pumps, only one of which should be running at any one time. Each pump can be started/stopped by a dedicated start command signal. The signals are PUMP1.START.CMD, PUMP2.START.CMD, PUMP3.START.CMD, PUMP4.START.CMD.

If all of these signals are placed in a signal list, the DEMUX module can be used to select which of the four pumps should be started.

The signal PUMP.START. is set to ON, and the signal PUMP.SELECT. allows the operator to choose which of the pump command signals will be turned on by PUMP.START. The value of PUMP.SELECT specifies the position in the list which will receive the value of PUMP.START.



For more information on the DEMUX Module, see the *ACCOL II Reference Manual* (document# D4044).

Chapter 9 - What Are Signal Lists?

Specifying An Event List For the Audit/EAudit Module

The Audit Trail or Extended Audit Trail (EAudit) Modules allow signal value changes for selected signals to be stored in a buffer. The buffer may then be read and output by a Logger Module, by the Open BSI DataView utility, or by UOI commands.

A list of signals for which value changes will be stored, called the event list, must be created. In the example, below, six signals are included in list number 12. This list serves as the event list for the Audit Module, and is referenced on that module's LIST terminal.

```
70 * AUDIT
   MODE     2
   LIST     12
   STATUS   AUDIT.STATUS.CODE
```

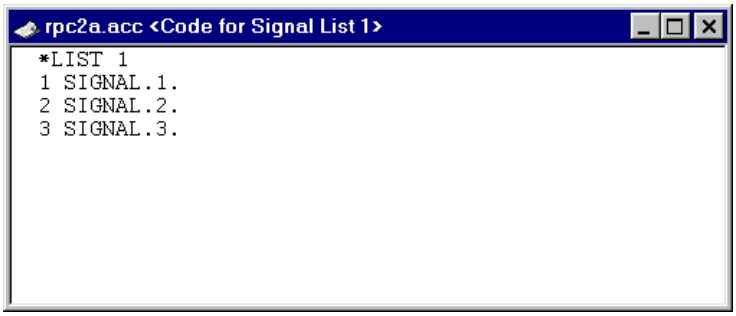
Signal value changes for the signals in List 12 will be logged in the Audit Trail buffer

```
*LIST 12
1 FLOW1.SETPT.
2 FLOW2.SETPT.
3 FLOW3.SETPT.
4 FLOW4.SETPT.
5 FLOW5.SETPT.
6 FLOW6.SETPT.
```

For full details on using the Audit/EAudit Modules see the *ACCOL II Reference Manual* (document# D4044).

How Are Signal Lists Created?

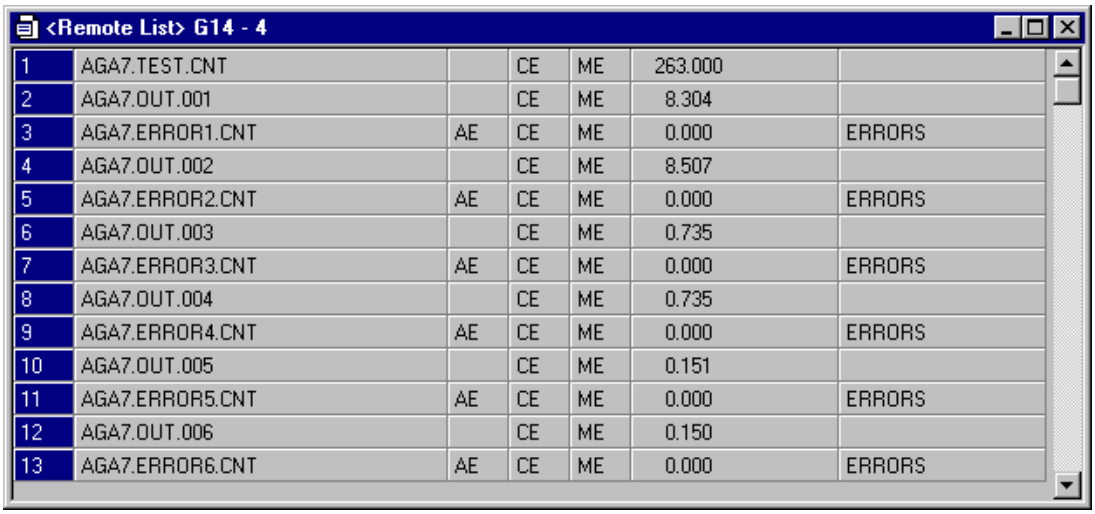
Signal Lists are created within ACCOL Workbench. For information on creating a signal list, see the *ACCOL Workbench User Manual* (document# D4051).



Chapter 9 - What Are Signal Lists?

How Can The Operator View Signal Lists?

The operator can view signal lists using the Remote List feature of DataView. The operator can also change signal values or inhibit/enable bits. For information on this feature, see the *Open BSI Utilities Manual* (document# D5081).



1	AGA7.TEST.CNT		CE	ME	263.000	
2	AGA7.OUT.001		CE	ME	8.304	
3	AGA7.ERROR1.CNT	AE	CE	ME	0.000	ERRORS
4	AGA7.OUT.002		CE	ME	8.507	
5	AGA7.ERROR2.CNT	AE	CE	ME	0.000	ERRORS
6	AGA7.OUT.003		CE	ME	0.735	
7	AGA7.ERROR3.CNT	AE	CE	ME	0.000	ERRORS
8	AGA7.OUT.004		CE	ME	0.735	
9	AGA7.ERROR4.CNT	AE	CE	ME	0.000	ERRORS
10	AGA7.OUT.005		CE	ME	0.151	
11	AGA7.ERROR5.CNT	AE	CE	ME	0.000	ERRORS
12	AGA7.OUT.006		CE	ME	0.150	
13	AGA7.ERROR6.CNT	AE	CE	ME	0.000	ERRORS

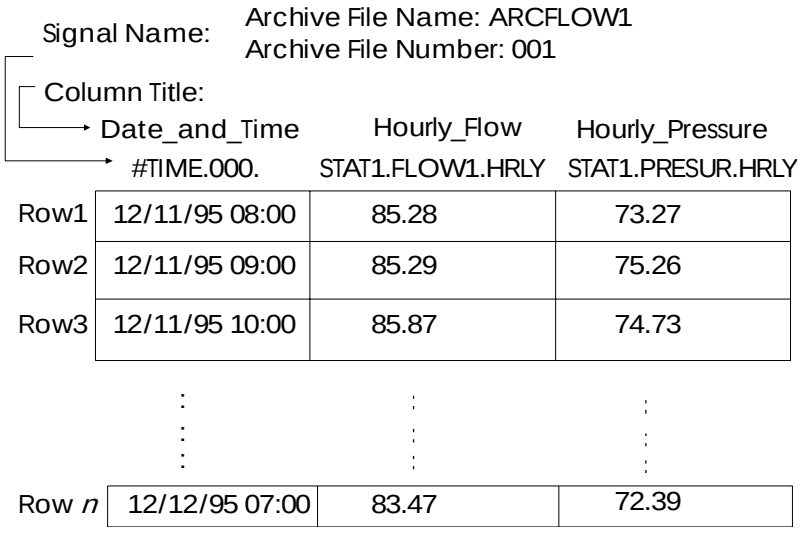
Chapter 10 - What Are Archive Files?

What Are Archive Files?

Archive files are structures residing within the Network 3000 controller, and are very similar to Data Arrays (discussed earlier in this manual).[1]

Like arrays, archive files are tables of data, organized in rows and columns. Unlike arrays, however, each column is associated with a specific ACCOL signal, and has a descriptive title; and each row is called a **record**. Also, each and every archive file must be assigned a unique name and number.

Typically, the archive files are configured so that data wraps around, overwriting the oldest data, with newer data. The ordering of data in the Archive File is determined by **sequence numbers**.



How Is Data Stored In An Archive File?

Data is stored in the archive file by executing the ARC_STORE Module in one of several available modes. Some modes allow calculations to be performed on data before it is stored in the archive file. Not all modes are available for all Network 3000 controllers. Full details on configuring the ARC_STORE Module, and the available modes, appear in the *ACCOL II Reference Manual* (document# D4044).

A typical application would be to execute the ARC_STORE Module hourly, to store hourly totals, and then re-initialize the hourly total signals to 0 in order to accumulate new data for the next hour. NOTE: Once a data record has been stored in the Archive

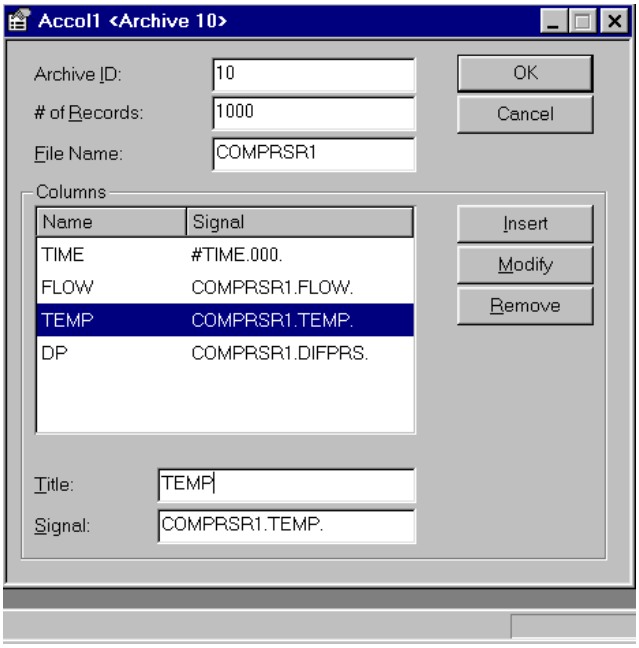
[1] *Not all controller, ACCOL Tools, or firmware versions support the use of archive files. To see if it is supported, check the 'Hardware and Software Requirements' chart of the ACCOL II Reference Manual (document# D4044) and verify that the ARC_STORE module is supported for your particular configuration.*

Chapter 10 - What Are Archive Files?

File, and the ARC_STORE Module has advanced to the next row of the file, the data in the Archive File cannot be altered.

How Are Archive Files Defined?

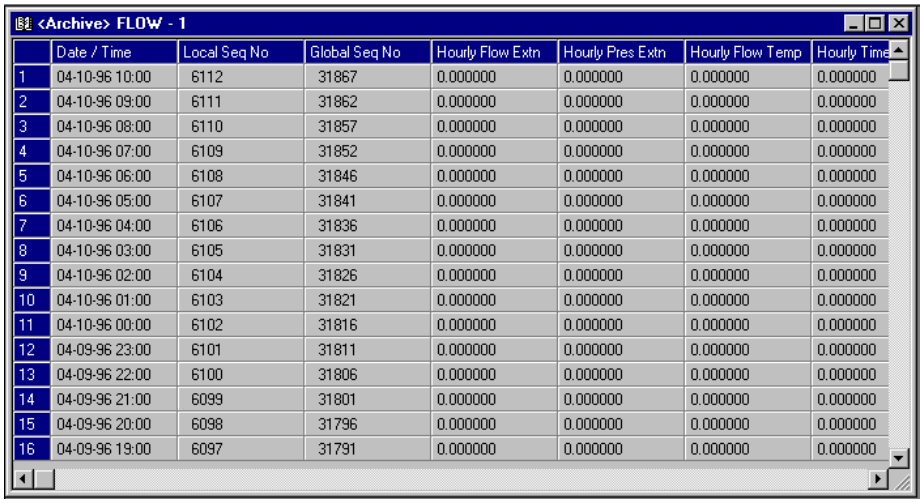
The structure of the archive file, including its name, file ID number, the number of records (rows), the signal for each column, and the title for each column, are defined in the ACCOL source file. See the *ACCOL Workbench User Manual* (D4051) for instructions on defining an archive file.



How Does the Operator View Archive Data?

There are several different ways to access archive data in a running Network 3000 series controller.

- While running the Open BSI DataView utility, users can call up the archive file for viewing on the screen. See the *Open BSI Utilities Manual* (document #D5081) for details.



	Date / Time	Local Seq No	Global Seq No	Hourly Flow Extn	Hourly Pres Extn	Hourly Flow Temp	Hourly Time
1	04-10-96 10:00	6112	31867	0.000000	0.000000	0.000000	0.000000
2	04-10-96 09:00	6111	31862	0.000000	0.000000	0.000000	0.000000
3	04-10-96 08:00	6110	31857	0.000000	0.000000	0.000000	0.000000
4	04-10-96 07:00	6109	31852	0.000000	0.000000	0.000000	0.000000
5	04-10-96 06:00	6108	31846	0.000000	0.000000	0.000000	0.000000
6	04-10-96 05:00	6107	31841	0.000000	0.000000	0.000000	0.000000
7	04-10-96 04:00	6106	31836	0.000000	0.000000	0.000000	0.000000
8	04-10-96 03:00	6105	31831	0.000000	0.000000	0.000000	0.000000
9	04-10-96 02:00	6104	31826	0.000000	0.000000	0.000000	0.000000
10	04-10-96 01:00	6103	31821	0.000000	0.000000	0.000000	0.000000
11	04-10-96 00:00	6102	31816	0.000000	0.000000	0.000000	0.000000
12	04-09-96 23:00	6101	31811	0.000000	0.000000	0.000000	0.000000
13	04-09-96 22:00	6100	31806	0.000000	0.000000	0.000000	0.000000
14	04-09-96 21:00	6099	31801	0.000000	0.000000	0.000000	0.000000
15	04-09-96 20:00	6098	31796	0.000000	0.000000	0.000000	0.000000
16	04-09-96 19:00	6097	31791	0.000000	0.000000	0.000000	0.000000

Chapter 10 - What Are Archive Files?

- Users with Bristol Babcock's Universal Operator Interface (UOI) software can export archive data values to binary files and then use the binary files to create logs. See the *UOI Configuration Manual* (document# D5074) for details.

- While running the Open BSI Data Collector or Open BSI Scheduler, users can retrieve archive data, and store it in files for export to third-party HMI applications. See the *Open BSI Collection/Export Utilities Manual* (document# D5083) and the *Open BSI Scheduler Manual* (document# D5082), respectively, for details.

Appendix A
Creating A Sample ACCOL Load

NOTE

This appendix includes a step-by-step example for creating a sample ACCOL load.

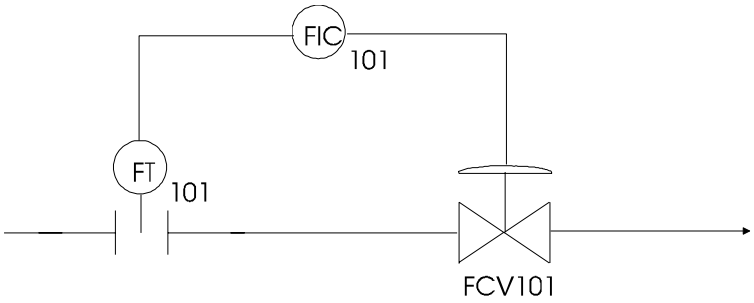
It assumes that you have already installed ACCOL Workbench software, and Open BSI Utilities software, according to the instructions in the *ACCOL Workbench User Manual* (document# D4051) and the *Open BSI Utilities Manual* (document# D5081).

Note, also, that this example shows one possible way to approach a problem. ACCOL is a flexible language which frequently allows many different solutions to a given problem.

The fictitious Sunken Valley Water Company wants to set up a PID (proportional, integral, derivative) loop for controlling the flow of liquid through a pipeline.

They have a flow control valve to vary the flow, and a flowmeter to measure it.

Both the valve and flowmeter are connected to a DPC 3330 controller.



Before trying to create an ACCOL load which will perform the PID control, we need to make a list of each thing the ACCOL load will be doing.

1) Bring in the flow data from the pipeline.

   The flow in the pipeline is measured by the flowmeter FT101. Because this is data that varies over a range of values, it should be stored in an analog signal. In order to bring in analog signal data, we will need an ANIN Module.

2) Slow down reaction to flow changes so as to reduce wear and tear on the valve.

   We want to ensure that we don't wear out the control valve trying to respond too quickly to changes in flow. To do this, we need to delay response to the input flow data (from item 1) using a LEAD/LAG Module.

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3) Perform the actual PID calculation.

To perform the actual PID control, we can use the pre-defined PID3TERM Module.

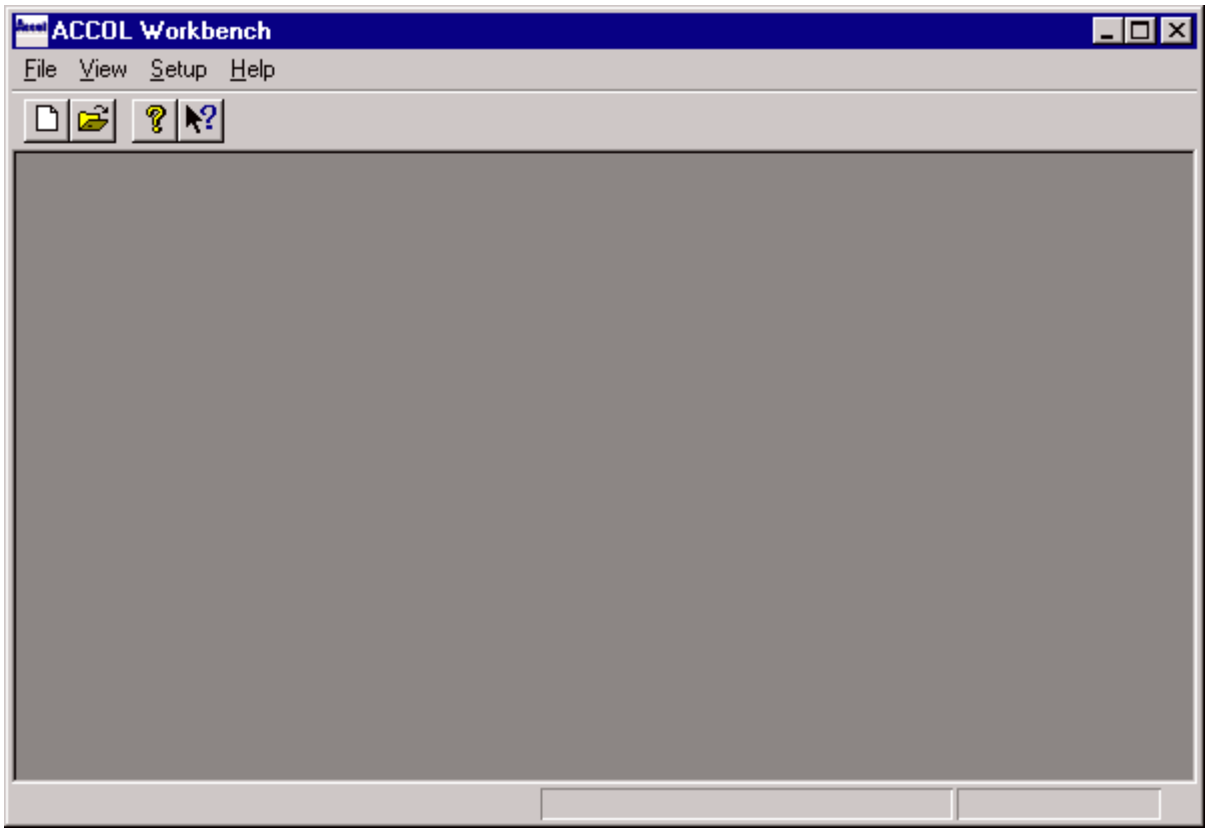
4) Send data to the control valve.

The controller will have to send data out to the flow control valve (FIC101/FCV101), in order to vary the position of the valve to regulate the flow. This will require an analog signal, and since it will be sent out, we will need an ANOUT Module.

Now that we know, roughly, what we're trying to do, let's create an ACCOL load to do it:

Step 1. Start ACCOL Workbench. To do this, double-click on the Workbench icon (if you have one) or start it through the Windows™ Start Programs menu.

ACCOL Workbench will start:



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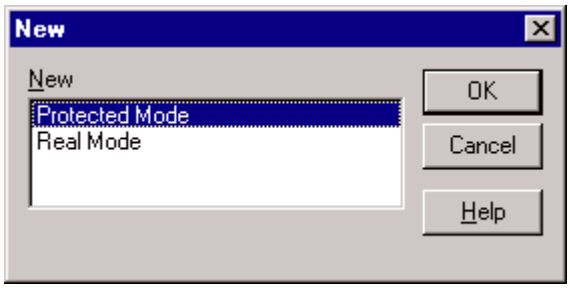
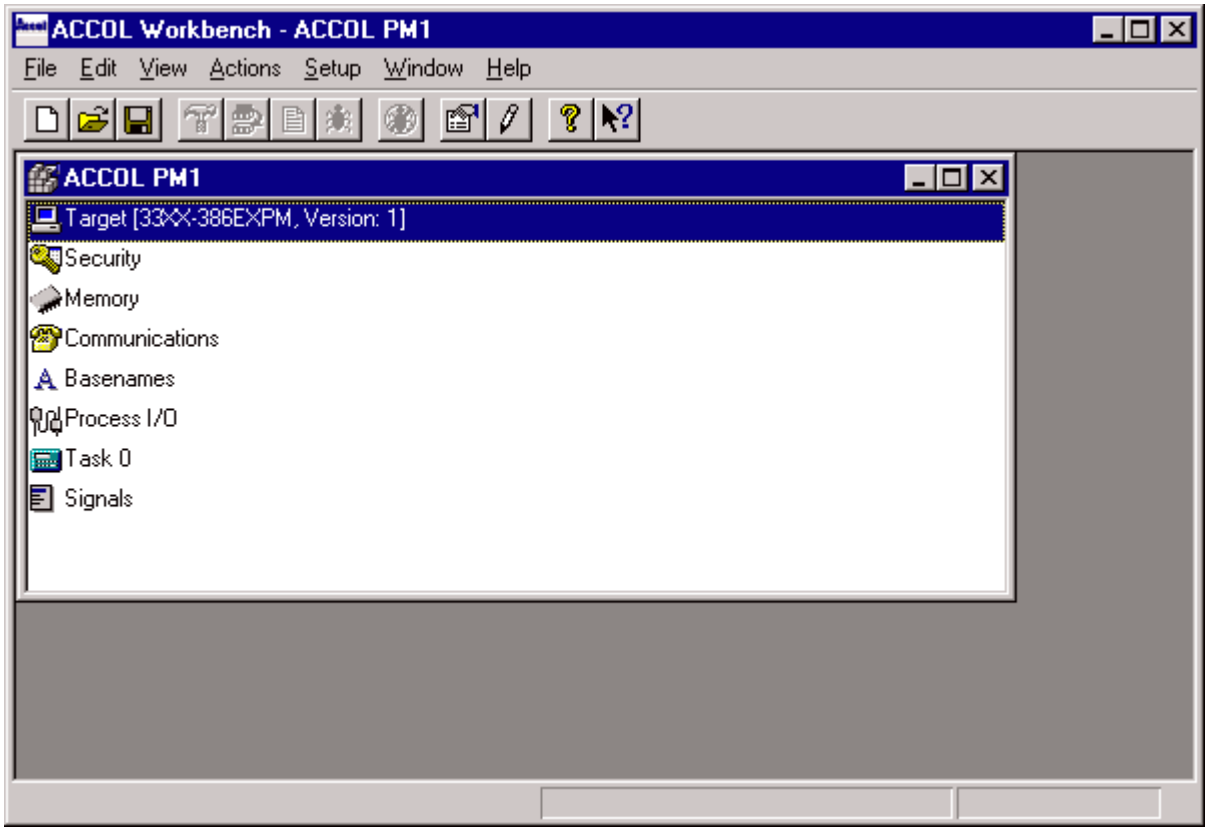
Step 2. Open a new ACCOL source file. To do this, click on **"File"** in the menu bar, and **"New"** in the pull down menu. Choose 'Protected Mode' you are creating an ACCOL load for a controller which has the 386EX Protected Mode CPU. For any other type of controller, choose 'Real Mode'.



Click on **[OK]** when you've made your choice.



We have now opened a new ACCOL source file. A default name is displayed in the title bar. We'll rename it later on.

Before we do anything else, we need to define certain characteristics of the controller such as its memory configuration, how its ports are to be used, and which process I/O boards are installed in it. These subjects are discussed in the next few steps.

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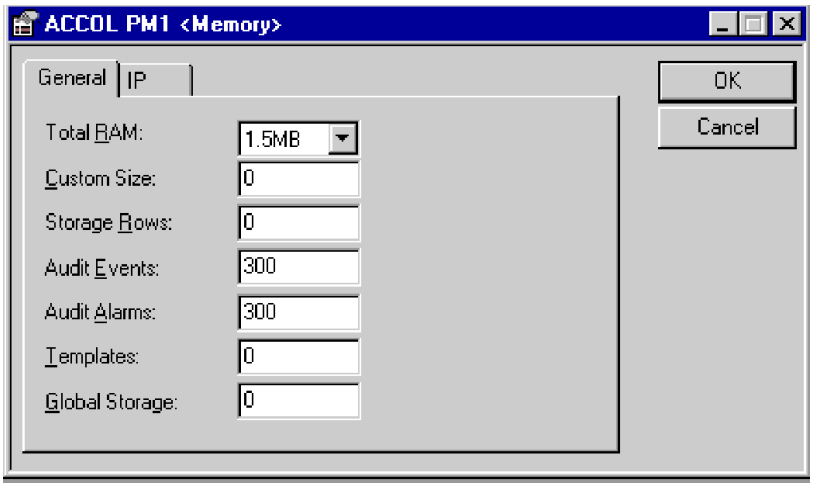
Creating A Sample ACCOL Load

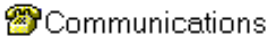
Step 3. Edit the memory configuration. To do this double-click on the Memory icon, and follow the instructions below.

The *MEMORY section of the ACCOL source file specifies how much memory is installed in the controller, and also can be used to set aside memory for certain special structures.

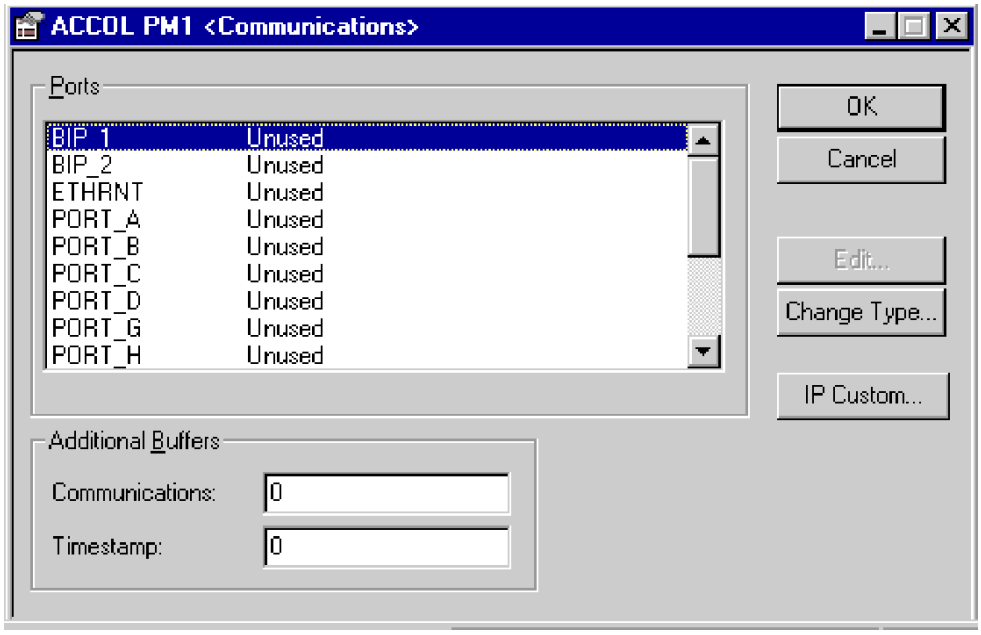
Click on the **"Total RAM"** list box, and select the appropriate amount of RAM installed in your unit. Next click on the **[OK]** push button to exit the *MEMORY section.



Step 4. Configure the Communication Ports. To do this, double-click on the Communications icon, and follow the instructions below.



The *COMMUNICATIONS section of the ACCOL source file specifies how the controller's communication ports will be used.



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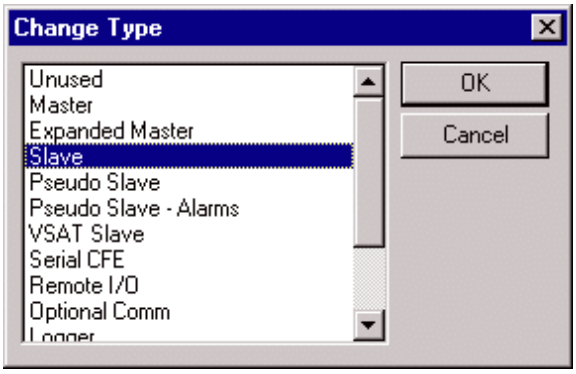
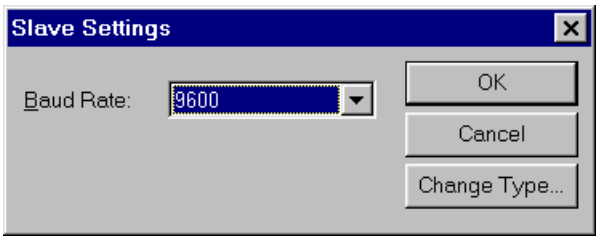
We will want to define one port for communication with the operator workstation running Open BSI Utilities software. This should be configured as a Slave Port, which will allow us to download into the unit. To configure Port B as a Slave Port, click on 'PORT_B Unused' in the list box, then click on the **[Change Type]** push button. The Change Type dialog box will appear. Select 'Slave' from the list box, and click on the **[OK]** push button.



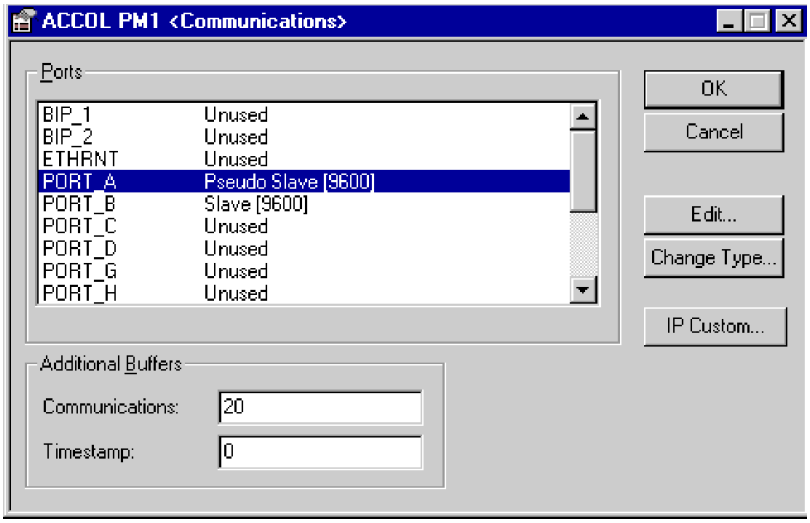
The Slave Settings dialog box will appear. Use the default baud rate of 9600, or change it using the **"Baud Rate"** list box; then click on the **[OK]** push button.



Another port, called a Pseudo Slave Port, will be used for local communication if a technician wants to connect a laptop running Open BSI. Click on 'PORT_A Unused', and define a Pseudo Slave Port at 9600 baud using the same method used, above, for defining a Slave Port.

Finally, it's a good idea to set aside some extra communication buffers.[1] Type '20' in the **"Communications"** field under **"Additional Buffers"**.

When finished, the window should appear as shown at right; click on the **[OK]** push button to exit the *COMMUNICATIONS section.



[1] *Buffers are discussed in detail in the ACCOL II Reference Manual (document# D4044).*

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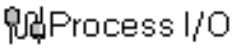
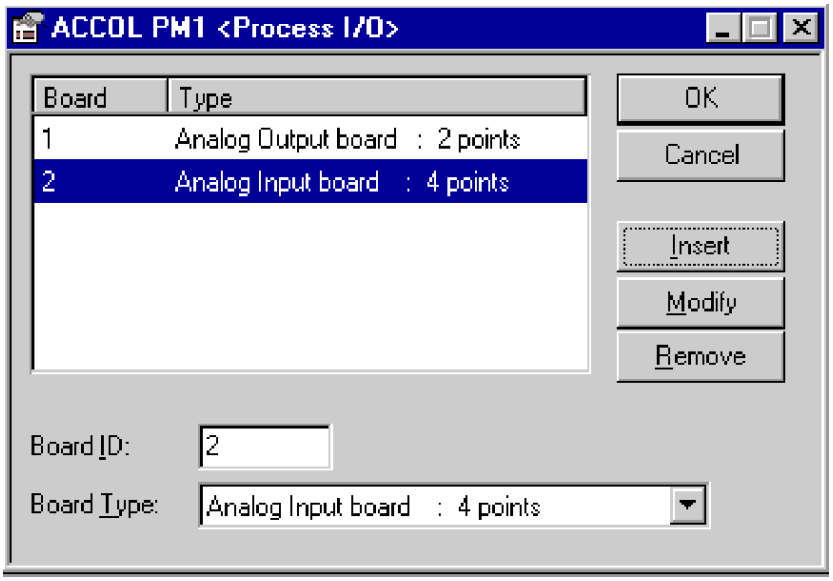
Creating A Sample ACCOL Load

Step 5. Configure the Process I/O. To do this, double-click on the Process-I/O icon, and follow the directions below.



The *PROCESS-I/O section of the ACCOL source file specifies what type of process I/O boards are installed in the controller. For purposes of our example, our controller must have an Analog Input board and an Analog Output board installed.



Let's say the Analog output board has 2 I/O points, and is in slot 1, and the Analog Input board has 4 I/O points, and is in Slot 2. A '1' already appears in the **"Board ID"** field. Choose 'Analog Output board : 2 points' from the **"Board Type"** list box, then click on the **[Insert]** push button. Next, enter '2' in the **"Board ID"** field, and select 'Analog Input board : 4 points' from the **"Board Type"** field, and click on the **[Insert]** push button. When finished, the dialog box should look as shown, above. Click on the **[OK]** push button to exit the *PROCESS-I/O section.

Step 6. Define signals.

Now that we've defined the characteristics of the controller, let's get to work on the problem at hand - - controlling the flow in the pipe.

To start off, let's create some signals. We know that we need an analog signal for the incoming flow data. To create this signal, double-click on the Signals icon.

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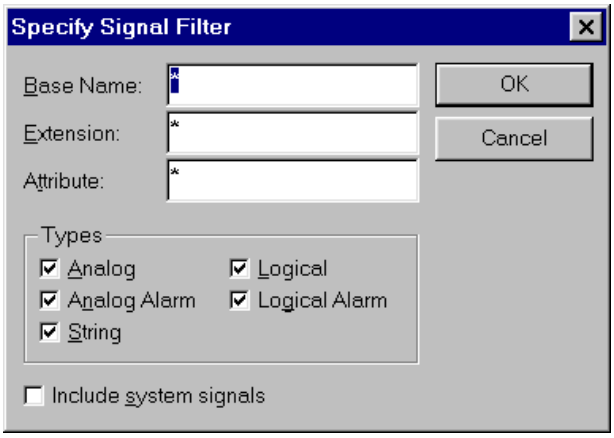
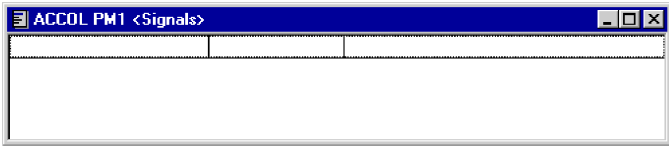
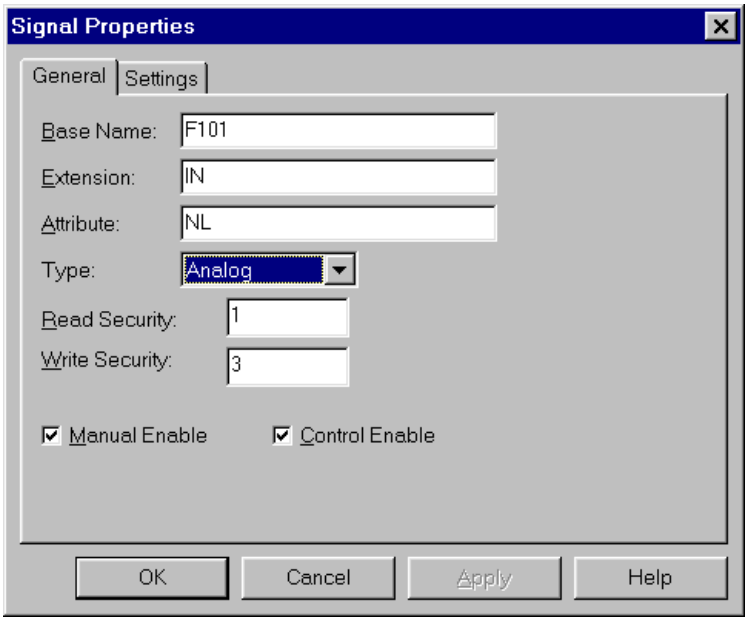
The Specify Signal Filter dialog box will appear. This dialog box lets you limit which types of signals are displayed in the Signal window.



Just click on the **[OK]** push button. An empty signals window will appear.



Click on **"Edit"** in the menu bar, and **"Insert"** in the pull down menu, and the Signal Properties dialog box will appear. Choose 'Analog' from the **"Type"** list box, and type 'F101' in the **"Base Name"** field, 'IN' in the **"Extension"** field, and 'NL' in the **"Attribute"** field.



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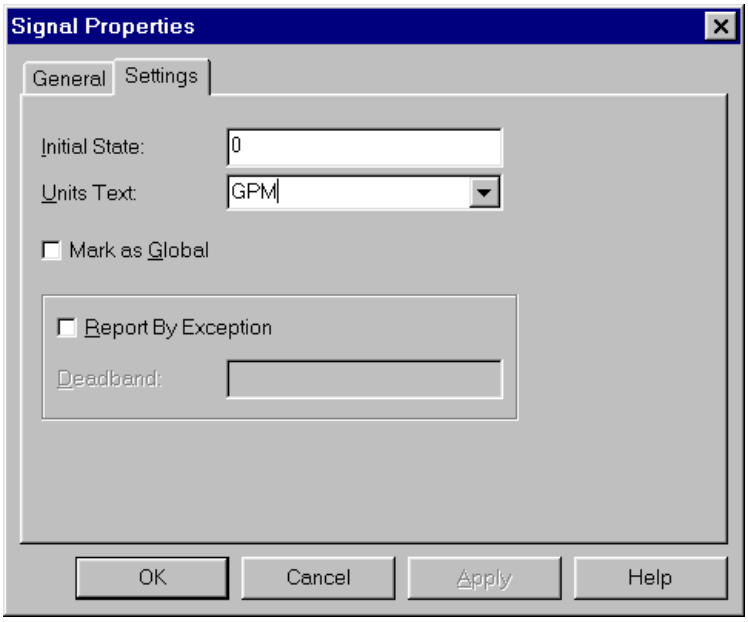
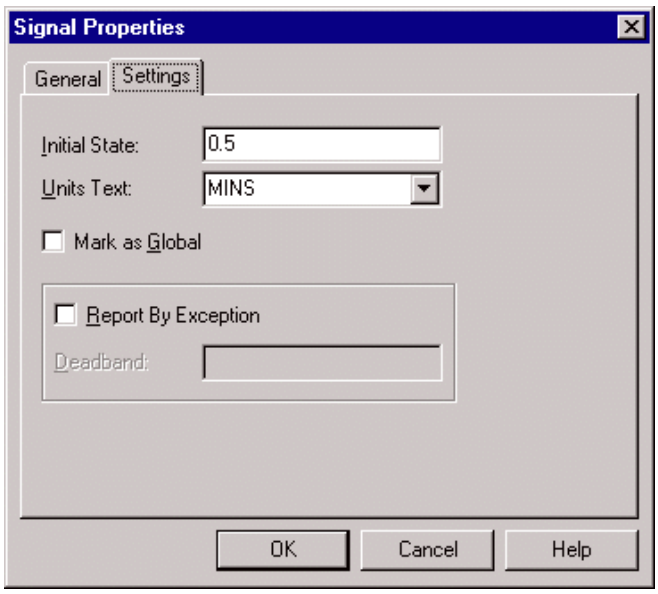
Next, click on the 'Settings' tab, and enter 'GPM' (for Gallons Per Minute) in the **"Units Text"**. Click on the **[OK]** push button, and the signal (F101.IN.NL) is created.



We also need an output signal which will be used to send data to the flow control valve. This signal will also be analog. To create it we can repeat the process we just used for the input signal, except use a name of F101.OUT. for the *new* signal, and assign units text of 'PERCNT' since the output signal will be a percentage at which the valve should be opened.

There are a few other signals we should create now. The LEAD/LAG Module which we will be using to delay response to input changes requires a signal to specify how long the delay should take. Create an analog signal called F101.LAG. for this purpose. This signal is a little different, because we are going to specify an initial value for it on the 'Settings' page. Enter '0.5' for the **"Initial State"** when you create the signal, and select 'MINS' for minutes as the **"Units Text"**.



We also need to create an analog signal which shows the range (called the span) of the input. Create one called F101.SPAN. and specify an **"Initial State"** of '250' and a

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"Units Text" of 'GPM', just like the input signal F101.IN.NL.

We need to create an analog signal which represents the desired operator setpoint for flow in the pipe. Create one called F101.SET. and specify an **"Initial State"** of '125' and a **"Units Text"** of 'GPM', just like the input signal F101.IN.NL.

We also need to create a few signals which will be used by the PID3TERM Module. Both are analog, and both require initial values of '1'. They should be named F101.P. and F101.I.

GENERAL NOTE ABOUT DEFINING SIGNALS:

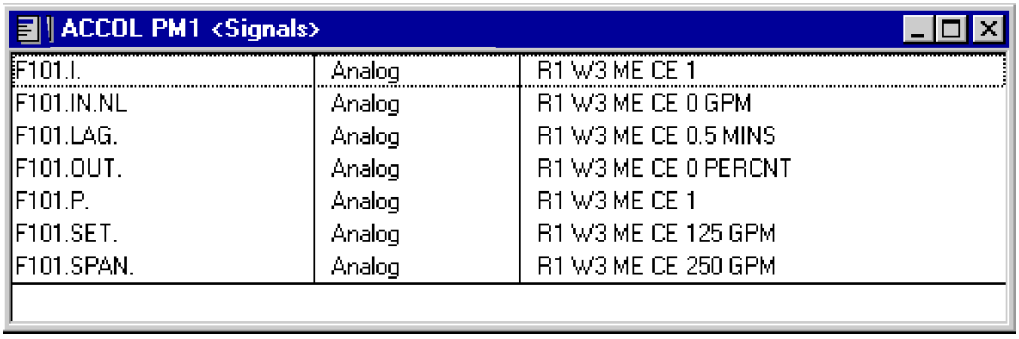
The user has the option of explicitly defining signals in the *SIGNALS section (as we are doing here) or of simply entering them on module terminals (which will be discussed in a later step.)

Defining them explicitly allows the user to have full control over the signal type, initial value, etc., and allows them to be 'dragged and dropped' to desired module terminals.

In contrast, if signals are defined simply by typing on the module terminal, they assume whatever signal type is the default for that terminal. The default signal type, however, may or may not be appropriate for the particular user application.

Either or both methods may be used.

After inserting all of these signals, the Signals window should appear as shown below:



We will need to do more with signals later, so *leave the Signals window on the screen*, but click on the main window (the one containing all the icons for Memory, Communications, etc.) and let's go on to our next step - - building an ACCOL task.

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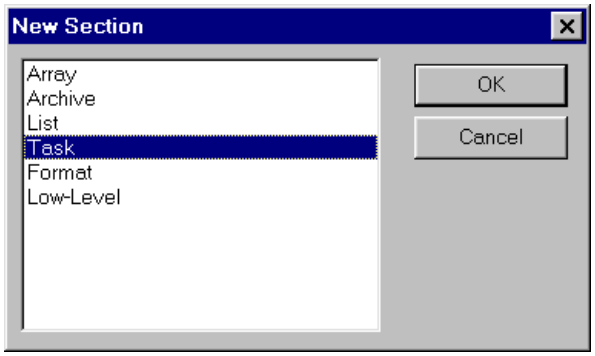
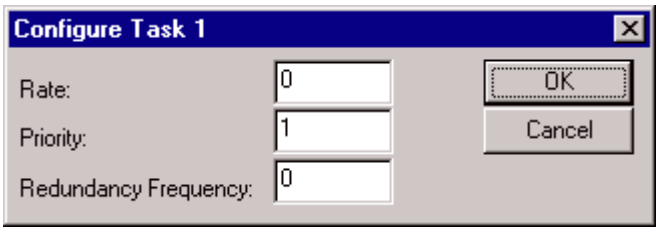
Step 7. Create an ACCOL Task, and include Modules in it.

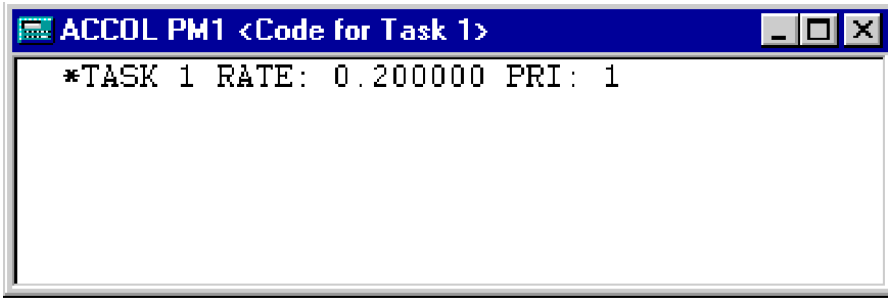
To create a Task, click on **"Edit"** in the menu bar, and **"Insert"** in the pull down menu. Click on 'Task' in the New Section dialog box, and click on the **[OK]** push button.



A dialog box similar to the one shown below should appear.

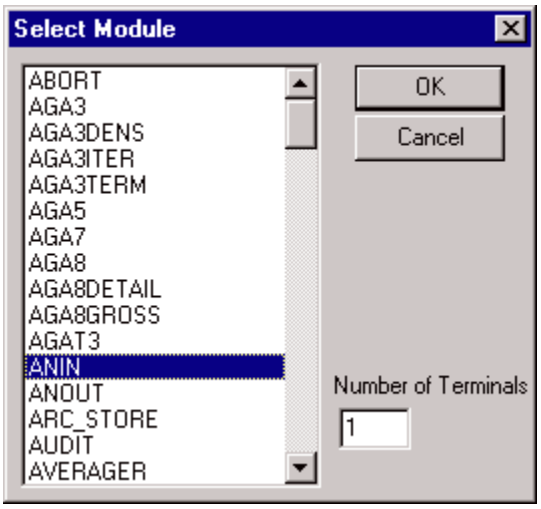


This dialog box allows you to configure certain characteristics of the task. By default, the task shows a task rate of 0, a task priority of 1, and a redundancy frequency of 0. This is not a redundant controller, so the redundancy frequency should be 0. Also, since we're only defining one task, we don't care that its priority is 1. We *do* need to change the task rate to something other than 0, or else the task will never execute. To do this, change the '0.0' to '0.2' in the dialog box, and click on **[OK]**. The first line of the task will now be displayed, as shown below:



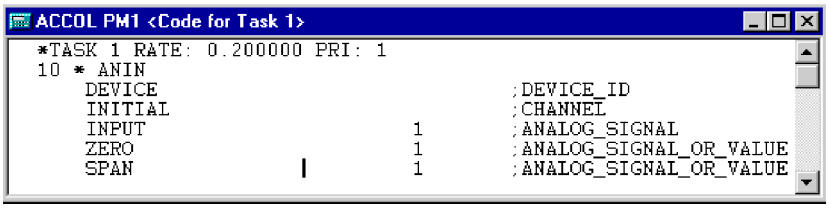
Appendix A
Creating A Sample ACCOL Load

Now, let's start inserting modules in our task. From our previous discussion, we know we need to get the data in using an ANIN module. Let's specify that first. To do so, click on the second line of the task (so as not to interfere with the information on the first line), and click on **"Modules"** in the menu bar, and **"Insert.."** in the pull down menu. The Select Module dialog box will appear. Click on 'ANIN' in the list box, then click on the **[OK]** push button.



NOTE: Before selecting certain I/O modules (ANIN, DIGIN, etc.) you need to specify the number of I/O terminals in the "**Number of Terminals**" field. For this example, however, we only need one analog input, which is the default, so we can just leave the default of '1' in the "**Number of Terminals**" field.

The ANIN Module appears in the task window. The DEVICE line specifies which slot the ANIN Module should reference.



Because our Analog Input Board is in Slot 2, we must erase the word 'DEVICE_ID' and specify a '2' in its place.

Next, erase the word 'CHANNEL' and enter '1' (this specifies that we are starting with the first I/O point on the board.

The module contains a single set of INPUT, ZERO, and SPAN terminals. If we were using additional analog input points on the board, we would have specified that number in the "**Number of Terminals**" field when we inserted the module. (If you forget to do that, you can just copy additional sets or simply type them in). Since, for this example, we have only one analog input value, we just have to define that.

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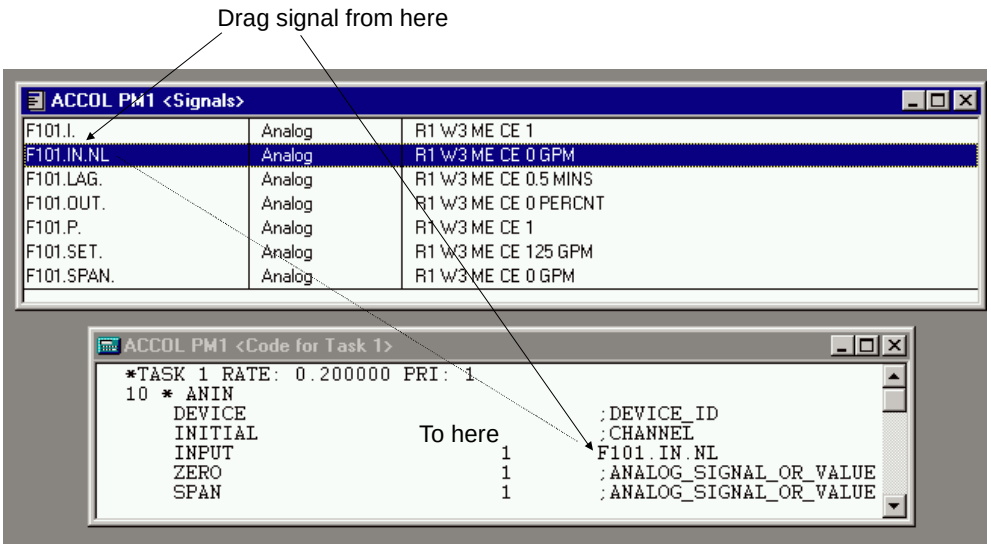
With the Signals window visible, click and drag the signal named 'F101.IN.NL' to the INPUT terminal of the module. (You could also just erase ';ANALOG_SIGNAL' and just type 'F101.IN.NL', but dragging the name will save you a few keystrokes.)

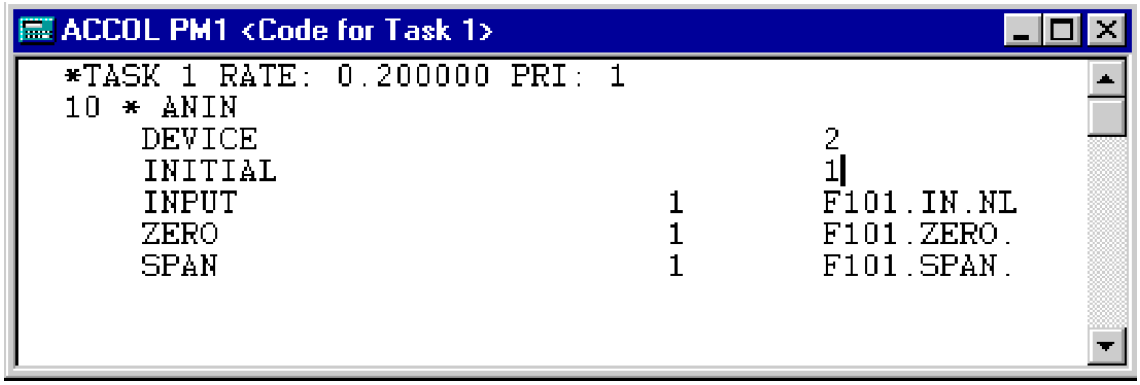


Next drag F101.SPAN. to the SPAN terminal, in the same way. (Or type it.)

Type F101.ZERO. on the ZERO terminal. (We didn't define it previously, so we can't drag it from the Signals window. Because the default initial value of all analog signals is 0, it wasn't necessary to define it separately.)

Together, the signals on the ZERO and SPAN terminals are used to specify the range of valid values for the INPUT signal. ZERO represents the lowest value, and SPAN is added to that value to determine the highest value. For this signal (F101.IN.NL), its range is 0 to 250 GPM. Note that we could have simply entered constant values for ZERO and SPAN, but then they could not be changed on-line.

When finished, the ANIN module should appear as shown:



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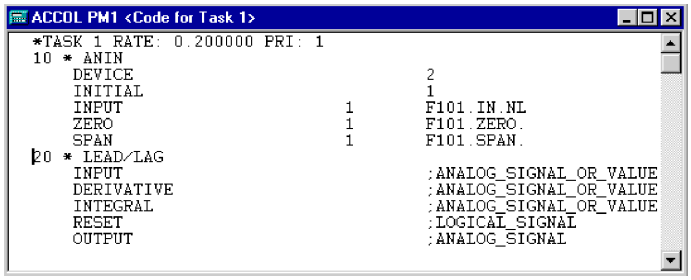
Next, let's insert the LEAD/LAG Module, which will be used to delay the rate at which input fluctuations are responded to. Place the cursor on the line immediately following the end of the ANIN module, and use the same technique used for inserting the ANIN module, except insert a LEAD/LAG module.

It should appear as shown in the window at right.



Drag F101.IN.NL from the Signals window to the INPUT terminal of the LEAD/LAG Module (or just type it). In doing this, we have 'wired' the ANIN and LEAD/LAG modules *together!*

Next, drag the signal named F101.LAG. to the INTEGRAL terminal. The F101.LAG. signal will allow the operator to specify a 'lag time', in minutes, so that changes in the module input F101.IN.NL will be reacted to gradually, so as to reduce wear on the control valve.

Type 'F101.IN.' on the OUTPUT terminal. This signal will be used to reflect a gradual change of the input (based on the lag time.) For example, if F101.IN.NL quickly changes from 1 to 5, and F101.LAG. is three minutes, then the value of F101.IN. will gradually 'ramp up' from 1 to 5 over a three minute period. We didn't need to explicitly create F101.IN. in the Signals window, earlier, because it will automatically be classified as an analog signal based on the context in which it is used; and it has no initial value.

Leave the DERIVATIVE and RESET terminals alone.

When you're finished, the LEAD/LAG Module should appear as shown.

```
20 * LEAD/LAG
    INPUT                    F101.IN.NL
    DERIVATIVE               ;ANALOG_SIGNAL_OR_VALUE
    INTEGRAL                 F101.LAG.
    RESET                    ;LOGICAL_SIGNAL
    OUTPUT                   F101.IN.
```

Appendix A
Creating A Sample ACCOL Load

Now insert a PID3TERM Module after the LEAD/LAG Module. The INPUT to the module is the F101.IN. signal from the LEAD/LAG Module, so type that name on the INPUT terminal on PID3TERM.

Drag the signal F101.I. from the Signals window to the INTEGRAL terminal of the PID3TERM module (or just type the name).

Drag the signal F101.P. from the Signals window to the PROPORTION terminal of the PID3TERM module (or just type the name).

Drag the signal F101.SET from the Signals window to the SETPOINT terminal of the PID3TERM module (or just type the name).

Type F101.D. on the DERIVATIVE terminal of the PID3TERM module. (We didn't create it earlier, so we can't drag it in.) This signal may be used by the operator to determine how much the change of the input should affect the output of the module.

Type F101.OUT. on the OUTPUT terminal. Again, this is analog, based on its usage. It is the actual output that will be sent to the control valve.

Type F101.RESET. on the RESET terminal, and F101.TRACK. on the TRACK terminal. F101.RESET. is an analog signal, based on its usage, and F101.TRACK. is a logical signal, based on its usage. These signals are used by the module to prevent the OUTPUT terminal from going out of range.

The ERROR and DEADBAND terminals can be left alone. The finished PID3TERM Module should appear as shown at right.

```
30 * PID3TERM
     INPUT                          F101.IN.
     SETPOINT                       F101.SET.
     DEADBAND                       ;ANALOG_SIGNAL_OR_VALUE
     PROPORTION                     F101.P.
     INTEGRAL                       F101.I.
     DERIVATIVE                     F101.D.
     RESET                          F101.RESET.
     TRACK                          F101.TRACK.
     OUTPUT                         F101.OUT.
     ERROR                          ;ANALOG_SIGNAL
```

Finally, we need to insert an ANOUT Module, in order to send the analog output data, out to the control valve. Follow the same method, used previously, for inserting modules.

Type a '1' on both the DEVICE and INITIAL terminals of the ANOUT Module. This causes the module to reference the first process I/O slot in the controller, which we identified in Step 5, as an Analog Output board, and the first output point on that board.

Type the signal name F101.TRACK. on the TRACK terminal, F101.RESET. on the RESET terminal, and F101.OUT. on the OUTPUT terminal.

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Creating A Sample ACCOL Load

Type in a value of '0' on the ZERO terminal. This represents the 0% output for the flow control valve.

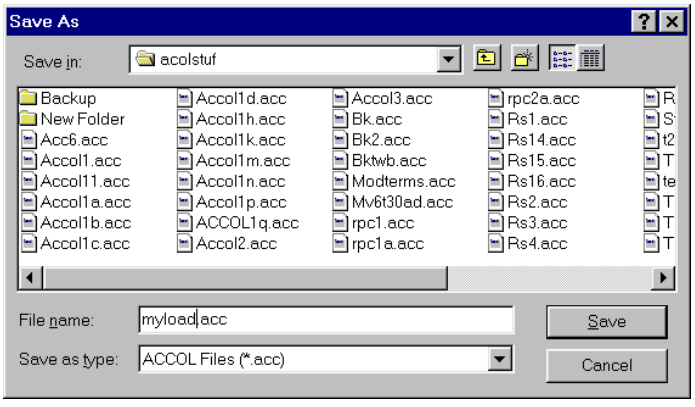
Type in a value of '100' on the SPAN terminal. This represents the 100% output for the flow control valve.

The completed ACCOL task should appear as follows:

```
*TASK 1 RATE: 0.200000 PRI: 1
10 * ANIN
       DEVICE                              2
       INITIAL                             1
       INPUT                    1          F101.IN.NL
       ZERO                     1          F101.ZERO.
       SPAN                     1          F101.SPAN.
20 * LEAD/LAG
       INPUT                               F101.IN.NL
       DERIVATIVE                          ;ANALOG_SIGNAL_OR_VALUE
       INTEGRAL                            F101.LAG.
       RESET                               ;LOGICAL_SIGNAL
       OUTPUT                              F101.IN.
30 * PID3TERM
       INPUT                               F101.IN.
       SETPOINT                            F101.SET.
       DEADBAND                            ;ANALOG_SIGNAL_OR_VALUE
       PROPORTION                          F101.P.
       INTEGRAL                            F101.I.
       DERIVATIVE                          F101.D.
       RESET                               F101.RESET.
       TRACK                               F101.TRACK.
       OUTPUT                              F101.OUT.
       ERROR                               ;ANALOG_SIGNAL
40 * ANOUT
       DEVICE                              1
       INITIAL                             1
       OUTPUT                   1          F101.OUT.
       ZERO                     1          0
       SPAN                     1          100
       TRACK                    1          F101.TRACK.
       RESET                    1          F101.RESET.
```

Step 8.

Save the ACCOL source file. Click on **"File"** in the menu bar, and **"Save As"** in the pull down menu. Enter a file name in the **"File Name"** field (in this case we used the name 'myload') and click on the **[OK]** push button. Your edits will be saved in a file with the extension (.ACC).



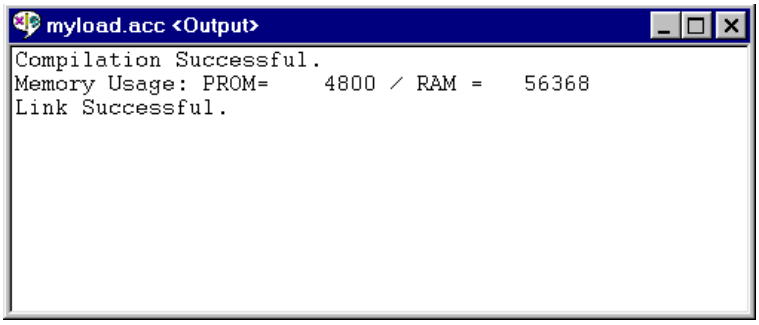
Step 9. Issue a 'Build' command, if errors are present, correct them and repeat step

Appendix A
Creating A Sample ACCOL Load

9.

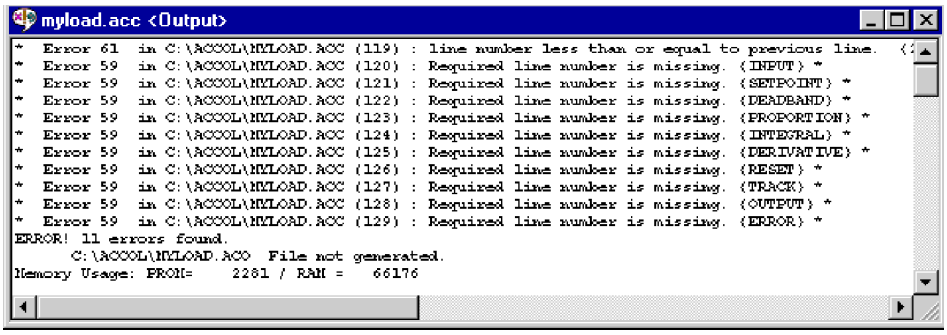
Now that you've completed your ACCOL source file, you can translate it into an ACCOL load file, which can be downloaded into your controller. To do this, click on **"Actions"** in the menu bar, and **"Build"** in the pull down menu. The load file generation will commence, and its progress will be displayed on the screen.

If a window appears with the messages 'Compilation Successful' and 'Link Successful', you're done. An ACCOL Load file has been generated.



If, instead, error messages appear, you must correct them.

In some cases, you can simply double-click on the error, and the window will display the location in the file which caused the error. You can edit the file right in the window, then save the changes, and re-issue the build command.



For more information on correcting errors, see the *ACCOL Workbench User Manual* (document# D4051).

When all errors have been corrected, and a successful build has been completed, you will have an ACCOL Load file.

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Creating A Sample ACCOL Load

IMPORTANT
Even though you now have a downloadable ACCOL load file, You must ALWAYS keep a copy of your current ACCOL source file (.ACC). The ACC file will be necessary should you ever want to change data in the running ACCOL load. It is strongly recommended that you keep a backup copy of your ACC file on diskette.

Step 10. Download the ACCOL load file into the controller.

If Open BSI Utilities is running, the Downloader utility can be activated from within ACCOL Workbench, and the load file can be downloaded into the controller. For instructions on downloading, see the *Open BSI Utilities Manual* (document# D5081) and the *ACCOL II Reference Manual* (document# D4044).

WARNING
Before attempting to perform a download, make sure that the controller is 'isolated' from the running process, either by disconnecting I/O, using manual backup systems, etc. An untested ACCOL load should never be downloaded if the controller is already controlling a process. Failure to follow these precautions could result in injury to personnel or damage to process equipment.

Appendix B
Working with Floating Point Numbers

All digital computers represent numbers as a series of 0's and 1's. Each '0' or '1' is referred to as a 'bit'. ACCOL analog (floating point) signals in Bristol Babcock's Network 3000-series controllers use 32 such bits, and these bits are organized according to the single-precision IEEE floating point standard.

This industry standard provides compatibility and the necessary degree of accuracy for most applications.

When single-precision floating point numbers are added, however, the smaller number will lose precision if the difference between the exponent of the most significant digit of the larger number of the expression, and the exponent of the least significant digit in the smaller number of the expression, is greater than 7. Here are some examples to clarify this rule:

Say a metering station is recording accumulated flow totals in an analog signal. The current total number of gallons is 623.71. A new reading of 12.274 gallons is to be added to the total.

The most significant digit in the larger number is the 6 in 623.71. Shown in exponential notation it is $6 * 10^{2}$. Similarly the least significant digit in the smaller number is the 4 in 12.274 or $4 * 10^{-3}$. The difference between the exponents is 5, i.e. 2 - (-3) = 5. Since this is not greater than 7, there is no loss of precision, and the result is 635.984.

As a second example, say we have a station accumulating the amount of natural gas flowing in a pipeline. The accumulated total for the month is 8,384,983.0 cubic feet. An additional 25.443 cubic feet must be added to the total.

The most significant digit in the larger number is the leftmost 8 in 8,384,983.0. Shown in exponential notation it is $8 * 10^{6}$. The least significant digit in the smaller number is the 3 in 25.443 or $3 * 10^{-3}$. The difference between the exponents is 9, i.e. 6 - (-3) = 9. Since this is greater than 7, the smaller number will lose some precision, and will be added as 25.375, causing the result to be 8,385,008.375.

The loss of the smaller number's least significant digits is unavoidable under the IEEE single precision floating point standard. When the smaller number is scaled, bits 'drop off the end' of the scaled result.

If the magnitude of the larger number exceeds that of the smaller number by 16,777,216 then the smaller number *will be zero* after scaling, and it will not add to the accumulation at all. So adding 1.0 to 16,777,216 will fail, as will adding 2 to 33,554,432, or 0.25 to 4,194,304.

This problem is inherent in any computer using this format to represent numbers, from

Appendix B
Working with Floating Point Numbers

your hand-held calculator, to a large mainframe system.

For most applications, however, this is not a major concern, since many instruments cannot support such precise measurements, and many industrial applications frequently do not require such precision.

Work-Arounds For This Situation

Don't Accumulate Totals Indefinitely

One way to prevent this kind of situation is to limit the size of accumulations.

If, for example, you are performing accumulations which can get large, and add small increments to it, say, an equipment runtime measurement using the Command Module's RUNTIME terminal, you might want to 'zero out' the runtime every month, after saving the monthly total in a signal which can be used later as part of a yearly runtime accumulation.

Use Double-Precision Modules, Where Necessary

Another way to lessen the impact of these problems is to use modules which support double-precision calculations. Double-precision calculations allow many more bits for representing numbers, internally. Note, however, that they too can eventually run out of space for displaying full precision - - it just takes much longer to run out.

Among the modules which support double-precision internal calculations are the Averager, ETOT/TRND, TOT/TRND, and EIntegrator. The output of these modules is *still* a single-precision value, but it is based on the more accurate double-precision internal calculations.

The Daccumulator also allows double-precision operations, but its output is two single-precision numbers which, when combined, provide an approximation of a double-precision number. See the Daccumulator section of the *ACCOL II Reference Manual* (document# D4044) for details.

If you have more questions concerning these subjects, contact Bristol Babcock Application Support for help.

Glossary

ACCOL	is an acronym for Advanced Communications and Control-Oriented Language. It is the standard software programming language for Bristol Babcock Network 3000-series controllers.
AccolCAD	is a software package, available from Bristol Babcock, which allows an ACCOL source file to be created using graphical symbols.
ACCOL Load	also known as the .ACL file, is created from an ACCOL Object file. It is called the ACCOL Load file because it is in a machine-readable format which is downloaded into the Network 3000-series controller. Once downloaded, the controller executes instructions in the ACCOL load file in order to measure or control a plant or process.
ACCOL Object File	also known as the .ACO file, is created from an ACCOL source file. The ACO file is used by ACCOL Workbench to generate an ACCOL Load file.
ACCOL Source File	also known as the .ACC file, is created by the ACCOL programmer using ACCOL Workbench, AccolCAD, or by using any ASCII text editor. The ACCOL source file defines the modules, task, signals, and other ACCOL structures which define the measurement and control instructions for this particular application. The ACCOL source file, when finished, is used to generate an ACCOL Object file, and ACCOL Load file.
ACCOL Task(s)	is a series of modules and control statements which execute sequentially as a functional block. Task execution occurs at a user-specified rate and priority.
ACCOL Tools	is a set of software programs which includes ACCOL Workbench, ValScan, and DIAG6.
ACCOL Workbench	is a Windows-based software program which allows you to create an ACCOL source file, and to build an ACCOL object file, and ACCOL load file from it.
Alarm Limit	is a number, associated with an analog alarm signal, which determines (in combination with a deadband value) when the signal is in an alarm state.

Alarm Message	is a communications message, generated when an analog or logical signal enters an alarm state. Alarm messages are passed up through the network to MMI software at the operator workstation, to notify the operator that an alarm condition exists.
Alarm Priority	is a user-defined classification for the importance of a given alarm signal. 'Critical' is the most important alarm priority, followed in descending order of importance, by 'Non-Critical', 'Operator Guide', and 'Event' alarms.
ASCII	is an acronym for American Standard Code for Information Interchange. This refers to characters of text.
Base Memory	is a term which applies to 186-based and 386EX Real Mode controllers only. Each of these types of units has 64K of base memory which holds most ACCOL structures. 386EX Protected Mode units do NOT use the term 'base memory'.
Bit	A value of '0' (OFF) or '1' (ON). Bits are used to represent information in computers.
BSAP	Bristol Synchronous Asynchronous Protocol.
Byte	A group of 8 bits.
Character string	A collection of alpha numeric information. For example "PUMP NUMBER 4" is a string of 13 characters (which includes spaces.)
Cold Start	is a condition in which the Network 3000 controller has lost all accumulated data, either because of a watchdog failure, or because the operator has pressed the unit's reset button. Upon cold start, the unit will wait for a new ACCOL load to be downloaded, unless one already has been stored in EPROM or FLASH memory.
Communication Ports	these are devices on the Network 3000 controller, which allow the controller to exchange data with other controllers and devices.
Control Statement(s)	these are statements which may be included in an ACCOL Task to modify the execution of the task. Common control statements include SUSPEND, RESUME, ABORT, IF, ENDIF, etc.

Data Array(s)	these are tables of values. Arrays can contain either logical values (1 for ON, 0 for OFF), or floating point analog values.
Data Concentrator	This is a Network 3000 controller which has a Master Port, through which it accepts data from one or more slave controllers. Data concentrators are typically used when ACCOL control decisions must be made based on data from more than one controller.
Deadband	this is a value used to provide a range, above or below an alarm limit, (or RBE value, in the case of RBE signals) in which the alarm state (or RBE report status) will not change.
DIAG6	is one of the ACCOL Tools. It is also called the 33XX Diagnostics Program. It is used to test certain parts of the Network 3000 controller hardware.
Download	is the process of transferring an ACCOL load file into the memory of a Network 3000-series controller. Downloading is performed using the Open BSI Downloader.
DPC	Distributed Process Controller. See Remote Process Controllers
EPROM	Erasable Programmable Read-Only Memory.
Expanded Memory	is extra memory, beyond the base memory, which is installed in a 186 or 386EX Real Mode controller. This memory is used to hold certain selected ACCOL structures which may be shifted out of base memory, to free up space in the base memory area. In addition, there are certain structures which can only exist in expanded memory. The term expanded memory does NOT apply to 386EX Protected Mode controllers.
FLASH	is a type of memory used in some types of Network 3000 controllers which allows an ACCOL load file (but not data) to be retained even after a cold start condition.
Human-Machine Interface (HMI)	this is a software package, such as OpenEnterprise, Intellution® FIX®, or Iconics Genesis, which is used to display and report data for an operator.

LocalView	is an Open BSI utility which allows local communication with a controller. It also allows the user to perform field upgrades of controller firmware for certain controller models.
Memory	is the part of the Network 3000 controller which holds the ACCOL load file, and accumulated data.
Module	are pre-programmed structures which are used to perform mathematical, communication, and process control functions in ACCOL. Modules are inserted into ACCOL tasks in a logical order, and are connected together using signals.
Module Terminal(s)	are used to specify the inputs, or outputs of a module. Signals (or in some cases, constant values) are entered on module terminals. By entering the same signal name on two different terminals, those terminals are said to be 'wired' together.
NETBC5	is one of the ACCOL Tools. It is also called the Network Batch Compiler. This program takes an ASCII file and uses it to generate the Network file NETFILE.DAT. NOTE: Open BSI 3.0 or newer users MUST use NetView instead.
NETREV5	is one of the ACCOL Tools. It is also called the Network Reverse Compiler. This program takes the NETFILE.DAT file, and converts it into an editable ASCII file. NOTE: Open BSI 3.0 or newer users MUST use NetView instead.
NETTOP5	is one of the ACCOL Tools - - also known as the Network Topology Program. It allows the user to define the structure of the controller network including network levels, addresses, etc. The NETTOP files containing this information are NETFILE.DAT, GLADXREF.DAT, and RTUXREF.DAT. NOTE: Open BSI 3.0 or newer users MUST use NetView instead.
NetView	a program in Open BSI used to define your communication network, and to start communications. See the *Open BSI Utilities Manual* (document# D5081) for details.
Network 3000	a product name for a family of Bristol Babcock digital remote process controllers and related equipment.

Node	a Network 3000 controller which is part of a network of controllers.
Open Bristol System Interface	see Open BSI
Open BSI	stands for Open Bristol System Interface. Open BSI is a set of software utility programs which facilitate data collection and communications with a network of Bristol Babcock Network 3000-series controllers. The utilities in the standard Open BSI set include NetView, LocalView, DataView, and the Downloader.
Points	these are input/output (I/O) connections on a process I/O board.
Pre-emptive Multi-Tasking	a method in which multiple ACCOL tasks execute concurrently, however, those with higher priority are always executed first.
Process I/O	the input/output (I/O) data from a process or plant. This data comes from devices such as meters, pressure switches, temperature transmitters, etc. This type of data comes into the controller through Process I/O boards.
Process I/O boards	these are hardware devices, installed in slots in the Network 3000 controller, which are used to send and receive process I/O data. See Process I/O.
RAM	Random Access Memory. This is memory that can be both read from, and written to.
Read-only	this is data in memory which is fixed; i.e. it cannot be changed by an operator on-line.
Read Priority	this is the security level, required by an operator or program, to read signal data.
Read/Write	this is data in memory which can be either read, or changed.
Redundant	this refers to a configuration in which two Network 3000 controllers are linked together in a way in which one can assume the duties of the other, if the other controller fails.

Remote Process Controllers	also known simply as ‘remotes’. These are essentially a type of computer which is used to measure or control a process. (Typical examples of processes include controlling flow in a natural gas pipeline, measuring liquid level in a tank, or controlling a factory production line.) Bristol Babcock’s Network 3000 series of remote process controllers includes the DPC 3330, DPC 3335, RTU 3305, RTU 3310, etc. These units collect data, perform calculations, and issue control commands to the process. The term ‘remote’ is sometimes used to refer to controllers because they are often installed at locations that are physically distant from the operator workstation. Other synonymous terms include ‘RTU’ or ‘DPC', or '33XX'. See also Node.
RTU	Remote Terminal Unit. See Remote Process Controllers
Signal	is a software structure which is used to pass data from module to module in an ACCOL load. They are similar to ‘variables’ or ‘tags’ in other programming languages. The ACCOL programmer enters a signal name on a module terminal. By placing the same signal name on a terminal of a different module, the modules are said to be ‘wired’ together, and data can pass between them; i.e. the value of a signal on an output terminal of one module becomes an input to another module, and so on. There are five types of signals in ACCOL: Logical, Logical Alarm, Analog, Analog Alarm, and String.
Signal List	a signal list is a way to group signals together. Signals are referenced by their position in the list. Several ACCOL modules are available for referencing signal lists.
Supervisory Control and Data Acquisition (SCADA)	is a method of process control in which a supervisory computer, typically running MMI software, collects data from a network of remote process controllers, displays the data for an operator, and allows the operator to issue commands which are sent out to control the process.
System Signals	these are special ACCOL signals (distinguished by a ‘#’ as the first character in the signal base name) which are created by the system for various housekeeping purposes.

	They may be used by the ACCOL programmer, but cannot be created or deleted by the ACCOL programmer.
Task	see ACCOL Task(s)
Task Control Statements	see Control Statements
Task Priority	is a value, assigned by the ACCOL programmer, to each ACCOL Task. This value is used to determine which task should execute next. Priorities can range from 1 to 64. Tasks which perform important calculations should be given higher priorities.
Task Rate	specifies how often an ACCOL task is scheduled to begin execution. If a particular task has a task rate of 1 second, for example, then it will begin executing every second. If a task cannot complete execution prior to its next scheduled execution, its execution will be delayed until the previous execution has completed; this situation is called 'slippage', and indicates that the task rate has been set too fast.
Terminals	see Module terminals
Top Level Node(s)	a Network 3000 controller in a BSAP network, which is on the network level immediately below the operator workstation running Open BSI. Also known as a 'first level node' or 'first level slave'.
Warm Start	if a Network 3000 controller suffers a power failure, and power is restored prior to failure of the backup battery, the ACCOL load will resume execution from the point where it lost power.
Watchdog	a failure condition, indicated by the Watchdog (WDOG) LED on the controller. A Network 3000 controller in a watchdog state must be reset, and possibly re-downloaded in order to function again.
Word	A unit of measurement representing two bytes of memory.
Write Priority	this is the security level, required by an operator or program, to change signal data.

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