NBT

SM800

PROGRAMMER REFERENCE

Nota Bene Technology, Inc.
952-928-8872

1. Software

1.1 Requirements

The NBT RA-PLC Programmer^{tm} will work on any computer running Microsoft Windows 95 or later.

Procomm Plus by DataStorm (version 1.1 or later) may also be used as a minimum means of accessing the RTU displays and editing functions.

1.2 Installation

Windows 95,98,Millennium,2000

1. Place the RA-PLC Programmer installation disk in drive a: or b: (whichever is designated as the floppy drive).

2. Click Start, Run, and enter a:\setup.exe (or b:\setup.exe).

3. Next you will be prompted for the name of a directory (default is nbtcomm). Type in a name, or press enter to accept the default. This is where the programmer will be installed.

4. The setup program will create the appropriate folder in the Programs directory.

5. Installation is complete.

2. SM805 - RTU Overview

The SM805 RTU has a logic table, called "Table 1", which deals with the I/O points, calculations, etc. The communications table, called "Table 2", handles all the communication activities either by serial cable (DB9), standard phone line, or radio.

3. The NBT Programmer

The NBT Programmer is a great tool to quickly and easily program your SM805 RTU. A program can be created or edited in either an online or offline mode.

In the offline mode, a one page edit screen makes viewing and editing point parameters easy. The necessary parameters for a particular point are automatically displayed based on the point type (i.e., digital in, analog in, calculated, etc.).

Editing can also be done in a real-time online mode. The program is displayed in a spreadsheet type format.

The various screens, icons, and other details are described in the following sections.

3.1 Off line mode

Note: *When a program is created or edited in the offline mode, it is not automatically uploaded to the RTU. This must be done with an Xmodem transfer (upload).*

When the NBT Programmer is started, a blank table is displayed. This table cannot be edited. Either an existing file must be opened for editing, or the file "A805.rtu" must be used as a template to create a new program.

Once the desired file is open, editing may be performed in two ways. The first is by moving the highlight over the field you wish to edit (with the arrow keys), press the "insert" key, and enter the value.

The second method is to double-click on the field you wish to edit. This displays the "edit screen" as mentioned above. From there you may click on the arrow buttons in the upper right corner to display and edit other lines, or click "exit" to return to the first screen.

Switching between editing methods may be done at any time.

3.1.1 Main Screen

This screen will appear when the program is initially started.
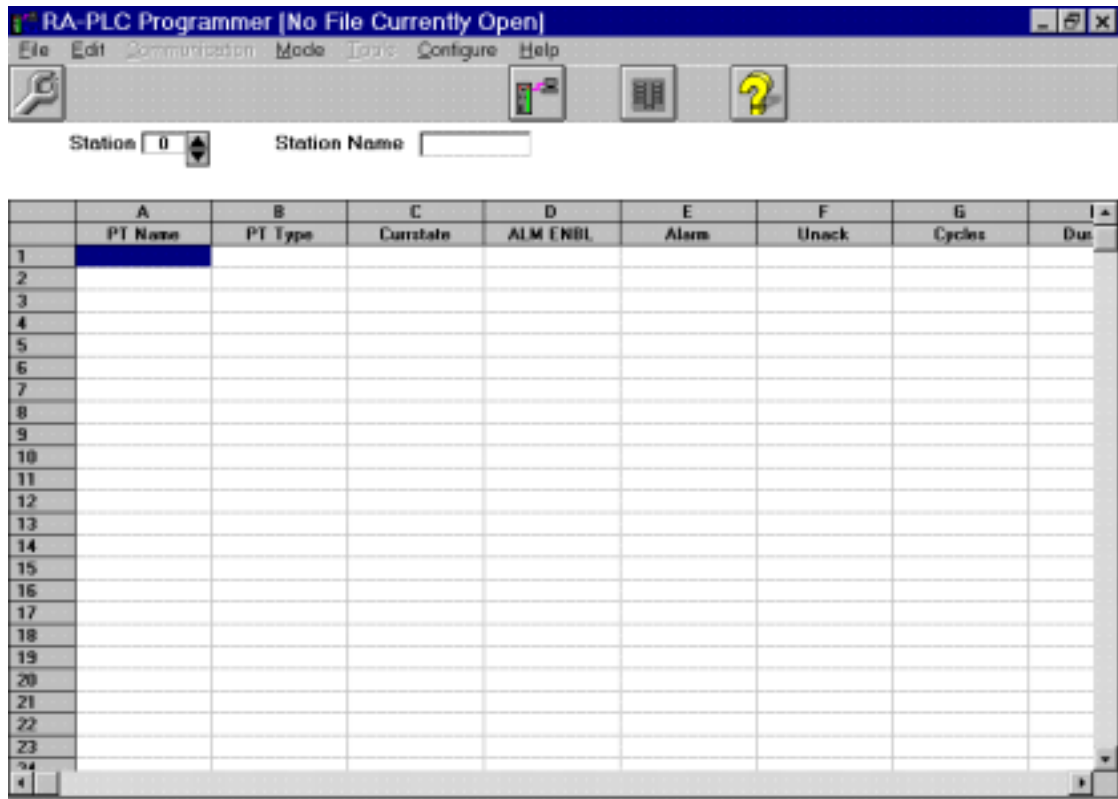
A program may not be created from a blank screen such as this. First, a template program must be opened. Open the file "A805.rtu" to use as a template, or open an existing file you wish to edit.

If opening the template file, the screen will appear as below.

RA-PLC Programmer [C:\NBTMONIT\A805.RTU]

File   Edit   Communication   Mode   Tools   Configure   Help

Station 1 ⬍   Station Name sta name

SM800

	A	B	L	M	N	P	Q	MC
	PT Name	PT Type	NU/HILIM	NU/LOLIM	ALM ENBL	HW Type	PT Type	
1	MAJR ALM	DIG IN			En	INTERNAL	DIG IN	0
2	AC PWRIN	ANL IN	260	05	En	INTERNAL	ANL IN	0
3	DI INT 0	DIG IN			En	INTERNAL	DIG IN	0
4	AI INT 0	ANL IN	0	0	En	INTERNAL	ANL IN	0
5		DIG IN			En	INACTIVE	DIG IN	0
6		DIG IN			En	INACTIVE	DIG IN	0
7		DIG IN			En	INACTIVE	DIG IN	0
8		DIG IN			En	INACTIVE	DIG IN	0
9		DIG IN			En	INACTIVE	DIG IN	0
10		DIG IN			En	INACTIVE	DIG IN	0
11		DIG IN			En	INACTIVE	DIG IN	0
12		DIG IN			En	INACTIVE	DIG IN	0
13		DIG IN			En	INACTIVE	DIG IN	0
14		DIG IN			En	INACTIVE	DIG IN	0
15		DIG IN			En	INACTIVE	DIG IN	0
16		DIG IN			En	INACTIVE	DIG IN	0
17		DIG IN			En	INACTIVE	DIG IN	0
18		DIG IN			En	INACTIVE	DIG IN	0
19		DIG IN			En	INACTIVE	DIG IN	0
20		DIG IN			En	INACTIVE	DIG IN	0
21		DIG IN			En	INACTIVE	DIG IN	0
22		DIG IN			En	INACTIVE	DIG IN	0
23		DIG IN			En	INACTIVE	DIG IN	0
24		DIG IN			En	INACTIVE	DIG IN	0

To edit a line, either double-click on it, or move the highlight over the desired cell and press "insert". If a double-click is used, the associated parameters for that point will automatically be shown all in one screen, which appears below. This edit screen will show the necessary parameters for the point type that is selected (i.e., digital in, analog out, calculated, etc.). As you change the point type, the parameter fields automatically change also.

3.1.2 Icons

Below are the offline icons defined.
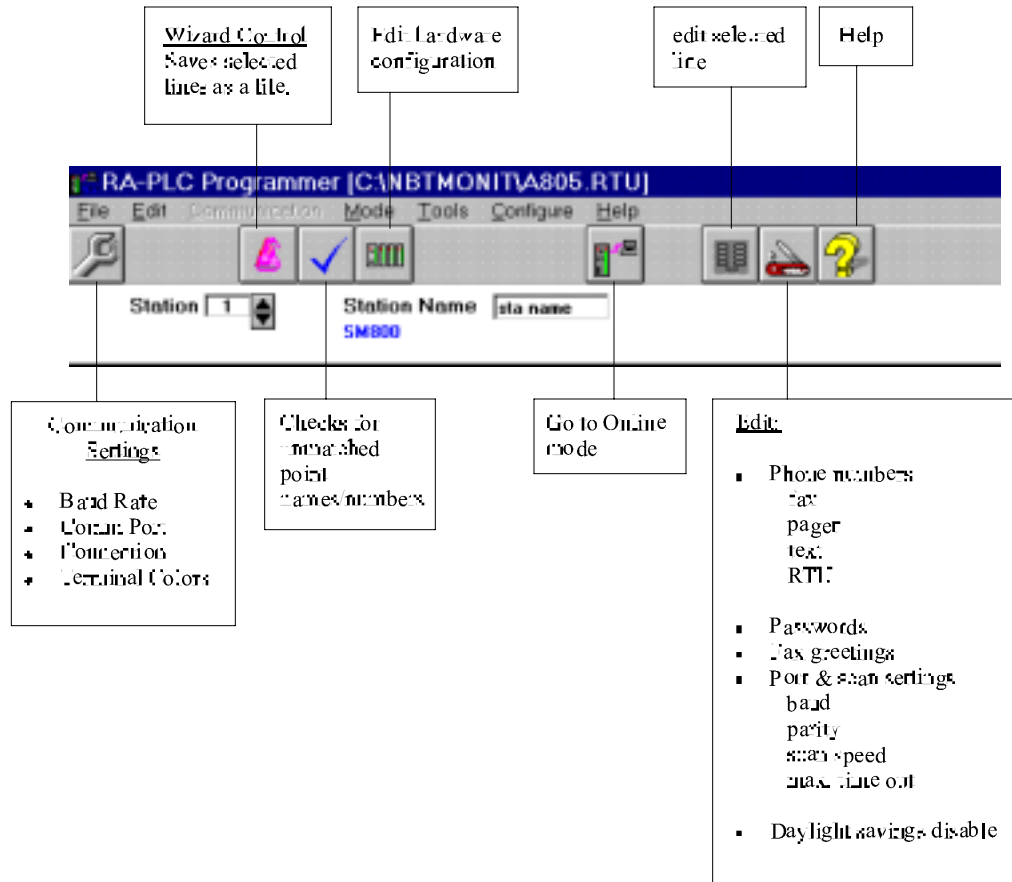
To go to the online mode from here, click on the center icon (labeled above).

3.1.3 Editing an existing file

Open the file you wish to edit by clicking *"File"*, *"Open"*, then select the file.

Editing lines in an existing file can be done two ways. One is to move the highlight onto the cell you wish to edit, press *"insert"*, and enter the correct value.

The second option is to double click on the desired line and all its parameters appear on a second screen, as shown below. Once this box is open you can scroll to other lines with the arrows in the upper right hand corner. When the point type is selected or changed, the associated parameters are automatically updated and displayed in the screen for editing.

3.2 On line mode

After clicking the "go online" icon, this screen will appear.
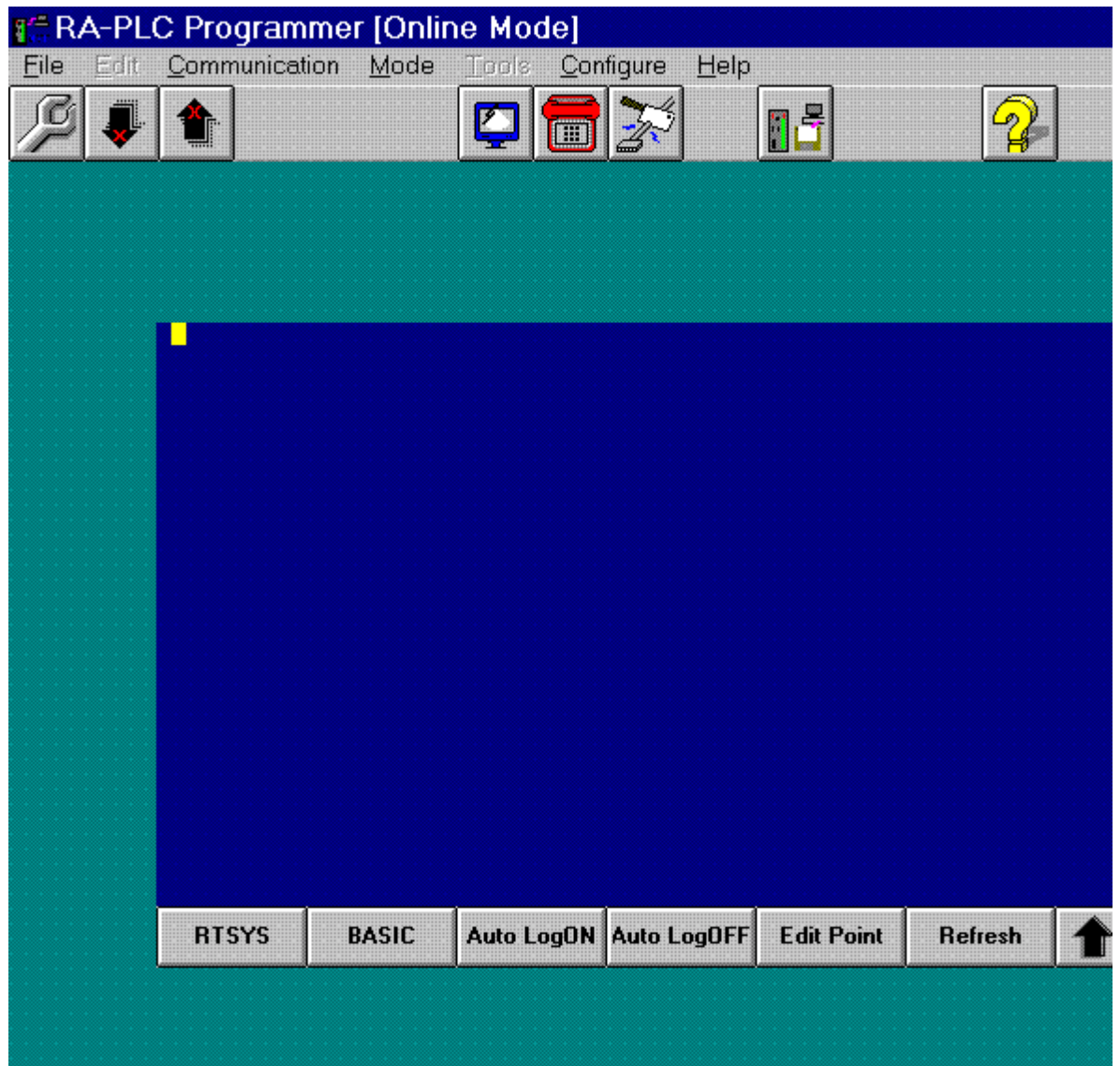
This is where the password is entered. The default is "qwerty" and is shown in the box. Unless you have changed the password, "qwerty" will always appear in this box. Simply press "enter" or click the "ok" box to accept.
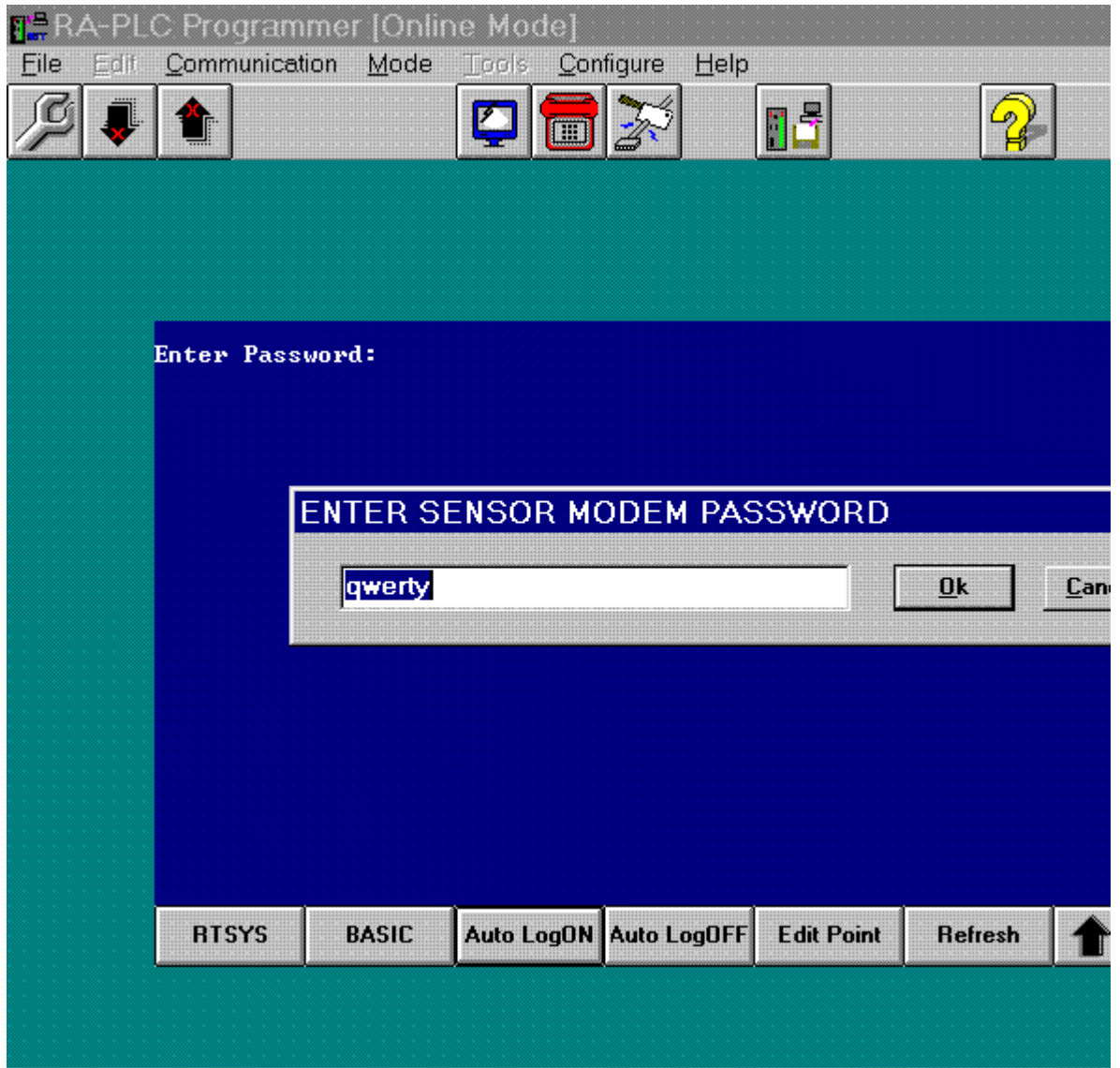
After entering the password, the working online screen will appear.

```
RA-PLC Programmer [Online Mode]
File   Edit   Communication   Mode   Tools   Configure   Help

      Station      1   JBarrack   TABLE1_DATA-CUR/SUM Monday      13:2

      File =TODAY'S    DST=En      Scan is ON      PTMSK=      ALLPoints
           A            B           C           D           E           F
      PT.NAME     PT TYPE    CURSTATE   ALM ENBL    ALARM      UNACK
   01 MAJR ALM   DIG IN      OFF               En
   02 AC PWRIN   ANL IN         12.4   VOLT
   03 DI  INT 0  DIG IN      OFF               En
   04 AI  INT 0  ANL IN          544   MV
   05            DIG IN      OFF               En
   06            DIG IN      OFF               En
   07            DIG IN      OFF               En
   08            DIG IN      OFF               En
   09            DIG IN      OFF               En
   10            DIG IN      OFF               En
   11            DIG IN      OFF               En
   12            DIG IN      OFF               En          ALARM
   13            DIG IN      OFF               En          ALARM
   14            DIG IN      OFF               En          ALARM
   15            DIG IN      OFF               En          ALARM

   RTSYS      BASIC    Auto LogON  Auto LogOFF  Edit Point   Refresh
```

3.2.1 Icons

TOP ROW
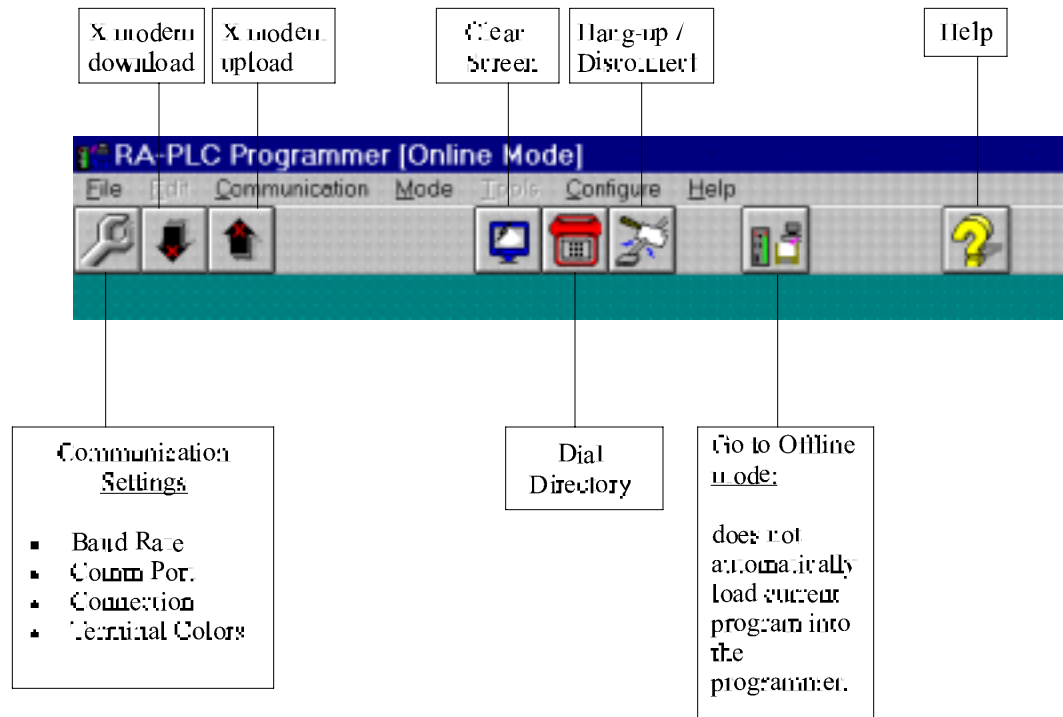
BOTTOM ROW
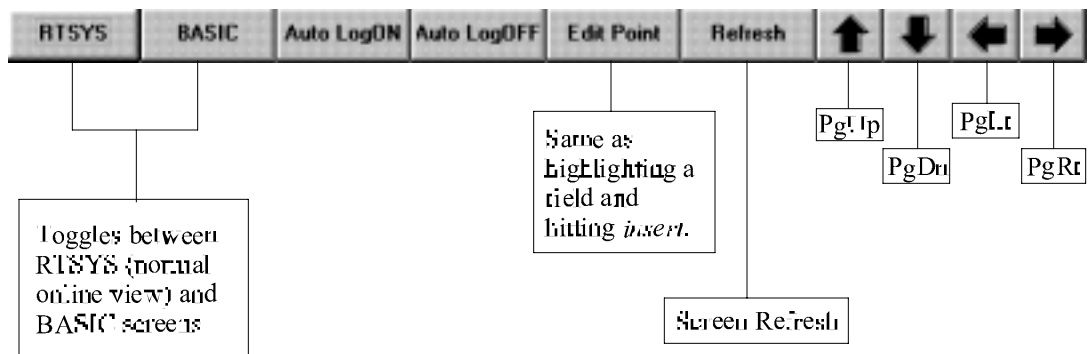
3.2.2 Logging on/off

Logging on to the RTU with the Programmer is as easy clicking the
"Auto LogON" button on the bottom row as noted earlier. When prompted, press *"Enter"* to accept the default (qwerty), or type in your password and you're "on line".

To log off, simply click *"Auto LogOFF"*.

3.2.3 Accessing menus

Once online, access the online menus by pressing the "/" key on the lower right hand side of the keyboard (the same key as the "?" on most keyboards). Use the arrow keys to highlight the appropriate menu item and press *"Enter"*. To get out of the menu line without making a selection, press *"Esc"*.

4. Table 1 (Logic Table)

4.1 General setup

4.1.1 Setting the time & date

The current time is used to time stamp alarms and events and analog minimum and maximums. It is also used for "Time of Day" calculations.

The time and date settings are in the online Table 1 menu and sub-menus. Press "/" to access the menu line, highlight *"Time"*, and press *"Enter"*. The menu sequence is as follows:

/ - Time

  TimeDate
    Seconds
    Minutes
    Hours
    Day
    Month
    Year

  SetWeekday
    Sunday-Saturday (use up or down arrow key to scroll)

  Wrt_RTC*

As each parameter is entered (seconds, minutes, day, etc.) you will need to go through the menu list again to set the others.

*Note: **If changes are made to the time they must be written to the "real-time-clock" or the changes will be lost when power is removed**. After all changes are made to the time/date settings be sure to select the function **"Wrt_RTC"** (under the "Time" menu option) which will make the changes to the actual real-time-clock permanent.

4.1.2 Station name & number

<u>ONLINE</u>: The station name and station number settings are in the online Table 1 menu under *"Station"*. Press "/" to access the menu line, highlight *"Station"*, and press *"Enter"*. Next, highlight the selection you want, press *"Enter",* and type in the text or number you want for that station.

<u>OFFLINE</u>: Highlight the "sta name" next to *"Station Name"* at the top of the page and type the new name. To change the station number click the up or down arrow key next to *"Station"*.

4.1.3 Setting and using passwords

The default password is "**qwerty**". This default will always be accepted if **dip switch 2**, on the front of the SM805, is in the **up position** (default). The password system is enabled by setting **dip switch 2** in the **down position.**

Passwords can be changed through the menu line in <u>Table 2</u>. From the menu line in Table 1, select *"Display", "Table_2"*; then press "/" again and select *"Passwords"*. Passwords may be any six (6) character entry.

Six (6) indexes, identified as passwords 1-6, are available and have different levels of access and authority. These different levels are defined as follows:

Password 1:   Display only in the RTSYS area, no changes allowed; cannot access the BASIC programs or other areas.

Password 2:   Same as password 1.

Password 3:   Editing in RTSYS allowed, but no access to Time/Date change, Xmodem transfers, or DBload and DBdump commands.

Password 4:   Same as password 3.

Password 5:   Unrestricted access; all areas and commands are available.

Password 6:   Same as password 5.

Remember: In order to use non-default passwords, *dip switch 2* on the front of the unit must be in the *down* position. Otherwise the default (qwerty) will always be accepted.

4.1.4 Scan enable / disable

The scan in the RTU must be enabled in order for the program to execute. This parameter is accessed through the main menu by pressing "/", then select *"Station"* and *"Scan On/Off"*. Use the up/down arrow keys to toggle between on and off, and press *"Enter"*.

Note: When a program is loaded into the RTU, the scan is automatically disabled, and must be enabled to reestablish proper operation

4.2 Column definitions

4.2.1 Alphabetically by column letter (A-Z, AA-AH)

Some column letters appear more than once. This is because the display headings change depending on the actual point type being viewed. To update the display headings online, highlight the desired point or line number and press the *"End"* key. This will refresh the screen. In the table below, the "Point Type" column shows when that column name is displayed. For example, column "C" has two names. The first, "CURVALUE", is displayed for analog points, and "CURSTATE" is displayed for digital points. An empty "Point Type" column indicates the line is <u>always</u> displayed, regardless of point type. Starred columns are those shown when the configuration mask ("Config Msk") is selected from the "Format" menu option.

COLUMN	POINT TYPE	NAME	DEFINITION
A*		PT.NAME	User assigned name for point.
B		PT TYPE	Point type: dig in, dig out, etc.
C*	Analog	CURVALUE	Current value of this point.
C *	Digital	CURSTATE	Current state of this point.
D	Analog type pts.	ALM ENBL	Shows point alarm enable condition.
D	Analog	UNITS	Shows Engineering Unit label.
E		ALARM	Shows current alarm status.
F		UNACK	Shows current alarm acknowledge status.
G	Analog	MAXVAL	Maximum value for analog points.
G	Digital	CYCLES	Number of OFF to ON transitions since midnight.
H	Analog	MINVAL	Minimum value for analog points.
H	Digital	DURATION	Duration of ON state (in minutes) since midnight.
I	Analog	LstAlarm	Time of last alarm, for analog points.
I	Digital	Last ON	Time of last transition to the ON state.
J	Analog	TimeOfMx	Time of Maximum value, for analog points.
J	Digital	Last OFF	Time of last transition to the OFF state.
K	Analog	TimeOfMn	Time of Minimum value, for analog points.
K	Digital	N.U.	Vacant column for digital points.
L	Analog	HI LIMIT	High limit for analog points.
L	Digital	NU/HILIM	Vacant column for digital points.
M	Analog	LO LIMIT	Low limit for analog points.
M	Digital	NU/LOLIM	Vacant column for digital points.
N		ALM ENBL	Shows point alarm enable condition.
O		ModulSTS	Communications status for origin of data.
P*		HW TYPE	Data source type: internal register, exp. I/O , etc.

Cont'd

COLUMN	POINT TYPE	NAME	DEFINITION

Q*		PT TYPE	Assignment for this point: DI, DO, AI, AO, etc.
R		Famly/#P	Not used.
S*	Calculated	CALCTYPE	Selects type of calculation to be performed.
S* CALC-PT.	An./Dig.	MOD ADDR	Data source address for all points but
T*	Calculated	IN PT 1	First parameter used by the calculation.
T* reg).	An./Dig.	REG/PT	Selects source register (offset from first
U*	Analog	RANGE/FS	Full scale reading when A-D converter is at max.
U*	Digital	BIT POS	Bit position of the data within the register.
U*	Calculated	IN PT 2	Second parameter used by the calculation.
V*	Analog	OFFSET	Offset parameter for scaling analog points.
V*	Digital	N.U.	Not used for digital points.
V*	Calculated	IN PT 3	Third parameter used by the calculation.
W*	Calculated	CONST .	Constant entry for calculated points.
W*	Digital	Membr/LZ	Not used.
W*	Analog	Resol/LZ	Selects scaling resolution:
X*		Link Pt	Links a point to another line for input or output.
Y*		INVERT	Logically inverts data before using or storing.
Z*	Analog	UNITS	Shows Engineering Unit label for analog points.
Z*	Digital	LabelSel	Selects label for digital point display (on/off, etc.)
AA	Analog	N.U.	Vacant column for analog points.
AA	Digital	CURSTATE	Current state of this point, for digital points.
AB		M&M Reset	Selects "daily"/ "none" for min/max reset criteria.
AC*		DEC.PT.	Decimal point position for display purposes.
AD*		AlmType	Select alarm groups for common alarms:

For the Resol/LZ row:

0 =10 bit, bipolar, hardware full scale = -515 to +512
1 =10 bit, unipolar, hardware full scale = 0 to +1023
2 =12 bit, bipolar, hardware full scale = -2047 to +2047
3 =12 bit, unipolar, hardware full scale = 0 to +4095

For the AlmType row:

0 = none
1 = major,
2 = minor,
3 = major & minor.

Cont'd

COLUMN	POINT TYPE	NAME	DEFINITION
AE*		AlmAct'n	Suppression of alarm acknowledge:
			0 = normal alarming 1 = suppress unacknowledge on set or return, 2 = suppress unacknowledge on return, 4 = flash DO (expansion I/O) on set, 6 = flash DO (exp. I/O) on set, not on return.
AF*		AlmDelay	Seconds of delay before alarm condition.
AG*		SmplType	Shows sampling criteria assigned:
			1-180= index point to use for trigger; 250= record when change of state or alarm limit; 251= every minute; 252= every hour; 253= max. & min. every hour (2 records).
AH*		SmpField	Selects normal field (as indicated by type), or min. and max. field selection for sampling.

4.2.2 Alphabetically by column name ("Alarm" - "Units")

Starred names indicate names/columns that are displayed when the "configuration mask" ("Cfg_Msk") is selected from the "Format" menu option.

NAME	COLUMN	POINT TYPE	DEFINITION
ALARM	E		Shows current alarm status.
ALM ENBL	D	Digital	Shows point alarm enable condition.
ALM ENBL	N	All Types	Shows point alarm enable condition.
AlmAct'n*	AE		Allows suppression of alarm acknowledge for return to normal or new alarm:
			0 = Normal alarming,
			1 = Supress unack on set or return,
			2 = Supress unack on return,
			4 = Flash DO (expansion I/O) on set,
			6 = Flash DO (expansion I/O) on set, not on return.
AlmDelay*	AF		Seconds of delay before alarm condition
AlmType*	AD		Select alarm groups for common alarms:
			0 = none
			1 = major,
			2 = minor,
			3 = major & minor.
BIT POS*	U	Digital	The bit position of the data within the register.
CALCTYPE*	S	Calculated	Selects type of calculation to be performed.
CONST.*	W	Calculated	Constant entry for calculated points.
CURSTATE	AA	Digital	Current state of this point, for digital points.
CURSTATE*	C	Digital	Current state of this point, for digital points.
CURVALUE*	C	Analog	Current value of this point, for analog points.
CYCLES	G	Digital	Number of OFF to ON transitions since midnight.
DEC.PT.*	AC		Decimal point position for display purposes.
DURATION	H	Digital	Duration of ON state (in minutes) since midnight.
Famly/#P	R		Not used.
HI LIMIT	L	Analog	High limit for analog points.
HW TYPE*	P		Data source type: internal registers., exp. I/O, etc.
IN PT 1*	T	Calculated	First parameter used by the calculation.
IN PT 2*	U	Calculated	Second parameter used by the calculation.
IN PT 3*	V	Calculated	Third parameter used by the calculation.
INVERT*	Y		Logically inverts before using or storing.
LabelSel*	Z	Digital	Selects label for digital point display (on/off, etc.)
Last OFF	J	Digital	Time of last transition to the OFF state.
Last ON	I	Digital	Time of last transition to the ON state.
NAME	**COLUMN**	**POINT TYPE**	**DEFINITION**

Link Pt*	X		Links a point to another line for input or output.
LO LIMIT	M	Analog	Low limit for analog points.
LstAlarm	I	Analog	Time of last alarm, for analog points.
MAXVAL	G	Analog	Maximum value for analog points.
Membr/LZ*	W	Digital	Not used.
MINVAL	H	Analog	Minimum value for analog points.
M&M Reset	AB		Selects "daily"/ "none" for min/max reset criteria.
MOD ADDR*	S	An./Dig.	Data source address for all points but CALC-PT.
ModulSTS	O		Communications status for origin of data.
N.U.	AA	Analog	Vacant column for analog points.
N.U.	K	Diogital	Vacant column for digital points.
N.U.	V	Digital	Not used for digital points.
NU/HILIM	L	Digital	Vacant column for digital points.
NU/LOLIM	M	Digital	Vacant column for digital points.
OFFSET*	V	Analog	Offset parameter for scaling analog points.
PT TYPE	B		Point type: dig in, dig out, etc.
PT TYPE*	Q		Assignment for this point: DI, DO, AI, AO, etc.
PT.NAME*	A		User assigned name for point.
RANGE/FS*	U	Analog	Full scale reading when the A-D cnvtr. is at max.
REG/PT*	T	An./Dig.	Selects source register (offset from first reg.).
Resol/LZ*	W	Analog	Selects scaling resolution:

0 = 10 bit, bipolar, hardware full scale = -515 to +512
1 = 10 bit, unipolar, hardware full scale = 0 to +1023
2 = 12 bit, bipolar, hardware full scale = -2047 to +2047
3 = 12 bit, unipolar, hardware full scale = 0 to +4095

SmpField*	AH		Selects normal field (as indicated by type), or min and max field selection for sampling.
SmplType*	AG		Shows sampling criteria assigned:

1-180 = index point to use for trigger;
250 =record when change of state or alarm limit;
251 = every Minute;
252 = every Hour;
253 = Max & Min every Hour (2 records).

TimeOfMn	K	Analog	Time of Minimum value, for analog points.
TimeOfMx	J	Analog	Time of Maximum value, for analog points.
UNACK	F		Shows current alarm acknowledge status.
UNITS	D	Analog	Shows Engineering Unit label for analog points.
UNITS*	Z	Analog	Shows Engineering Unit label for analog points.

4.3 Point setup

4.3.1 General

Each active point has a number of various parameters which vary depending on point type.

The setup of local points (Table 1) is relatively intuitive, and parameters associated with a point may be altered at will. When using the Programmer™, selecting a point type in the edit screen will automatically display the associated parameters for that point type.

Note that if only raw point values are needed (for transmission to a master station), you may not need to configure Table 1 points. See Table 2 setup section for discussion of accessing local expansion I/O raw values.

Table 1 points provide the ability to perform calculations, scale, alarm, sample, and other common functions. Table 1 points can be defined to place individual points (or associated parameters like "run-time", "number of starts", etc.) in Table 2.

4.3.2 The "Configuration Mask"

In order to facilitate the setup and configuration of points in Table 1 (the logic table), a specialized configuration mask (*"Cfg_Msk"*) is accessible from the *"Format"* menu option. This mask is a pre-defined "hide-mask" which suppresses display of several of the columns in the Current/Summary (*"CUR/SUM"*) display. This allows you to focus on the key setup parameters for configuring points.

After the points are initially defined, the user can return to the normal *"Hide Off"* condition (also found under the *"Format"* menu option) which shows all columns for: fine tuning the point, entry of remaining operating parameters, or normal viewing.

4.3.3 List of point types

- Digital in/out
- Analog in/out
- Calculated
- Average (analog)
- Totalize (analog)
- PWI 3-15 (pulse width digital input)
- AI w/DBA (analog input w/moving alarm limits)
- CTR-IN (counter/rate inputs)

4.3.4 I/O point addressing

Below are the internal I/O options and a table of addresses.

The SM805 includes one internal I/O card. The two typical card options are called a 2240 card, and a 4311 card (the number refers to the I/O configuration). The 2240 card has 2 digital inputs, 2 digital outputs, and 4 analog inputs. The 4311 card has 4 digital inputs, 3 digital outputs, 1 analog input, and 1 analog output (refer to the SM805 Reference Manual for hardware details). Also, there are two user assignable front panel LED's; and two system monitoring signals with LED's (below the user assignable LED's) that monitor the main power and logic power. Several internally generated "common" alarm signals are also available.

Note: The Module address parameter (MOD ADDR) is not used for linking internal I/O to Table 1 points. (i.e., the MOD ADDR field, column S, should be zero)

Description		Register	Bit
Digital Input Registers			
Int. Phys. I/O 0 (Terminal Strip-5)	DI	0	0
Int. Phys. I/O 1 (TS-6)	DI	0	1
Slave Communications Alm	DI	0	2
Master Communications Alm	DI	0	3
Common Major Alarm	DI	0	4
Common Minor Alarm	DI	0	5
Int. Dig. In. 2 (4311= Terminal Strip-7)	DI	1	0
Int. Dig. In. 3 (4311= TS-8)	DI	1	1
Digital Output Registers			
Int. Phys. Out. 0 (2240=TS-8; 4311=TS-10)	DO	0	0
Int. Phys. Out. 1 (2240=TS-9; 4311=TS-11)	DO	0	1
Common Reset Major & Minor Alarms	DO	0	2
Common Acknowledge All Points	DO	0	3
Common Reset Minor Alarms	DO	0	4
Int. Phys Out 2 (for 4311, TB1-12)	DO	0	6
User LED 1 (Front panel)	DO	1	0
User LED 2 (Front panel)	DO	1	1
Analog Input Registers			
Int. Phys. I/O 0	AI	0	
Int. Phys. I/O 1	AI	1	
Int. Phys. I/O 2	AI	2	
Int. Phys. I/O 3	AI	3	
Main Power Voltage	AI	5*	
Logic Voltage	AI	6*	

(* for scaling use 275 for Full Scale, "1" for Resol, 1 decimal)

4.3.5 Special point (alarm) functions

4.3.5.1 Common Alarm Points

Major and minor common alarm points are available. They are set by any Table 1 point having the Alarm Type field (*"AlmType"*, column AD) set to be included in the major, minor, or both alarm groups.

4.3.5.2 Common Slave Communication Fail Point

This point will set any time a slave station's communication status goes to "Failed". It is accessed through an internal digital in point (register 0, bit 2). This point sets on the leading edge of a communication fail and must be manually reset. It can be reset by setting the alarm reset point (internal DO point, register 0, bit 2).

4.3.5.3 Superior Master Communication Failure

This point will set any time communication with the "master" station fails. It is accessed via internal digital in point, register 0, bit 3. This point will set and reset by itself based on successful communication with the master.

4.3.5.4 Common Reset Major & Minor Alarms

By setting the common alarm reset point (internal DO point, register 0, bit 2) the major, minor, and RTU communication alarms will be reset.

4.3.5.5 Common Acknowledge All Points

All alarm points will be acknowledged by setting this bit. This point is an internal digital out point, register 0, bit 3.

4.3.5.6 Common Reset Minor Alarms

All minor alarms will be acknowledged by setting this bit. This point is an internal digital out point, register 0, bit 4.

4.3.6 Making points viewable

To make the display easier to read, the inactive lines/points may be hidden from view. Select *"Display"*, *"PointSel"*, *"ALLActive"*. This will display only the points which are being used in the program (i.e., "active").

In order to view hidden points go to the menu line (press "/") and select *"Display"*, *"PointSel"*, and then *"ALL Pts"*. This will display all points including those which are currently inactive.

4.3.7 Calculated points

See section 4.4, "Calculated Points".

4.3.8 Average (of analog) Points

Setup is similar to analog input points. "Average" points differ from analog input points in that the current value is the one minute average of the source data. And the "maximum" field (*"MAXVAL"*, column G) contains the most recent hourly average of the source data. The *"CURVALUE"* field is <u>updated</u> once per minute (averaging is actually performed approximately 6 times per minute).

> **CAUTION:** Except to initially zero out, <u>do not change</u> any values for
> *"TimeOfMx"* (column J), *"TimeOfMn"* (column K) or
> *"MINVAL"* (column H), as they contain internal numbers
> used in the calculations.

4.3.9 Totalize (of analog) Points

The setup of a "Totalize" point is similar to analog input points, and the source data may be scaled just as an analog input is scaled. "Totalize" points differ from analog input points in that the "current value" is the one minute average of the source data. Since the averages are for one minute, the <u>engineering units</u> that are being "totalized" must be in a <u>rate per minute</u> format (e.g., GPM, RPM, etc.). The rate value being totalized should be less than 10,000.

The minimum and maximum fields (*"MINVAL"* and *"MAXVAL"*) contain the "Totalized" reading of the source data. The least significant 4 digits in the *"MINVAL"* field, and 4 most significant digits in the *"MAXVAL"* field. The accumulated total is then:

Total = (Maximum field * 10,000) + Minimum field.

The "totalizing" is done every minute, and the totalizer <u>does not reset at midnight</u>. Zeros may be entered in the *"MINVAL"* and *"MAXVAL"* fields to clear out the totalizer at any time.

> **CAUTION:** Except to initially zero out, <u>do not change</u> any values for
> "TimeOfMx" (column J), "TimeOfMn" (column K) or
> MINVAL (column H), as they contain internal numbers used
> in the calculations.

The *"INVERT"* field is used to control whether positive or negative values are totalized: if the field is set to "NO-INVRT" (normal setting) only positive rates will be totalized. If the field is set to INVERT then only negative flows will be totalized.

If you wish to totalize the sum of several rates, or if the rate you want to totalize is already in a row in Table 1, the following method can be used:

set HW TYPE (P) to CALC
set PT TYPE (Q) to TOTALIZE
set CALC TYPE (S) to ADD

and then the fields *"IN PT 1"*, *"IN PT 2"* and *"IN PT 3"* can reference the rows that have the rates to totalize.

4.3.10 PWI 3-15 (Pulse width digital input)

This is designed to measure the "ON" duration of digital inputs that are used in pulse width duration equipment. Although a digital point is being monitored, the addressing of that point will look like an analog point to allow for an analog value (the total "ON" time).

The *"MOD ADDR", "REG/PT"* and *"BIT POS"* must be set to monitor a digital input point. However, the *"BIT POS"* field (column U) must be set to 0 (zero) and the *"REG/PT"* field (column T) will be the actual bit position within the digital input module for that digital point. The *"CURVAL"* field (column C)will contain the "ON" time in tenths of seconds. Maximum measurement is 25.5 seconds (displayed as 255).

4.3.11 AI w/DBA (Analog input with moving alarm limits)

This is similar to an analog input field except the range is used to calculate a dead band for alarming the point. The dead band is 2.3% of the range, if no range is specified then the dead band will be 5 counts.

When the input changes by more than the dead band the alarm will toggle for one scan cycle and then reset until the value again changes by more than the dead band. This is a convenient way to set an alarm point to trigger a report by exception transmission.

4.3.12 CTR-IN (Counter / Rate Inputs)

The *"CTR-IN"* point type (column Q) is used to read pulse inputs for the High Speed Counter module. The running total is maintained in a double register containing 8 digits of count. This value is viewed in the *"MAXVAL"* and *"MINVAL"* fields (columns H and G) for the point (4 digits in each).

> *Note:* The rate inputs from the counter module are accessed by an analog input (ANL IN) type point.

The first 4 inputs of a counter module are usable as either digital inputs or counter inputs. The second 4 inputs of a counter card are regular digital inputs only. For the first 4 inputs, "counts" "rate values" are both accessible. The first inputs' count input is register 0, and the corresponding rate value is register 4. The 2nd inputs' registers are 1 and 5, etc.

If the input is used as a digital input, enter "0" in the *"IN PT 1"* field (column T) and the appropriate bit number in the *"IN PT 2"* field (column U).

4.3.13 Other Point Related Parameters

After the main parameters have been entered, there are several additional parameters which affect the display appearance, alarming actions and sampling criteria.

Parameters which affect the display appearance include:

- • Label Selection (column Z)
- • Decimal Point (column AC)
- • Point Name (column A)
- • Invert (column Y)   (affects actual state too)

4.4 Calculated Points

Generally, a calculated point will use another Table 1 point (or points) as the source of data, and will perform a "calculation" on that input data. The result is stored in an output Table 1 point. A calculated point is defined by setting the *"HW TYPE"* field (column P) to *"CALC-PT"*.

The calculation type (*"CALCTYPE",* column S) is entered by accessing the menu line and making a selection using the up/down arrow keys. See the next section, 4.4.1, for a list of calculation types. The three arguments (*"IN PT 1", "IN PT 2",* and *"IN PT3"*) are numeric entries and are usually line numbers of other Table 1 points. In some cases, an argument entry may serve as a constant.

Calculated points are usually "input" points (where it receives the result data). In a few cases, calculated points are "output" points (where it stores the result data into a destination point).

For a calculated point as an "input" type (e.g., digital in) the third parameter (*"IN PT 3"*) is a **third input**. The result (output of calculation) is stored as the *"current value"* of that point.

For a calculated point as an "output" type (e.g., digital out) the third parameter becomes the **destination point** (output of calculation). The *"CURVAL"* field (column C) of the calculated point is used as the "3rd input".

> *Example:*
>
> A digital input "Boolean AND" ("BAND") calculation will calculate a digital point value whose state is the logical AND of <u>Point1</u>, <u>Point2</u> and <u>Point3</u> (in columns T, U, and V). The result will be the "current value" (*"CURVAL"*) of the calculated point.
>
> For an equivalent digital output calculation, the inputs are <u>Point1</u>, <u>Point2</u>, and the *"CURSTATE"* field (columns T, U, and C) of the calculated point, with the result being stored in the "current value" (*"CURVALUE"*) field of the line number referenced in <u>Point3</u> (*"IN PT 3"*, column V).

4.4.1 List of calculation types

The following is a list of the calculation types:

1. ADD
2. BAND
3. BMUX
4. BOR
5. BXOR
6. CHDET1
7. CHDET8
8. CLIP-A
9. COPY
10. CMPARE
11. CTDWN
12. CTRLR
13. CYCTMR
14. DATEck
15. DIV
16. LATCH
17. MULT
18. SUB
19. TOD-OS

4.4.2 Calculation type operations

4.4.2.1 *Boolean Operators (BAND, BOR, BXOR)*

Boolean calculated points operate with digital points and calculate a result based on the states of the input points. Results are stored in the destination point.

Parameters which are equal to 0 (zero) indicate "no point selected" for that term. BXOR generates a true (ON) result if one and only one of the inputs is true (ON).

If the *"PT TYPE"* is *"DIG IN"* then the *"CURSTATE"* will hold the result of the calculation. If the *"PT TYPE"* is *"DIG OUT"* then the *"CURSTATE"* field is used as a third input and the *"IN PT 3"* field (column V) will hold the result of the calculation.

4.4.2.2 *Logical Multiplexer (BMUX)*

The multiplexer calculation allows selection of one of two inputs (*"IN PT 1"* and *"IN PT 2"*) based on the control signal from *"IN PT 3"* (columns T, U, and V respectively). The OFF (0) state of the selector point will result in selection of the point associated with *"IN PT 1"*. The ON (1) state of the selector point will result in selection of the point associated with *"IN PT 2"*. This calculation type is unique in that it can be used with a point type of either digital or analog. The selector input will always be linked to a digital point (on/off).

4.4.2.3 *Analog Clip Function (CLIP-A)*

This is an analog point calculation (input only). The "CLIP" function allows positive input values to be clipped to a specified sub range, or to be clipped and converted to a percentage value. Input #1 (*"IN PT 1"*) is the source point to clip, and Input #2 (*"IN PT 2"*) determines whether the operation is clip, or clip and convert to a percentage (see list below). Input #3 (*"IN PT 3"*) is a multiplier to allow integer results from a percentage operation. The *"CURSTATE"* column will show the resulting value.

> The clip range is specified by the limits of the clip point or the limits of the source point as follows:

"IN PT 2" = 0	Clip,	Use source point limits
= 1	Clip & %	Use source point limits
= 2	Clip	Use this point's limits
= 3	Clip & %	Use this point's limits

4.4.2.4 *Controller (CTRLR)*

The controller calculation can be used in four basic modes: Pump-In, Pump-Out, Single set-point on/off, and Single set-point off/on. Pump-In implies "turn on" when below the low threshold and "turn off" when above the high threshold. The "mode" is determined by whether both "IN PT 1" (Low Limit) and "IN PT 2" (High Limit) are non-zero, indicating the use of both thresholds, or if only one of those parameters is linked. The input columns are references to other points in the table, and those points must have the alarms set to generate the HI and LOW thresholds that this controller uses for control.

The INVERT selection for the calculated point is used to select whether the operation is "Pump-in" or "pump-out". "INVERT" is for pump in, and "NO_INVERT" is for pump out.

If both "IN PT 1" and "IN PT 2" are non-zero, the controller calculation latches based on exceeding the associated high/low limit thresholds of the source point. The set and reset inputs can be set to the same or different source input points. This can be used for simple tank control operations.

Greater Than / Less Than function:

If <u>only</u> the set or reset input is used (leaving the other input as 0), the controller will be set only while the associated limit is exceeded, providing a greater than or less than function.

> **Note:** The "CTRLR" function has been specifically designed for use with analog points, if the controlling inputs are digital, such as float control, then the "LATCH" function is the best function to use.

4.4.2.5 Latch (LATCH)

<u>Regular Latch: CONST = 0</u>

This calculation type is useful for On/Off control based on limit switch inputs. The result will set on the leading edge of input 1, and will reset on the leading edge of input 2. The calculation is enabled when *"IN PT 3"* (column V) is set to zero, or if set to a line number, then that line becomes the enabling point. When disabled, the result is forced to the reset state. Invert has no effect on the result.

The LATCH may be used as a "one-shot" point. If input 2 is set to the same line number as the LATCH itself, then the LATCH will turn itself OFF after one scan cycle. When the enabling point turns OFF, it will automatically reset itself. This is the simplest way to set up a point that will only be ON for one scan cycle.

<u>Level Sensitive Latch: CONST = 1</u>

To use the LATCH function with level sensitive inputs, set the *"CONST"* field (column W) to one (1).

4.4.2.6 Change Detect 1 (CHDET1)

This calculation results in a set output if an input change of state occurs. The *"IN PT 2"* field (column U) is a constant (i.e., it does not refer to a line number) to specify the output as latching (1), or momentary (0). Invert has no effect on the result. The *"CONST"* field (column W) controls the three modes of operation.

If CONST is:

0   The output will set on the "leading" and "trailing" edge.
1   The output will set on the "leading" edge only.
2   The output will set on the "trailing" edge only.

4.4.2.7 Change Detect 8 (CHDET8)

This calculation results in a set output if any bit (0-7) of an input register (or point) changes state. It is convenient when determining a common alarm response to multiple input bits. The *"IN PT 2"* field (column U) is used to specify the output as latching (1), or momentary (0). Invert has no effect on the result. The CONST column controls the three modes of operation.

If CONST is:

0   The output will set on the "leading" and "trailing" edge.
1   The output will set on the "leading" edge only.
2   The output will set on the "trailing" edge only.

4.4.2.8 Arithmetic (ADD, SUB, MULT, DIV)

These calculation types will perform the indicated arithmetic operations on the source operands indicated by the calculation parameters. A simple "move" of an analog value can be accomplished by ADD'ing a single source point (set other parameters equal to zero).

> **Note:** The registers are signed 16 bit integers, so the range of possible values is -32767 to + 32767. Use caution that your calculations will remain within these limits. BASIC can be used for floating point calculations and large numbers.

ADD = (IN PT 1 + IN PT 2 + IN PT 3 + CONST)
SUB = (IN PT 1 - IN PT 2 - IN PT 3 - CONST)
MULT= (IN PT 1 * IN PT 2 * IN PT 3 * CONST)
DIV= (IN PT 1 / IN PT 2) * IN PT 3)

The DIV type uses *"IN PT 3"* for a multiply factor as follows:
    0 = x 1,
    1 = x 10,
    2 = x 100,
    3 = x 1000,
    4 = fractional value of 4096, for outputting directly to analog output.

4.4.2.9 Cycle Timer (CYCTMR)

The Cycle Timer momentarily sets the output every time the "timer" completes the cycle time. *"IN PT 1"* and *"IN PT 2"* (columns T and U) are multiplied to determine the total cycle time. "IN PT 1" and "IN PT 2" are CONSTANTS, they do not refer to line numbers in Table 1. The third input is used as an enable/disable function. Both input and output calculation types use the "current state" to show status. Invert has no effect on the result.

The total cycle time is the product of *"IN PT 1"* and *"IN PT 2"*:
(*"IN PT 1"* * *"IN PT 2"* = total cycle time - units defined below).

The CONST column controls several aspects of the timer.

If CONST is:

0   Inputs 1 & 2 are seconds. Thus, if either parameter is set to 60, the other parameter becomes, in effect, the number of minutes.

1   Inputs 1 & 2 are tenths of a second (0.1 seconds each).

2   Inputs 1 & 2 are seconds and the output functionality changes from a momentary to a square wave. The square wave has the same ON and OFF time as the total of inputs 1 & 2.

3   This is the same as "2" except the input times 1 & 2 are in tenths of a second.

4.4.2.10 Count Down (CTDWN)

This calculation has several options that control its functionality as a count down controller. This calculation is useful for measuring out a particular volume of product or providing timer control capabilities. Invert has no effect on the output.

Input 1 ("IN PT 1") – The first input references the point used to trigger the count down. If a zero is entered for Input 1 the count will decrease by one each time the function is evaluated, which is every 0.1 seconds.

Input 2 ("IN PT 2") – The second input references the point that will be the starting value to decrement. If a constant value is desired, set the *"CONST"* field to the desired value and set this field to zero. The starting value is only read at the beginning of each cycle.

Input 3 ("IN PT 3") – The third input references the enable point for the countdown. Each time the enable point is set the counter will reset and start counting down. The output will stay set until the enable point is reset. If Input 3 is set to <u>zero</u> the counter will repeat continuously setting the counter output for one cycle each time the counter reaches zero.

Note: This calculation <u>does not work</u> as an "output" type.

4.4.2.11 Time of Day - One Shot (TOD-OS)

The TOD function has three modes of operations. The normal calculation (*"CONST"* = 0) will set for approximately 1 minute at a particular time of day. The start/stop type calculations (*"CONST"* = 1 or 2) will set between the start and stop times. Invert has no effect on the result. The *"CONST"* parameter (column W) controls the functions as follows:

If CONST is:

0   Input 1 (*"IN PT 1"*) is the hour setting, if over 24 then the timer ignores hours. Input 2 (*"IN PT 2"*) is the minute setting.

1   Input 1 is the start minute and Input 2 is the stop minute.

2   Input 1 is the start hour and Input 2 is the stop hour.

Input 3 (*"IN PT 3"*) is a value to set the day-of-week parameter. The day-of-week value is based on setting bits for each day that is active. Each bit (therefore each day) has a weighted value. Add the weighted values of each day that needs to be "active". Input 3 will equal the sum of these weighted values. Every day active would be a value of 127.

<u>Example:</u>

If the timer is to be active on Monday and Friday, add the weighted values of the two days together as shown below. This will be the value for *"IN PT 3"*.

Day	Bit (0 or 1) set = 1	Weighted Value	Total
Sunday	0	0	0
Monday	1	2	2
Tuesday	0	4	0
Wednesday	0	8	0
Thursday	0	16	0
Friday	1	32	32
Saturday	0	64	0

Input 3 value   **34**

4.4.2.12 Date Compare (DATEck)

This calculation is used to set or clear based on the comparison of current date to either a date constant or to registers containing month and day values (defined below). The calculation is "set" if the dates match. Invert can be used to reverse the result (i.e., "set" if the dates do not match).

> **CONST** - The "constant" field (column W) is used to indicate if the input parameters 1 and 2 are to be considered constants or line numbers. The line numbers would point to registers containing month and day values.
>
> **Input 1 ("IN PT 1")** - If the "CONST" field = 0, this field contains the <u>month</u> value. If the "CONST" field = 1, then this field is the line number that contains a month value.
>
> **Input 2 ("IN PT 2")** - If the "CONST" field = 0, this field contains <u>day</u> value. If the "CONST" field = 1, then this field is the line number that contains a day value.
>
> **Input 3 ("IN PT 3")** - Not used

Note: This calculation <u>does not work</u> as an "output" type.

4.4.2.13 Copy (COPY)

The copy function will move data from one place to another. It is designed to route analog data to and from other analog points. The copy function is the only way to route data directly to the MIN, MAX, HI LIMIT and LO LIMIT fields of an analog point. The copy function only works with analog points.

<u>With "PT TYPE" defined as an analog output:</u>

The first parameter (*"IN PT 1"*) is the **<u>source data</u>**. If the value is zero, the *"CURVALUE"* column of this point will be used.

The second parameter (*"IN PT 2"*) is the **<u>destination field</u>**, defined as follows:

    0 = CURVALUE,
    1 = MAX,
    2 = MIN,
    3 = HI LIMIT,
    4 = LO LIMIT.

The third parameter (*"IN PT 3"*) is the **<u>destination line number</u>**.

With "PT TYPE" defined as an analog input:

The first parameter (*"IN PT 1"*) is the **source line number**.

The second parameter (*"IN PT 2"*) is the **source field**, defined as follows:

    0 = CURVALUE,
    1 = MAX,
    2 = MIN,
    3 = HI LIMIT,
    4 = LO LIMIT.

The *"IN PT 3"* field is used as an offset index. The *"IN PT 3"* value references another line number whose *"CURVAL"* field will contain the offset value. This offset causes the "copied" line number to be:

"Copied" *line number* = *"IN PT 1"* value (a line number) + the *"CURVAL"* value (of the line number referenced in *"IN PT 3"*)

Example:
>   Line 10 - *curval=35*
>   Line 11 - *curval=48*
>   Line 12 - *curval=27*
>   :
>   Line 20 - *curval=1*
>   Line 21 - **curval=48**, Hardware Type = CALC-PT, Point Type = analog input,
>   Calculation type = COPY, *"IN PT 1"* = 10, *"IN PT 2"* =0, *"IN PT 3"*
= 20

GIVEN: *"IN PT 1"* = 10 (original line number reference)
>   *"IN PT 2"* = 0 (defines the field to copy)
>   *"IN PT 3"* = 20 (the line number containing the "offset index value")

THEN: Line 21 - *"CURVAL"* = 48, which was copied from line 11.
> The original line number is 10. The offset value is 1 *(from "IN PT 3"*, which points to line 20, that has a *"CURVAL"* of 1). The "copied" *line number* is then the original line number (10) plus the offset value (1) which is 11. The *"IN PT 2"* value determines which field to copy, which is "0 = *CURVAL"* in this case. Therefore the copied value is 48, which is the *CURVAL* of line 11.

4.4.2.14 Compare (CMPARE)

If *"IN PT1"* is greater than or equal to *"IN PT 2"* then the current state = ON.

4.4.3 Input Function tables

The next figure is an overview of calculation types where the PT TYPE is set as an **input.**

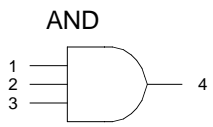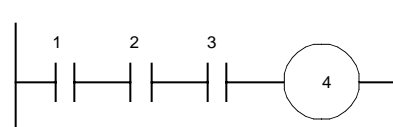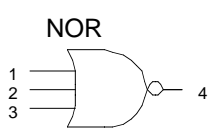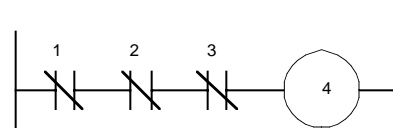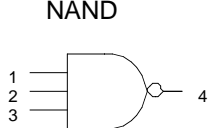| Column S FUNCTION	Column C CURSTATE	Column T IN PT 1	Column U IN PT 2	Column V IN PT 3	Column W CONST
BAND	Result	Source 1	Source 2	Source 3	N.U.
BOR	Result	Source 1	Source 2	Source 3	N.U.
BXOR	Result	Source 1	Source 2	Source 3	N.U.
BMUX	Result	Source 1	Source 2	Select 1 or 2 Digital only	N.U.
LATCH	Result	Set input	Reset input	Enable Pt	N.U.
CTRLR (also '>' and '<')	Result	Point for High trigger (< LO if this fld=0)	Point for Low trigger (> Hi if this fld= 0)	Enable Pt (if=0, ENB)	N.U. (Note: INVERT= PumpIn)
CTDWN	Result	Trigger point	Base Value	Enable	N.U.
ADD	Result	Source 1 +	Source 2 +	Source 3	Constant
SUB	Result	Source 1 -	Source 2 -	Source 3	Constant
MULT	Result	Source 1 *	Source 2 *	Source 3	Constant
DIV	Result	Source 1 /	Source 2 *	0=X1,1=X10,2=X100,3=X1000,4=fractional value of 4096	N.U.
CYCTMR	Result	Const time 1 (Note: period is product of const 1 & const 2)	Const time 2	Enable Pt (when Enable Pt goes to Off, Resets timer)	= 0: O.S., secs =1: O.S., 0.1 sec =2:SquWave,sec =3:S.W.,0.1 secs
TOD-OS	Result	If Const=0, HOUR # (else start hr or min)	IfConst =0, MINUTE # (else end hr or min)	Const code Day-of-week Sum of # :(Sun=1,Mon=2,etc)	0=normal, 1=minutes, 2=hours
CHDET1	Result	Source 1	Control code 0=momentary 1=latch	Enable	0=both edges 1=leading 2=trailing
CHDET8	Result	Source 1	0=momentary 1=latch	Enable	0=both edges 1=leading 2=trailing
CLIP	Result	Source	0=Clip,use Src limits 1=Clip%,use Src limits 2=Clip, use this pt's limits 3=Clip%,use this pt's limits	Multiplier 0= 1 1= 10 2= 100 3= 1000	N.U.
COPY	Result	Source point	0=CURVAL 1=MAX,2=MIN 3=HI LIMIT 4=LO LIMIT	Offset from Input 1	N.U.
DATEck	Result =Set if Date match.	If const=0, = Month, else = line #	If const=0, =Day, else = line # of day.	NU	0 or 1= const fields or line numbers.

INPUT Point Types

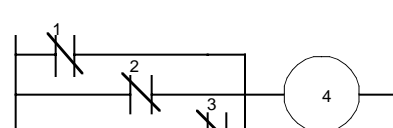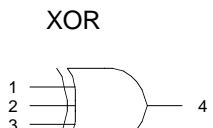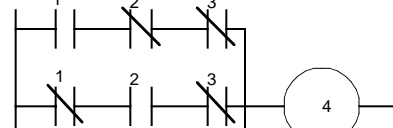### 4.4.4 Output Function tables
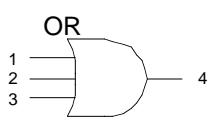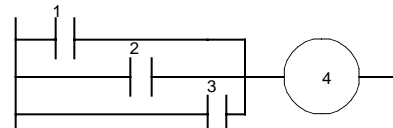
The next figure is an overview of calculation types where the PT TYPE is set as an **output.**

Column S FUNCTION	Column C CURSTATE	Column T IN PT 1	Column U IN PT 2	Column V IN PT 3	Column W CONST
BAND	Source 3	Source 1	Source 2	Destination	N.U.
BOR	Source 3	Source 1	Source 2	Destination	N.U.
BXOR	Source 3	Source 1	Source 2	Destination	N.U.
ADD	Source 3 +	Source 1 +	Source 2 +	Destination	Constant
SUB	Source 3 -	Source 1 -	Source 2 -	Destination	Constant
MULT	Source 3 *	Source 1 *	Source 2 *	Destination	Constant
COPY	N.U.	Source point	0=CURVAL 1=Mx,2=Min 3=HI LIMIT 4=LO LIMIT	Destination	N.U.

Figure.4-1
OUTPUT Point Types

4.4.5 Calculated Point Diagrams

The following tables show the comparison of calculated point Types with logic symbols and ladder logic representations.
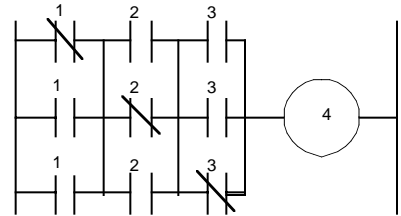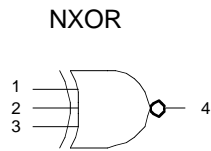
CALC TYPE	LOGIC SYMBOL	LADDER LOGIC EQUIV

BAND — AND

BOR INVERT — NOR

BOR — OR

BAND INVERT — NAND

BXOR — XOR

CALC TYPE	LOGIC SYMBOL	LADDER LOGIC EQUIV

BXOR
INVERT

NXOR

1
2
3

4

1   2   3

1   2   3   4

1   2   3

BXOR

A&!B

A 1
B 2
B 3

4

A   B

4

BMUX

2 INP MUX

A 1

B 2

SEL 3

!A/B

4

1   3

2   3

4

LATCH

EDGE TRIG LATCH

SET   1

RESET   2

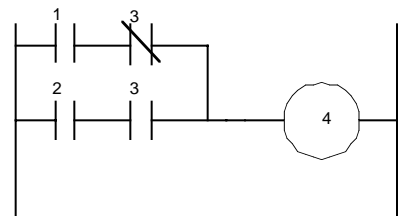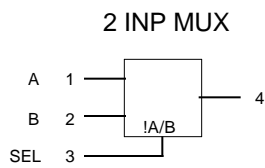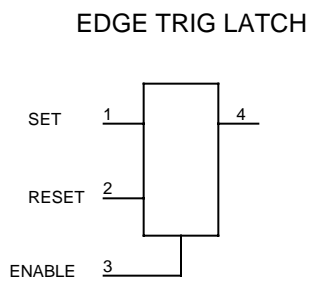ENABLE   3

4
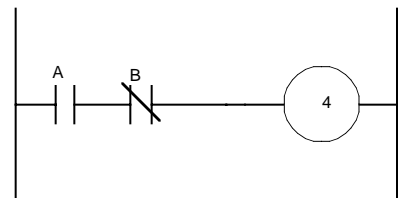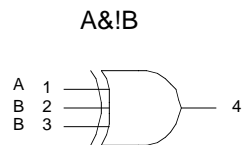
Sets on leading edge.
Resets on leading edge.
Held reset if not enabled.
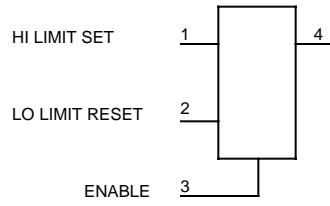
Note: if CONST = 1, the Latch
will be level sensitive.

CALC TYPE	LOGIC SYMBOL	LOGICAL EQUIV

PUMP OUT CTRLR

CTRLR

HI LIMIT SET — 1 ⌐ 4

LO LIMIT RESET — 2

ENABLE — 3

IF ENABLED,
 SETS ON HI LIMIT INP,
 RESETS ON LO LIMIT INP

PUMP IN CTRLR

CTRLR
 INVERT

LO LIMIT SET — 2 ⌐ 4

HI LIMIT RESET — 1
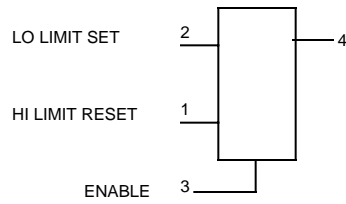
ENABLE — 3

IF ENABLED,
 SETS ON LO LIMIT INP,
 RESETS ON HI LIMIT INP

CHDET1

Const —

INPUT — 1 ⌐ 4

Latch Mode
0= No Latch — 2

Enable — 3

NON-LATCH (IN2=0)

In

Out-Mode 0

Out-Mode 1

Out-Mode 2

LATCH ON (IN2=1)

In

Out

Enable

CALC TYPE	LOGIC SYMBOL	LOGICAL EQUIV

CYCTMR

CONST MODE / SEL

1

2

ENABLE 3

X

4
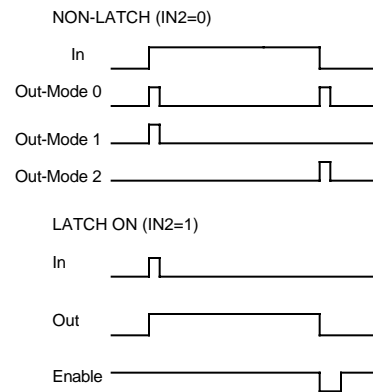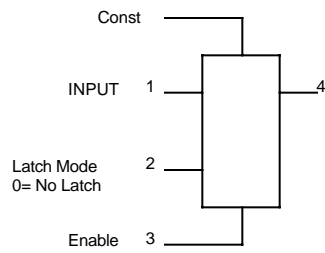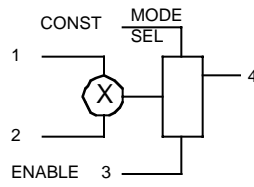
IF ENABLED,
 MODE 0- SECS/OneShot
 MODE 1- SECS/SQ.Wave
 MODE 2- 0.1 SEC/OneShot
 MODE 3- 0.1 SEC/SQ.Wave

Inputs 1 & 2 are consts and
multiply to give time value.

TOD-OS

Const=0 Mode / Sel

Hour Cnst 1
Min Cnst 2
WDay Cnst 3

4
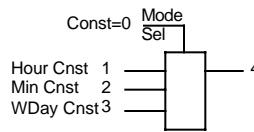
The curval output goes set at
the hour/min indicated for about
1 minute. If hour >24, it goes
set every hour.

TOD-OS

Const=1 Mode / Sel

Strt Min 1
Stop Min 2
WDay Cnst 3

4
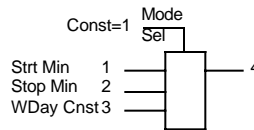
The curval output goes set at
the start min and stays set till
the end min, every hour.

TOD-OS

Const=2 Mode / Sel

Strt Hour 1
Stop Hour 2
WDay Cnst 3

4
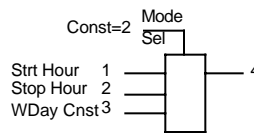
The curval output goes set at
the start hour and remains set
till the end hour.

CALC TYPE	LOGIC SYMBOL	LOGICAL EQUIV

CTDWN

PreSet- Const

Input Pt / 0 1   4

PreSet Pt / 0 2

Enable Pt / 0 3
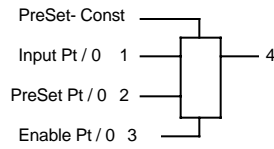
If Input Pt linked, counts down each Leading Edge, output goes set when Ct=0. If Input=0, counts down every .1 sec.

If Preset linked to Pt, Pt value is used as preset. If Preset=0, Const field is used as preset.

If Enable is linked to Pt, the Enable LE will load the Preset into the counter and allow count down. If Enable=0, Ct going to 0 will reload counter with preset.

ADD

1

2

3   +   4
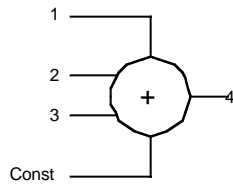
Const

Adds up to three Pts + Const

SUB

1

2

3   -   4
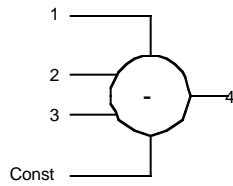
Const

Subtracts up to three Pts - Const
(1 - 2 - 3 - C)

MULT

1

2

3   X   4
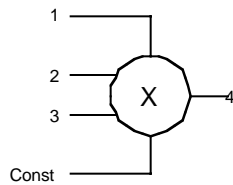
Const

Multiplies up to three Pts + Const (1 x 2 x 3 x Const)

DIV

1

2

3   /   4
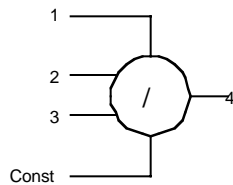
Const

Divides In 1 by In 2.
  Const=0: X1
  Const=1: X10
  Const=2: X100
  Const=3: X1000
  Const=4: fractional part of 4096

4.5 Scaling and Calibration

Table 1 analog points have individual full scale and offset parameters.

If the full scale parameter is left at 0 the analog value will not be converted and will show the raw value as presented by the hardware. The full scale value of zero is also used when displaying a value retrieved from another station which has already been converted to engineering units.

The resolution of the I/O hardware may be specified in the *"Resol/LZ"* field (column W).

Resolution options are:
    0 = 10 bit bipolar   HWFS = 512
    1 = 10 bit unipolar   HWFS = 1023
    2 = 12 bit bipolar   HWFS = 2047
    3 = 12 bit unipolar   HWFS = 4095

The default is 10 bit, bipolar A/D configuration (0).

4.5.1 Analog Inputs

A rough calibration of the sensor may be required depending on the hardware used. For SM805 expansion I/O modules, the points are referenced to a precision reference and there is no calibration required. They have a full scale trim which should not require field adjustment.

The basic formula for analog conversions is:

converted value = (raw value/HWFS * (Range - Offset)) + Offset

Note that the HWFS (Hardware Full Scale) term is the full scale for the A/D, Refer to the above list for actual HWFS values. The *"Resol/LZ"* field (column W) must be set to the proper value.

The *"RANGE/FS"* value (column U) is the maximum value displayed when the instrument is producing full scale for the analog input (i.e., 5 volts or 20 mA).

To quickly calculate the *"OFFSET"* (column V), first determine the percentage of the raw offset range that will be suppressed. Then multiply that by the range of the finished values.

A standard 4 - 20 mA (or 1 - 5 volt) input has a 25% range suppression (range = 20 - 4 = 16, and 4 / 16 = .25). Take 25% of the full scale RANGE value, and that will be the OFFSET.

Forexample, a 4-20 mA signal with a desired display of 0 to 100 would have OFFSET value of -25 and a RANGE of 100.

Examples (4-20 mA input):

Scaling	OFFSET	RANGE/FS
0 to 100	-25	100
0 to 200	-50	200
0 to 300	-75	300
0 to 400	-100	400
0 to 500	-125	500
0 to 2000	-500	2000
0 to 2500	-625	2500
-30 to 130	-70	130
-100 to +100	-150	100

Scaling to match field data

The first step in scaling analog values to match the field data is to take readings at two points so that a linear equation can be determined.

One reading should be at the low end and one at the high end of the scale (or somewhere close to each end). Set the analog scaling parameters *"RANGE/FS"* and *"OFFSET"* to zero so the raw analog values can be observed. The current values of the *"MINVAL"* and *"MAXVAL"* (columns H and G) fields are used for display, and the raw minimum and raw maximum readings are directly from the A-D converter.

The fundamental equation is, **$y = m*x + b$**, and the first step is to calculate the terms "m" and "b":

m = (MAXVAL - MINVAL) / (Raw maximum - Raw minimum)

m = (MAXVAL - MINVAL) / (Raw maximum - Raw minimum)

b = MINVAL - (m * Raw minimum)

The HWFS has four possible values depending on the hardware. The four values are 512, 1023, 2047 and 4095. These correspond to the four choices for hardware type in the *"Resol/LZ"* field (column W - 0, 1, 2, or 3).

After solving for "m" and "b", the *"RANGE/FS"* value can be determined by the following formula:

RANGE/FS = (m * HWFS) + b

The OFFSET value is equal to "b" and needs no further calculation, therefore:

OFFSET = b

Note: An EXCEL spreadsheet with the above calculations is available at no charge.

Example 1:

An elevated tank is being measured at ground level by a pressure transmitter with a range of 0 to 30 PSI. The tank is 20 feet high and has a total height of 50 feet It is desired to show the level in the bowl (0-30 feet) and suppress the riser pipe level. The transmitter is installed and the analog value read into the internal analog (12 bit bipolar, HWFS = 2047). Table 1 has zero values in the *"RANGE/FS"* and *"OFFSET"* columns (U and V).

69.3 ft		2048	
50 ft		1476	30 ft

Instrument
Range 0 - 30 PSI
(0 - 69.3 feet)

Desired
Scaling

20 ft		588	0 ft
0		0	
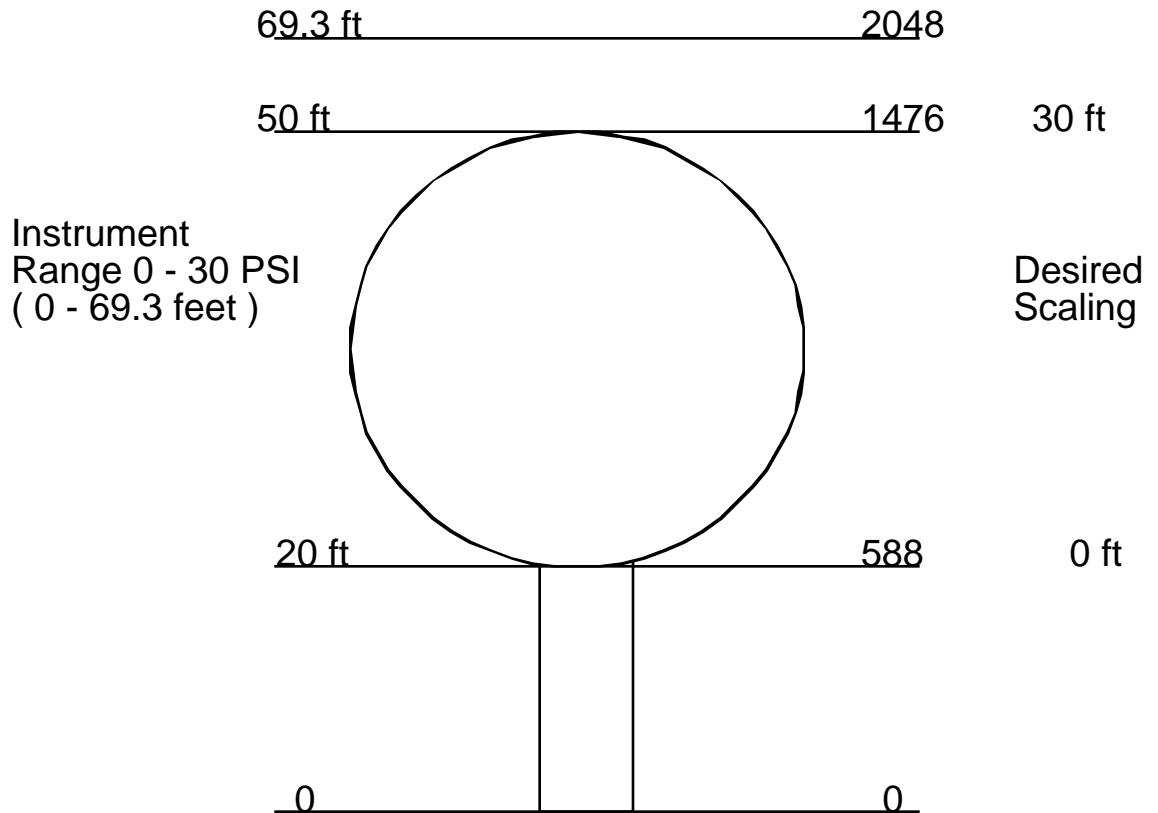
The values are observed when the tank is overflowing (known overflow at 50 feet); the value shown is 1476. We now have a maximum desired value of 30 feet with a maximum raw count of 1476.

The tank is drained to the bottom of the bowl and the raw count is noted at 588. The minimum desired value is 0 feet and minimum raw count is 588.

1. m = (30 - 0) / (1476 - 588) **= 0.03378**

2. b = 0 - (0.03378 * 588) **= -19.864**

3. RANGE/FS = (0.03378 * 2048) + (-19.864) **= 49.3**

4. OFFSET (same as b) = **-19.8**

Example 2:

A level transmitter has been factory calibrated so that a range of 0 - 12 feet will produce a 4 - 20mA output. This will be read into an analog expansion module with 12 bit resolution (i.e., HWFS = 4095). Since the maximum value desired is at the full scale output, the 12 feet can be entered directly into the RANGE/FS column and the standard 25% (4-20 mA loop) range offset would be 25% of 12, which is 3, and this can be entered into the *"OFFSET"* column.

For the sake of example we can show the full calculation. The high raw value will be 4095 and the low raw value will be 819 (20% of full scale).

1. m = (12 - 0) / (4095 - 819) **= 0.003663**

2. b = 0 - (0.003663 * 4095) **= -3.0**

3. RANGE/FS = (0.003663 * 4095) + (-3.0) **= 12.0**

4. OFFSET (same as b) **= -3.0**

4.5.2 Analog Outputs

Analog outputs will convert an engineering unit value to a 12 bit binary value suitable for a 12 bit D/A. Clamping at zero and maximum scale (4095) prevent undesirable "overflow" wrap-around from causing unwanted excursions of the output signal.

The conversion is as follows:

output value = 4095 * (EUvalue-Offset)/Range)

As an example, to convert a 0-100% value to a 4-20 ma output, the Range and Offset would be 125 and -25.

The Resol/LZ column has no effect on the conversion.

Invert will reverse the output range.

4.5.3 Engineering Unit Labels - Analog Points

A list of standard Engineering unit labels is available for analog points. They can be selected by using the up/down arrow keys to edit the label field (*"UNITS"*, columns D and Z). (Use the HOME key to return to the first entry) The available labels are:

1. MV
2. MA
3. VOLT
4. AMP
5. KV
6. KW
7. KVAR
8. KWHR
9. WATT
10. 'blank'
11. FEET
12. INCH
13. PSI
14. GAL.
15. KGal
16. GPM
17. MGal
18. GPM
19. MGD
20. SEC
21. DEG
22. DEG F
23. DEG C
24. R HUM
25. WndSp
26. InH20
27. MB
28. RPM
29. %
30. x10
31. x100
32. x1K
33. x10k

4.5.4 Engineering Unit Labels - Digital Points

The default label pair for digital points is ON/OFF. Several other label pairs are available, which make the display information more relevant to the use of the point.

These label pairs are selected by entering the number of the pair as shown below in the *"LabelSel"* field (column Z).

"LabelSel" Value	Point state 0	1
0	OFF	ON (default)
1	OPEN	CLOSE
2	STOP	RUN
3	ManOFF	Man ON
4	MANUAL	AUTO
5	Normal	High
6	Normal	Low
7	UP	DOWN
8	DisArm	Armed

4.6 Point Alarming Functions

All points in Table 1 can indicate an alarm condition (or alarm state). The display for an alarm can be suppressed by setting the *"ALM ENBL"* field to "disabled".

If the alarm is enabled for a point, the alarm acknowledge field (*"UNACK"*, column F) will set on any change in alarm state. It will remain set, even after the alarm condition disappears, until manually reset (acknowledged) by an operator.

4.6.1 Digital Alarming

Digital points that have alarming enabled will create an alarm on change of state. If the alarm delay value is set to a non-zero number of seconds, alarming will occur only after the delay period <u>if the alarm condition still exists</u>. The reset delay will be a maximum of 6 seconds regardless of the delay value.

If necessary, the *"INVERT"* parameter may be used to reverse the actual status to assure correct "alarm" and "normal" states for a digital point.

4.6.1.1 Annunciator Outputs

Digital outputs on the expansion bus have special characteristics that can be used with the alarm functions. If the *"AlmAct'n"* field (column AE) is set to 4 the output will flash on alarm and on return to normal. If set to 6 it will flash on alarm, but not on return to normal. Acknowledge will stop the flashing.

4.6.2 Analog Alarming

Analog points that have alarming enabled will create a high/low alarm if the corresponding limit is exceeded. If the alarm delay value is set to a non-zero number of seconds, alarming will occur after the delay period <u>only if the alarm condition still exists</u>.

4.6.3 Common Alarms-

Alarms can be classified as major, minor, both, or none. The *"AlmType"* field (column AD) is used to set this parameter.

        0 = Do not include as part of Major or Minor alarm set
        1 = Major alarm

2 = Minor alarm
            3 = Both major and minor

Alarm actions can be altered by setting the *"AlmAct'n"* field (column AE) to the desired mode. The *"AlmAct'n"* types are:

            0 = Normal alarming
            1 = Suppress unacknowledge on set or on return to normal
            2 = Suppress unack on return to normal
            4 = Flash expansion DO on alarm and on return to normal
            6 = Flash expansion DO on alarm but not on return to normal

All alarming on a particular point may be disabled by setting the Alarm Enable field (*"ALM ENBL"*, column N) to "Disabled".

An internal DI point (reg 0, bit 4) is set active upon the occurrence of any new "major" alarm. It can be accessed for output to an audible alarm or other actions. This point can be reset by an external input or manual toggling of the common alarm reset by the operator.

An internal DI point (reg 0, bit 5) is set active upon the occurrence of any new "minor" alarm. It can be accessed for output to an audible alarm or other actions. This point can be reset by an external input or manual toggling of the common alarm reset by the operator.

To reset major and minor alarms, the reset point is internal DO (reg 0, bit 2). To acknowledge all alarms the reset point is internal DO (reg 0, bit 3).

> **Note:** The controller type calculated point *("CTRLR")* uses the "alarm" thresholds as the set/reset inputs. To use a controller type calculated point without nuisance alarms, leave alarms enabled on the analog point and set the *"AlmAct'n"* field (column AE) to 1 (i.e., suppress unack. on set or on return to normal).

4.7 Data Storage

4.7.1 Summary Data

Summary data is captured at midnight for all points in Table 1. One previous day of summary data is available. Point specific setup is not required for this feature.

Display of "summary data" options are selected from the menu line. Access the main menu (press "/"), then select "Display", "Summary", and then the data that you want to display.

4.7.2 Historical Data Points

A Table 1 point may be recorded on a periodic or event based trigger for historical sample storage. The *"SmplType"* field (column AG) will set the conditions for sampling. A value of 0 (default) disables sampling for this point. The *"SmpField"* field (column AH) determines if the <u>sample value</u> will be determined by the *"SmplType"* field (column AG) or default to sampling the *"MINVAL"* and *"MAXVAL"* fields (columns H and G).

If the sampling parameter is set to a point number (between 1 and the maximum Table 1 point number), then recording will occur continuously while that enabling point is ON (Current State = 1). If, for example, the enabling point is a calculated cycle timer point then samples would be recorded while the timer is in the ON state.

Enabling point	Description
1 - 180	A trigger can be specified by entering the enabling point number of another point.
250	will enable "event" (alarm) recording for this point (i.e., records a sample when this point exceeds the alarm limit or changes state).
251	enables recording of a sample every minute.
252	enables recording of samples every hour.
253	a sample of the *"MINVAL"* and *"MAXVAL"* will be recorded once each HOUR.
254	A sample of the *"MINVAL"* and *"MAXVAL"* will be recorded once each HOUR **AND CLEAR**.

> *NOTE:* If *"PT TYPE"* is TOTALIZE and *"SmplType"* is 253, then both "totalize" registers are recorded each hour. The data "Type" in the history display will be "TL".

4.7.3 Historical Data Controls

The historical data display can be accessed from the Table 1 menu line by selecting DISPLAY, then HISTORY. Begin viewing data by pressing the HOME key.

The Historical display is not dynamically updated, so it is necessary to hit the HOME key to return to the current entry (last sample). If the "JUMP TO" control is used, the HOME key must be pressed to update the screen.

The arrow up/down and page up/down keys all cause page up/down operations. However, the arrow up/down keys will not refresh the banner and header areas, which the page keys will do.

The following figure shows the historical display with the main menu line. Note that the "PointSel" and "Control" menu options point to their respective sub-menus (superimposed, for illustration purposes only).

```
 STATION      15  Sta Name   HISTORICAL DATA   Wednesday 14:43:27  06/23/93

 RTN-EXIT   PointSel    Control     JumpTo      SetMarker  WrtCrtMrkr

 RECORDING:        CURRENT POS      MAX POSITION    MARK POSITION   OVERWR:  ON
 ON                   5854            12415             0           AUT/MN:  MANUAL
      DISP_CRIT>   PT1:     0    PT2:     0    STA:     0           TRIG PT:

 SAMPLE#    DAY    TIME      STATION / POINT#      TYPE     NAME        VALUE

  5853      23    14:43:00        15         16      DG                       0
  5852      23    14:43:00        15         15      DG                       0
  5851      23    14:43:00        15         14      DG                       0
  5850      23    14:43:00        15         13      DG                       1
  5849      23    14:43:00        15         12      DG                       0
  5848      23    14:43:00        15         11      DG                       0
  5847      23    14:43:00        15         10      DG                       0
  5846      23    14:43:00        15          9      DG                       0
  5845      23    14:43:00        15          8      DG                       0
  5844      23    14:43:00        15          7      DG                       1


                     Enbl/Dis   Auto/Man    AutoPnt    OverWrEnb   Clear


              Point #1   Point #2    StationSel
```

The header area of the "Historical Data" display contains several parameters. These parameters control the content of the displayed data and/or control the actual historical recording process.

NOTE: The standard number of samples available is 5,600. An optional memory chip is available which increases the number of samples to 22,000. Contact NBT for details.

MENU OPTIONS

PointSel Allows the selection of two different point numbers and/or a station address. The display will only show those points or station logs. This controls the display of data only. All of the data still remains in the historical file. If the values are zero, all points will be displayed.

Point #1	values are 1 through 180
Point #2	values are 1 through 180
StationSel	values are 0 through 240

Control The functions under "Control" are:

Enbl/Dis The command which turns the historical recording OFF and ON

Auto/Man This command is not presently used

AutoPnt The line number that will Enable/Disable historical recording, if 0, recording is Enabled

OverWrEnb This determines if the recording process will stop or continue when the data storage is full. If Enabled, then recording will continue from index zero

Clear Resets the pointer position to zero

JumpTo This allows jumping to any index in the historical file

SetMarker   This command keeps track of the last position that was sent during the last XMODEM transfer. The XMODEM file transfer will automatically reset this after each transmission but it can be manually set to the current position with this command. Note: follow this command with a WrtCrtMrkr (below) to copy the memory value to the History file

WrtCrtMrkr writes the SetMarker value entered (above) to the history file. Makes the entry "permanent".

4.8 Accessing Table 2 (Communications Table)

When Table 1 uses Table 2 data, the *"ENABLE"* field (column B) in Table 2 may be set ON or OFF. Regardless of the *"ENABLE"* setting, the *"STATUS"* field (column N) in Table 2 must show "Comm. OK" or the data will not be read into Table 1.

When linking a Table 1 point to a Table 2 register, the **line number** in Table 2 is used in the Table 1 *"MOD ADDR"* field (column S). The value specified in the Table 1 *"REG/PT"* field (column T) is the offset into the registers of that station index.

Note: Table 1 points use the remote station index (line number in Table 2) to access remote station data. They do not use the actual remote station address.