Hardware Manual
9900

Operator Interface Terminal

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HM9900 Revision 2

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Section 1: Introduction

The Model 9900 combines the functionality of message display, numeric entry device, and pushbutton station into a powerful Operator Interface Terminal. The unit features an forty character vacuum fluorescent display and eight user keys with light emitting diodes plus slide in legend tags.

The 9900 is fully programmable using ScreenMaker 9000 Windows™ based off-line software. The system engineer can customize each screen to fit the current application. Text and data can be combined in order to eliminate the need for the operator to know the origin of the data being displayed.

The text can be combined with variable fields coming from any data location internal to the PLC. In addition, the values can be displayed in various formats. Variables can also be defined as read only and when writing is allowed, individual limits can be assigned allowing for system protection.

The eight user keys can be configured to operate as momentary pushbutton switches or as push-on/push-off selector switches. The LEDs located next to each user key may be configured to follow the switch state or independently controlled by the PLC application program..

The 9900 is supplied with 64K bytes of EEPROM nonvolatile memory, therefore, the threat of losing the customized screens (up to 719) due to a power loss, dead battery, etc., is nonexistent.

What are Screens & Fields?

The 9900 is customize for a particular application by creating screens. A screen is similar to a canned message and may include variable information from the PLC. A group of text or a variable is referred to as a field. Each field has an assigned size and position within a screen. There are ten field types and up to ten fields may be included in a single screen. A brief explanation of the ten field types is given below.

Static Text This field allows fixed character strings to be displayed within a screen. The field size and position are user defined.

Scrolling Text Horizontal This field allows character strings to scroll right to left within a defined window. The window size and position are user defined.

Scrolling Text Vertical This field is also referred to as a ***Paging Field*** and allows character strings to scroll bottom to top within a defined window. The window size and position are user defined.

Date This field allows the current date to be displayed as: Month/Day/Year Note: only the last two digits of the year are used, however; no calculations are ever performed using this value. Year 2000 will have no surprise effects..

Time This field allows the current time to be displayed as: Hours/Minutes/Seconds

Window This field appears as fixed text within a screen and provides the mechanism for linking screens. When this field is created another screen number is specified. Moving the cursor to this field and pressing the **[ENT]** key will trigger the specified screen. This field is useful for creating menus, help screens, or multiple choice screens within an application

Section 1: Introduction

Data Set This field appears as fixed text within a screen. When this field is created an address and a data value are specified in addition to the field text. Moving the cursor to this field and pressing the **[ENT]** key will cause the data value to be written to the assigned address within the PLC.

Bit Status When creating this field a data bit and PLC address are specified. Two character strings are also typed in, one for the off state of the bit and one for the on state of the bit. One of the two character strings will then be displayed depending on the status of the specified data bit. If enabled this field will also function as a bit modify. Moving the cursor to the field and pressing the **[ENT]** key will cause the bit to be complimented by the 9900.

PLC Data This field will display variable information from within the PLC. The address from which data will be retrieved is specified when the *PLC Data* field is created. The data can be displayed in Hex, Octal, Binary, Decimal, or floating point formats. Modification to the value may be enabled or disabled. Individual data value limits are also set for each PLC *Data field* created. If enabled, values are entered by first moving the cursor to this field then pressing the **[ENT]** key; a new value is then keyed in and the **[ENT]** key pressed.

Bar Chart This field is displayed as a conventional bar chart expanding from left to right relative to the value of an assigned address within the PLC. During field creation the address is specified, a scale value that is applied to the raw data prior to display, and the character that will be use in the bar.

Initial Power Up

When the 9900 is first powered, an initialization process is started that performs diagnostic tests on both the hardware and software. An initialization screen will appear in the display window to indicate the target PLC, the input power type, and software version number.

The screen will look like this:

VV = AC or DC, WW = PLC Type
Z = PLC Model, XX = Software Version

```
9900-VV-WW-1-Z V2.XX
   for PLC TYPE
```

After the initialization process is complete, screen number zero will be displayed if it has been programmed. Screen number zero is a user identification screen and may be used to show a job number or company name. It cannot be displayed during normal operation of the unit.

While screen zero is being displayed the 9900 will attempt to establish communications with the PLC. The word "**BUSY**" will appear in the upper right hand corner of the display. If successful the 9900 will proceed with normal operation. If the 9900 is not successful in establishing communication the following screen will display:

```
PLC comm fault
Retry Reset
```

If "**Retry**" is selected the 9900 will again attempt to establish communication. If "**Reset**" is selected the 9900 will restart its executive program as though power were just applied.

Section 2: ScreenMaker 9000

The 9900 is customized for a particular application by creating screen files using ScreenMaker 9000 configuration software. One of the first steps is to create a tag name data base which essentially is a table that associates an alphanumeric label to a PLC address. When variables are used within a screen the label is used rather then the direct address. If the assigned address for a label is ever changed it will automatically change for every usage of the label.

Screen Properties

With every screen created there is an associated screen properties file that determines the destination of the screen and if displayed, how it will display. The destination for a screen can be directly to the display, to the screen stack for later display, to the printer port, or any combination of the three. Within the Screen Properties window are three check boxes labeled Display, Stack, and Printer.

Display: When selected, the screen will be immediately sent to the 9900's display.

Stack: When selected, the screen will be placed in the 9900's screen stack. Screens that are placed in the stack can later be displayed. Displaying stacked screens is discussed in section 2, page 7.

Print: When selected, the screen will be directed to the COM1 communication port. COM1 must be configured and connected to a receiving device such as a printer or computer.

When the Display box is selected the designer must consider how the screen will be displayed. The 9900 allows multiple screen to be triggered at any one time. If the application utilizes this feature then special attention must be given to the display parameters to insure a successful application.

Only one of the following three display attributes may be selected.

CLEAR: If the screen is configured as clear, the entire 9900 display will be cleared before this screen is displayed. This allows only one screen to appear on the display even if another screen was previously opened from another trigger source. The screen triggered by another trigger source is not destroyed, only hidden. If this new screen is closed, the screens triggered by the another trigger source will reappear. (Kind of like Windows!)

COVER: If the screen is configured as cover, it will be written on top of any screens previously triggered from other trigger sources. Any parts of the display that are not used by the new screen will remain as they were (again, kind of like Windows). Note however, that any PLC variable fields that show through from previous screens cannot be accessed.. Only those PLC variable fields on the cover screen can be accessed.

OVERLAY: This is identical to COVER with one exception. Any PLC variable fields that completely show through from another screen can also be accessed.

Section 2: ScreenMaker 9000

System Setup

To create a new application, ScreenMaker 9000 requires a PLC type to be selected, i.e., Allen-Bradley SLC500, or GE Fanuc Series 90. When you choose SETUP, OIT from the task bar a window will open presenting five folder choices.

General: This folder allows a four digit hexadecimal combination lock to be specified. You also select if the lock will effect the user keys, numeric keypad, or both. A combination value of zero will disable the combination lock function. See Section 2, page 5 for additional information.

LED's This folder allows you to choose how the LED will operate individually. The choice is PLC controlled or user key controlled. See Section 2, page 9 for additional information.

Peripheral Port This folder allows the serial transmission parameters for COM1 to be specified. The individual parameters include: baud rate, number of data bits, parity option, and number of stop bits.

PLC Port This folder allows PLC driver dependant parameters to be selected. See the appropriate appendix for the PLC driver type installed for specific information.

User Keys This folder allows you to choose how the user keys will operate individually. The choice is momentary pushbutton or push-on/push-off selector switch. See Section 2, page 9 for additional information.

Section 3: Run Mode

When in run mode the 9900 must share various information with the PLC. For example the 9900 must provide the PLC with the status of the User Keys; the PLC must dictate what screen(s) should be displayed at any particular time. To accomplish these tasks a contiguous group of words, referred to as the Dialogue File, must be reserved in the PLC for use with the 9900.

Dialogue File

The Dialogue File is a group of up to 57 contiguous words that are created or reserved within the PLC. The 9900 must know the starting address of this group of words and the numbers of words reserved. This information is provided to the 9900 during the system setup process using ScreenMaker 9000. The *Dialogue File* can be broken into five basic sections which are: The Command Register, LED control, user key status, screen triggering, and clock/calendar.

The *Dialogue File* structure is shown in this table.

ADDRESS	FUNCTION
Word 1	Command Register
Word 2	----
Word 3	----
Word 4	Red LEDs
Word 5	Switch Image
Word 6	Integer Trigger One
Word 7	Integer Trigger Two
Word 8	Integer Trigger Three
Word 9	Integer Trigger Four
Word 10 : Word 57	Bit Trigger Blocks & Clock/Calendar

Command Register

The *Command Register* word in the *Dialogue File* is viewed by the 9900 as sixteen individual bits. The individual bits instruct the 9900 to perform a specific function, or indicate the status of a function. The 9900 will monitor and update the *Command Register* frequently, so each of the bits may be changed by the PLC application program at any time.

The *Command Register* structure is shown in this table.

The bit numbers in the table are for reference only since memory configurations and designations vary between PLC brands. Bit 1 is always the least significant bit in the word, that is, the bit having the lowest binary weight. In some PLCs it may be references as Bit 0 or Bit 16. In some PLCs the bit numbers may be sequential numbered in octal or hexadecimal.

A description of the individual bits begins on the following page.

BIT	FUNCTION
1	Lock Edit keys
2	Lock User keys
3	Window Field Lock
4	Edit keys C_Locked
5	User Keys C_Locked
6	Window Field C_Locked
7	Invalid Combination Entered
8	Display Stack Screen
9	Stack Request
10	Stack is empty
11	Stack is full
12	Help key
13	Value Modified
14	Clear Stack
15	----
16	Communication Active Flag

Lock Edit Keys (Bit 1)

Section 3: Run Mode

The *Lock Edit Keys* feature allows the 9900's edit keypad and any external keyboard to be completely disabled by the PLC application program. When Command Register Bit 1 is energized the 9900 will light the **LOCKED** LED and ignore any edit keys. The display will remain operational, that is, screens may still be triggered by the PLC.

When Command Register Bit 1 is de-energized the **LOCKED** LED will turn off, providing Bits 2 and 3 are also off, and normal edit key operation will resume.

Lock User Keys (Bit 2)

The *Lock User Keys* feature allows the 9900's sixteen user keys to be disabled by the PLC application program. When Command Register Bit 2 is energized the 9900 will light the **LOCKED** LED and ignore any activity on the user keys. The display and edit keys will remain operational.

When Command Register Bit 2 is de-energized the **LOCKED** LED will turn off, providing Bits 1 and 3 are also de-energized, and normal user key operation will resume.

Lock Window Field (Bit 3)

The *Lock Window Field* feature allows the PLC to prevent all *Window Fields* from operating. When Command Register Bit 3 is energized the 9900 will light the **LOCKED** LED and all *Window Fields* will be disabled. The *Window Fields* will still appear within a screen as they normally would, however, moving the cursor to that field and pressing the enter key will not produce any action.

When Command Register Bit 3 is de-energized the **LOCKED** LED will turn off, providing Bits 3 and 2 are also de-energized, and all *Window Fields* will function normal.

Combination Lock (Bits 4, 5, 6, 7)

The three locks, previously described, (Bits 1, 2, & 3) are controlled by the PLC alone. The 9900 and the operator have no way to override their effect. A second method of locking the edit keys, function keys, and window fields is available. This method takes the form of a combination lock.

These Command Register Bits are used with the combination lock feature.

- Bit 4 - Edit keys C_Locked
- Bit 5 - User keys C_Locked
- Bit 6 - Window Fields C_Locked
- Bit 7 - Invalid Combination Entered

The combination lock may be activated or de-activated by either the PLC or the operator. The combination lock can only be activated if a valid combination value was assigned during system setup. The following rules apply when either the PLC controls the locks or the operator does.

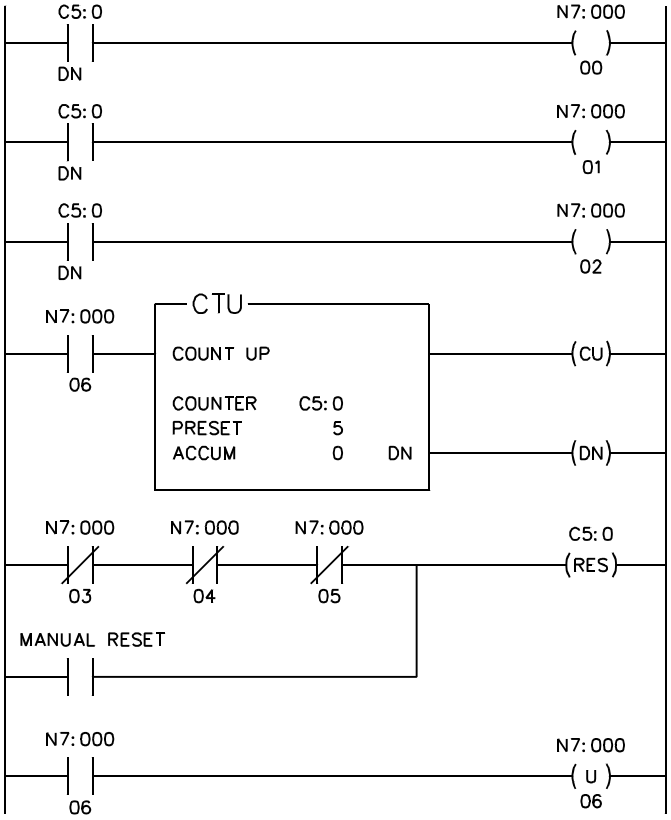
- If any of Command Register Bits 4, 5, or 6 are energized the **LOCKED** LED will flash.
- When the combination lock is activated by the operator, Bits 4, 5, and 6 will be activated or de-activated by the 9900 based on the initial setup configured using ScreenMaker 9000.
- When the combination lock is de-activated by the operator, Command Register Bits 4, 5, and 6 will be de-energized by the 9900. If any of these bits are being held on by the application program the 9900 will not be successful in de-energizing them.

- The PLC may energize a bit that can not be energized by the 9900. For example if user keys were not selected for combination lock control during setup, the PLC may energize the corresponding bit and lock the user keys.
- The 9900 can not override bits within the command register that are being held energized or de-energized by the PLC's application program. The PLC can override the 9900.

The operator activates the combination lock by pressing the **[LOCK]** key. This will start the **LOCKED** LED flashing and the selected locks will be enforced. De-activating the combination by the operator requires the correct four digit combination value being keyed into the 9900. The process is started by pressing the **[LOCK]** key. Next, the four digit combination value must be entered including any leading zeros, followed by the **[ENT]** key. If the combination value is correct and the PLC is not forcing the combination lock feature on the **LOCKED** LED will stop flashing and normal operation will resume. If an incorrect combination value is entered the 9900 will energize Command Register Bit 7 .

Application Note:

This application shows the circuitry required in a SLC500 to lock out the 9900 after 5 consecutive failed attempts to unlock the unit using the combination lock. Although addressing may be different for other brands of PLCs, the basic logic will remain valid.



N7:000/00 = Lock Edit Keys
N7:000/01 = Lock User Keys
N7:000/02 = Window Field Lock
N7:000/03 = Edit Keys C_Locked
N7:000/04 = User Keys C_Locked
N7:000/05 = Window Field C_Locked
N7:000/06 = Invalid Combination

Counter C5:0 is incremented each time an invalid combination is entered. If five consecutive invalid combinations are entered the counter will energize its output which will energize lock bits 00, 01, and 02 in the *Command Register*. At that point no further entries will be allowed until a manual reset occurs.

Section 3: Run Mode

Screen Stack (Bits 8, 9, 10, 11, 14)

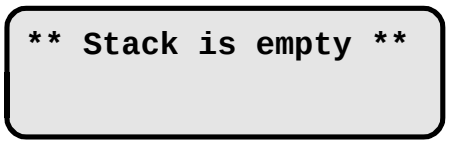
When screens are created one of the attribute flags allows the screens to be placed within a stack that resides inside the 9900's RAM memory. Up to 100 screens may be in the stack at any time.

These five Bits in the Command Register are associated with the Stack feature.

- Bit 8 - Display Stack Screen
- Bit 9 - Stack Request
- Bit 10 - Stack is Empty
- Bit 11 - Stack is Full
- Bit 14 - Clear Stack

A special screen, number 720, is associated with the screen stack feature. Screen 720 will be displayed when Command Register Bit 8 is energized to enable stack screen display, and no stacked screens are present. Screen 720 may be modified using ScreenMaker 9000, however it can not be deleted.

Screen 720 looks like this as shipped from the factory.



The following points describe the basic features offered by the screen stack.

- To direct a screen to the stack the "**Stack**" flag must be selected .
- Command Register Bit 8 (Display Stack Screen) enables stacked screens to be displayed. This bit is controlled by the PLC, however, through ladder logic one of the 9900 User Keys may be used to energize or de-energize it.
- When Command Register Bit 9 (Stack Request) is energized the next screen on the stack will be moved to the display. If there are no screens in the stack, screen 720 will automatically be displayed. This bit is controlled by the PLC, however, through ladder logic one of the 9900 user keys may be used to energize or de-energize it.
- Command Register Bit 10 (Stack is Empty) will be energized by the 9900 when no screens are in the stack. It is at this time that screen 720 is displayed. The 9900 will de-energize this bit when at least one screen is in the stack.
- Command Register Bit 11 (Stack is Full) will be energized by the 9900 when one hundred screens are in the stack. While this bit is energized no additional screens will be accepted by the stack, they will be lost. The 9900 will de-energize this bit when the number of screens in the stack falls below one hundred.
- When Command Register Bit 14 (Clear Stack) is energized all screens that are in the stack are deleted leaving the stack empty.

Help Key (Bit 12)

This Command Register bit is controlled by the **[HELP]** key in the 9900's edit keypad. The **[HELP]** key functions like a pushbutton. When the **[HELP]** key is pressed the 9900 will energize Command Register Bit 12. When the **[HELP]** key is released the 9900 will de-energize Bit 12. The actual use and implementation of this feature is left up to the programmer.

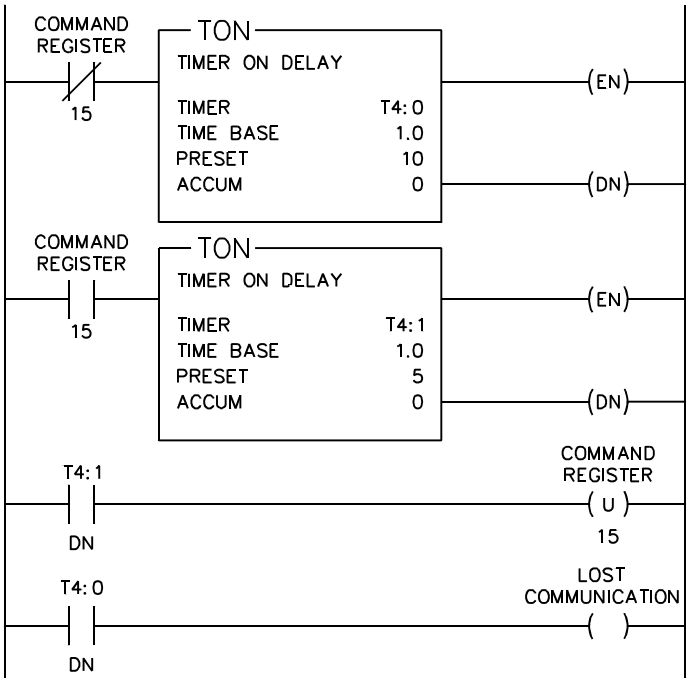
Section 3: Run Mode

Value Modified (Bit 13)

Command Register bit 13 is energized by the 9900 any time a screen sends data to the PLC. This includes Data Set Fields, PLC Data Fields, and Bit Status Fields when used in the bit set format. The 9900 does not de-energize this bit, therefore the PLC application program must acknowledge the modification by de-energizing the bit each time it is set. If this function is not used by the PLC application program then it may simply be ignored.

Communication Active Flag (Bit 16)

The 9900 will monitor Command Register Bit 16 frequently. This bit will be energized by the 9900 anytime it is found de-energized. The PLC can use this bit as part of a watchdog timer circuit that can detect a loss of communication with the 9900. The following SLC500 ladder logic is used to detect a loss of communication with the 9900. Although addressing may be different for other brands of PLCs, the basic logic will remain valid.



Section 3: Run Mode

LED control

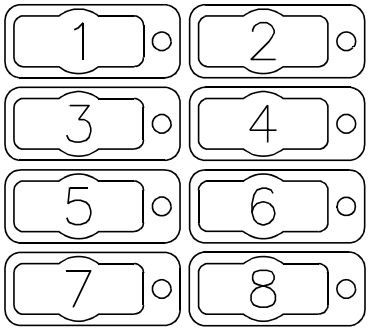
The LEDs located adjacent to each user key may be controlled by their associated switches, or they may be independently controlled by bits inside the PLC. Dialogue File word four is reserved for this purpose. Each LED is assigned one bit in the LED word.

	LED Number & Word Bit Number															
LED Designation	--	--	--	--	--	--	--	--	8	7	6	5	4	3	2	1
Dialogue File Word 4	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

The bit numbers in the table above are for reference only since memory configurations and designations vary between PLC brands. Bit 1 is always the least significant bit in the word, that is, the bit having the lowest binary weight. In some PLCs it may be references as Bit 0 or Bit 16. In some PLCs the bit numbers may be sequential numbered in octal or hexadecimal.

The LEDs are numbered as shown here.

To illuminate an LED, the appropriate bit must be energized. For example, to light LED two, bit number two of Dialogue File word four must be energized.



User Keys

The eight user keys may be configured as momentary pushbutton switches or as push-on/push-off switches. Dialogue File word number five is reserved for use as a switch image register. The 9900 will frequently update the bits in this word to correspond to the action on the user keys.

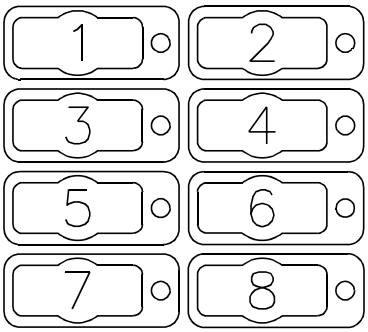
Each switch is assigned one bit in the Switch Image LED word.

	Switch Number & Word Bit Number															
Switch Designation	--	--	--	--	--	--	--	--	8	7	6	5	4	3	2	1
Dialogue File Word 5	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

The bit numbers in the table above are for reference only since memory configurations and designations vary between PLC brands. Bit 1 is always the least significant bit in the word, that is, the bit having the lowest binary weight. In some PLCs it may be references as Bit 0 or Bit 16. In some PLCs the bit numbers may be sequential numbered in octal or hexadecimal.

Section 3: Run Mode

The Switches are numbered as shown here.



The effect the 9900's switches have on their assigned word bits depends on how the switch is configured.

Configured as Selector Switch -

When the switch is pressed, the 9900 will compliment the state of the associated switch image bit. For example, if the switch image bit is energized and the switch is pressed, the bit will be de-energized by the 9900. If the bit is de-energized and the switch is pressed, it will be energized. This action produces the push-on/push-off selector switch effect.

Configured as Pushbutton Switch -

When the switch is pressed, the 9900 will energize the associated switch image bit. When the switch is released, the 9900 will de-energize the associated bit. This is typical of a standard discrete industrial pushbutton switch.

Notice! **The 9900 will allow two switches to be pressed at any one time. If more than two are pressed, the entire keyboard is ignored.**

Screen Triggering

A trigger is a means by which a screen is made to display. The 9900 has two screen trigger methods, Integer Trigger and Bit Trigger. Both trigger methods may be used simultaneously. The two trigger methods will be discussed separately.

Integer Triggers

To trigger a screen using the integer trigger method a value, which is the screen number, is written into one of the Dialogue File Integer trigger words. The 9900 provides four integer trigger words. These are words six, seven, eight, and nine. Each integer trigger word is independent. Any one or all may be used simultaneously; however, when using more than one integer trigger word care and planning is critical for success.

Using multiple integer trigger words can make the application program in the PLC simpler and easier to understand. In most applications there are multiple types of messages that need to be displayed. Some examples are: status, faults, instructions, setups, and maintenance messages. Providing multiple triggers allows these messages to be grouped, thus adding greater organization to the PLC's application program.

Section 3: Run Mode

Each of the 9900's integer trigger words is structured as shown below.

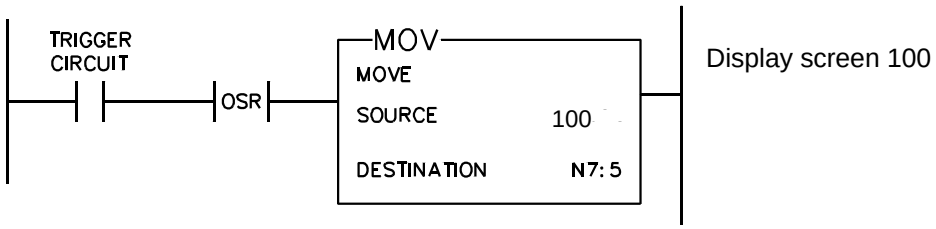
Trigger Word Bit Number															
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
		Always Zero				Screen Number									
	Fault or Screen does not exist														
	Screen has been processed														

The bit numbers in the table above are for reference only since memory configurations and designations vary between PLC brands. Bit 1 is always the least significant bit in the word, that is, the bit having the lowest binary weight. In some PLCs it may be references as Bit 0 or Bit 16. In some PLCs the bit numbers may be sequential numbered in octal or hexadecimal.

Since the screen number can not be greater than 722 only the ten least significant bits of the trigger words are used when a screen number is moved into it. The 9900 uses bits 15 & 16 to indicate status back to the PLC. The 9900 will set (energize) bit 16 when the screen specified by bits 1 through 10 has been accepted for display, stack, or printing. If the screen does not exist, or has syntax errors, then bit 15 will also be set.

Displaying a screen is referred to as "opening a screen". Each time a new screen number is moved into a particular trigger word, that screen number will be recognized by the 9900 and the screen will become open. The new screen will overwrite any screen previously specified by that trigger word. Removing a currently displayed screen is referred to as "closing a screen". Only one screen may be open for each trigger word at any one time. It is possible to close a currently open screen without opening another to replace it. This is done by moving a value of zero into the trigger word.

The SLC500 ladder logic below shows the basic circuit for triggering a screen using an integer trigger word. This circuit moves the constant value 100 into the integer trigger word. Notice that the move is configured as a one shot function. This is important so that the 9900 can modify trigger word bits 15 and 16.



Section 3: Run Mode

Bit Triggers

Screens may also be triggered using individual bits. The bits within Dialogue File words ten through 54 each correlate to a particular screen number. To trigger a screen simply energize the bit associated with the screen number you want to display.

The following table shows the association between screen numbers and bits.

	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	Bit 16
Word 10	*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Word 11	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Word 12	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Word 13	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
Word 14	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Word 54	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719

Notice that trigger word 10, bit 1 does not have a screen number assigned to it. This bit is used to close any screen that was opened by a bit trigger. Furthermore, as long as trigger word 10, bit 1 is energized the 9900 will ignore all bit triggers.

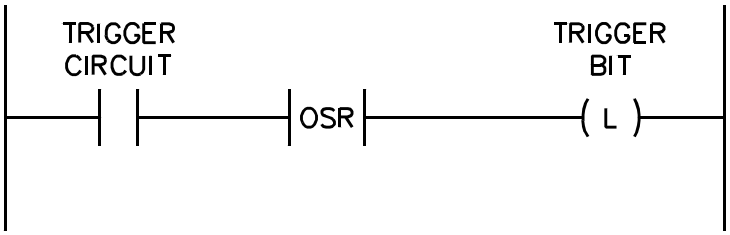
The 9900 scans the bit trigger table starting from word ten, bit zero and continuing through bit sixteen of word 54 or the last word available, which ever is lower. If Bit trigger mode is not going to be used or if only a portion of the screens are to be bit triggered, the number of words created or specified for the Dialogue File should be reduced to only what is needed. This will improve the 9900,s response time.

As the 9900 scans the bit trigger table, the first off-to-on transition that is found will cause the associated screen to be displayed. Only one bit trigger screen may be open at any time, therefore, each time a new off-to-on transition is found the currently displayed screen will be closed prior to opening the new one.

The 9900 maintains an image of the bit trigger table. Each time the table of bits is read from the PLC it is first compared to the image to detect off-to-on transitions, then it is saved as the new image.

Once a screen has been displayed it can not be opened again until its trigger bit has been detected in the de-energized state. When the 9900 detects an off-to-on transition it will acknowledge the acceptance of the trigger by attempting to de-energize the trigger bit in the PLC. If the trigger bit in the PLC is programmed as a standard coil the 9900 will not be capable of de-energizing the bit. If the coil is programmed as a latch and the controlling circuit is a one shot the 9900 will be able to unlatch the circuit. This is the recommended configuration since the initiating contact need only be energized for one PLC scan.

Typical Trigger Circuit



Section 3: Run Mode

Programmer's Tool

Screen 722 is a special screen which allows access to any file within the PLC. Screen 722 can not be accessed by the screen editor. It can only be triggered by the integer trigger method. When screen 722 is triggered it will appear as shown below.

Any address that is available in the PLC may be accessed and the value of that address may be modified.

```
A:O000:000      [HEX]
D:0000
```

Caution!

This feature should be used only by individuals completely familiar with the application program resident in the PLC. Entering a value into an address without knowing what impact it might have on the operation of the PLC is very dangerous.

Transfer Date & Time to PLC

The 9900 contains a real time clock (TimeKeeper) that allows the date and time to be displayed within screens. The clock setup parameter in ScreenMaker 9000 must be set to "YES" to allow the clock/calendar data to be sent to the PLC. If the date and time is to be sent to the PLC, the Dialogue File must be configured with a minimum of twelve words. The date and time will be stored as BCD data in the last three words of the Dialogue File.
These last three words will not be interpreted as Bit Triggers.

The date and time will be transferred to the PLC in Binary Coded Decimal (BCD) format.

	High Byte of Word	Low Byte of Word
Last Word minus two	Seconds [00-59]	Minutes [00-59]
Last Word minus one	Hours [00-23]	Day [01-31]
Last Word in Dialogue File	Month [01-12]	Year [00-99]

Notice!

The year parameter is transferred to the PLC as a two digit value. If this value is used within any calculation, or is used to initiate any operation or action it will not meet Year2000 compliance.

Screen 721 is a preexisting screen that allows the Real Time Clock to be set and calibrated. Refer to Section 4 for information on this subject.

Section 4: Utilities

When power is first applied to the 9900, the keyboard is scanned to see if a key is being held down. If a key is being held down it will enter Utilities Mode.

Utilities Mode allows clock/calender setting and calibration, testing, initialization, and file transfers.

When the Utilities is entered this screen will be displayed.

```
A:TEST [00] 12:01:02
Key[1D-“ ”] 09/23/98
```

While this screen is displayed a keyboard test can be performed. The user keys are all configured as selector switches. Pressing any user key will cause its LED to change state. The **[SHIFT]** key will toggle the **SHIFTED** LED. Pressing any of the remaining editing or numeric keys will cause a character code to appear within the "**Key**" field on the display.

The "**A:TEST**" field is a paging field that presents the following four selections to be made:

A:TEST	Self cycle hardware test	**B:TIME**	Set and calibrate real time clock
C:INIT	Initialize EEPROM memory	**D:COMM**	Uploading and Downloading
E:EXIT	Exit utilities mode and enter run mode.		

[A]:TEST Pressing the **[A]** key will start the 9900 self testing. Two serial port test plugs are required to allow the test to pass successfully. A field will be scrolling various graphic characters. These characters are used to test for burnt out or continuously energized pixels. The red LEDs will be energized one at a time. The following communication faults may be encountered.

COM X RTS/CTS FAULT . . . . . CTS did not follow RTS.
COM X DID NOT RESPOND . . . . . Transmitted data was not received.
COM X BAD DATA . . . . . Transmitted data was received wrong.

[B]:TIME Pressing the **[B]** key will trigger the real time clock editing screen (screen 721). Each component of the date and time is modified separately, i.e., hours, minutes, etc.

The real time clock editing screen (screen 721) looks like this:

```
D:09/23/98  Cal:000
T:10:00:00     Save
```

Date & Time Setting

Each element of the date and time is edited separately. To edit a particular element, such as minutes, use the arrow keys to place the flashing cursor over top of the minutes field. Next press the **[ENT]** key, the new value, then the **[ENT]** key again. This process is typical for each element. To make any changes effective, the “**Save**” field must be activated.

Section 4: Utilities

Calibration

The Timekeeper is driven by a quartz crystal controlled oscillator with a normal frequency of 32768 Hz. The Timekeeper is typically accurate within ±1 minute per month at 25°C without calibration. The timekeeper is tested by the component manufacture not to exceed ±35 ppm (Parts Per Million) oscillator frequency error at 25°C, which comes to about ±1.53 minutes per month. The oscillation rate of any crystal changes with temperature.

The Timekeeper used in the 9900 provides a calibration technique that employs periodic counter correction. The calibration circuit adds or subtracts counts from the oscillator divider circuit at predefined intervals which will either increase or decrease the oscillator speed. The "**Calibrate**" parameter may be set to any value from -31 to +31. Each unit of change provides 2.034 ppm of adjustment providing a total adjustment range of ±63.07 ppm. Assuming the crystal frequency is exactly 32768 Hz, each of the 31 units would represent 5.35 seconds per month.

The "**Calibrate**" parameter is modified by moving the cursor to this field, pressing the **[Enter]** key, keying in the desired value then pressing the **[ENT]** key again. The change will not be stored in the Timekeeper until the "**Save**" parameter is selected .

[C]:INIT Pressing the **[C]** key trigger the memory initialization screen shown below.

```
Initialize Memory???
NO   YES
```

This screen allows the entire EEPROM screen memory to be erased. If "**NO**" is selected the utilities screen will return to the display. Selecting "**YES**" will initialize the memory.

As shown here, the word “ERASING” will appear on the display while the memory is being initialized. This may take a few minutes.

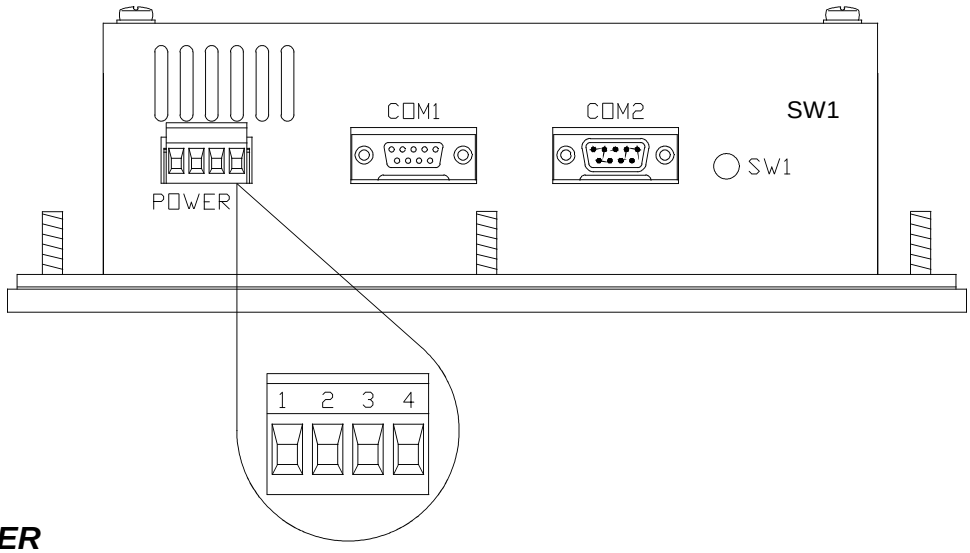
```
Initialize ERASING
NO   YES
```

[D]:COMM Pressing the **[D]** key will set the 9900 on-line for communication with ScreenMaker 9000 configuration software. Screen files and setup files can be uploaded or downloaded through this utility function.

[E]:EXIT Pressing the **[E]** key will exit the 9900 from Utilities mode and re-boot the 9900 into Run mode.

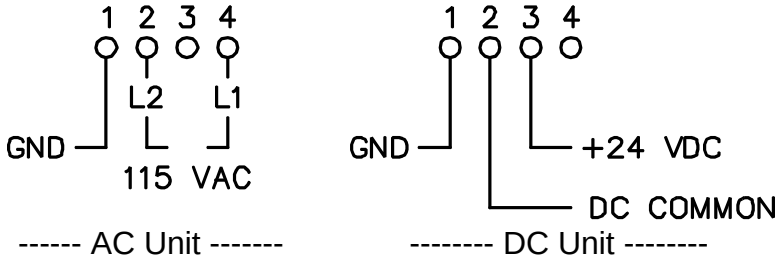
Appendix A: 9900 Access Plate

All connections to the 9900 are made through various connectors located at the bottom of the unit. DIP switches are also accessed through the bottom of the unit. This following diagram shows the placement of the various connectors and switches.



INPUT POWER

Power is provided to the 9900 through a three position removable terminal block. The following schematics show the connection required for both AC and DC units.



Serial Communication Port COM1

COM1 is provided through a nine pin female D-type connector. This is the interface to printers and computers for documenting an for uploading or downloading screen and setup files. This port uses RS-232C signal levels. The signal connections are shown below.

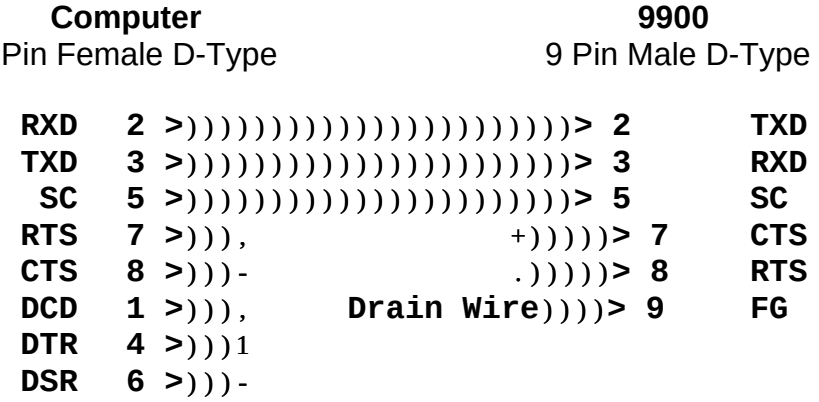
Pin 2	TXD Transmit Data, output	Pin 3	RXD Receive Data, input
Pin 7	CTS Clear To Send, input	Pin 8	RTS Request To Send, output
Pin 5	SC Signal Common	Pin 9	FG Frame Ground

Pins one, four, and six are wired together and do not connect to any circuitry within the 9900. The RTS signal will become active when the 9900 is attempting to send data. The 9900 will not transmit any data until CTS becomes active. If the connecting device does no use RTS and CTS these signals may be wired together at the 9900 to allow proper operation. The cable between the 9900 and any other device should not exceed fifty feet. Quartech offers a cable (Model 2126) that is configured to interface the 9900 to a personal computer.

Appendix A: 9900 Access Plate

Model 2126 Communication Cable

Used to load setup and screen files between the 9900 and personal computer



Serial Communication Port COM2

COM2 is provided through a 9 pin male D-type connector. This is the interface to a PLC. This port provides either RS-232C or RS-485 signal levels. The signal connections are shown below.

9900 with RS-232 interface on COM2:

Pin 2	TXD	Transmit Data, RS-232 out	Pin 3	RXD	Receive Data, RS-232 in
Pin 4	RTS	Request To Send, RS-232 out	Pin 5	CTS	Clear To Send, RS-232 in
Pin 7	SC	Signal Common	Pin 1	FG	Frame Ground

9900 with RS-485 interface on COM2:

Pin 1	TXDB	Transmit Data, RS-485 out	Pin 7	TXDB	Transmit Data, RS-485 out
Pin 2	TXDA	Transmit Data, RS-485 out	Pin 8	TXDA	Transmit Data, RS-485 out
Pin 3	TXDB	Receive Data, RS-485 in	Pin 4	RXDA	Receive Data, RS-485 in
Pin 5	TC	Transmit Control	Pin 6	SC	Signal Common
Pin 9	FG	Frame Ground			

Appendix B: Error Codes

The 9900 will display one of the following messages if it encounters a configuration, communication, or hardware error it cannot recover from without operator assistance.

The following messages typically indicates hardware failure. If re-powering the unit does not correct the problem, repair may be necessary.

- *RAM FAULT!!*
- *XXXX EPROM FAULT !!*

The following message is configuration related. The 9900 must be correctly configured.

- *Invalid Dfile*

The following messages may be displayed in response to certain keystrokes. These are not fatal errors. The message will be displayed for a few seconds then the 9900 will resume operations.

- *Value out of range*
- *Invalid address*
- *Invalid lock data*

The following error message may be electrical, configuration, or connection orientated. Action must be taken to correct the source of the problem.

- *PLC comm fault*

If this fault is encountered the following are potential trouble areas.

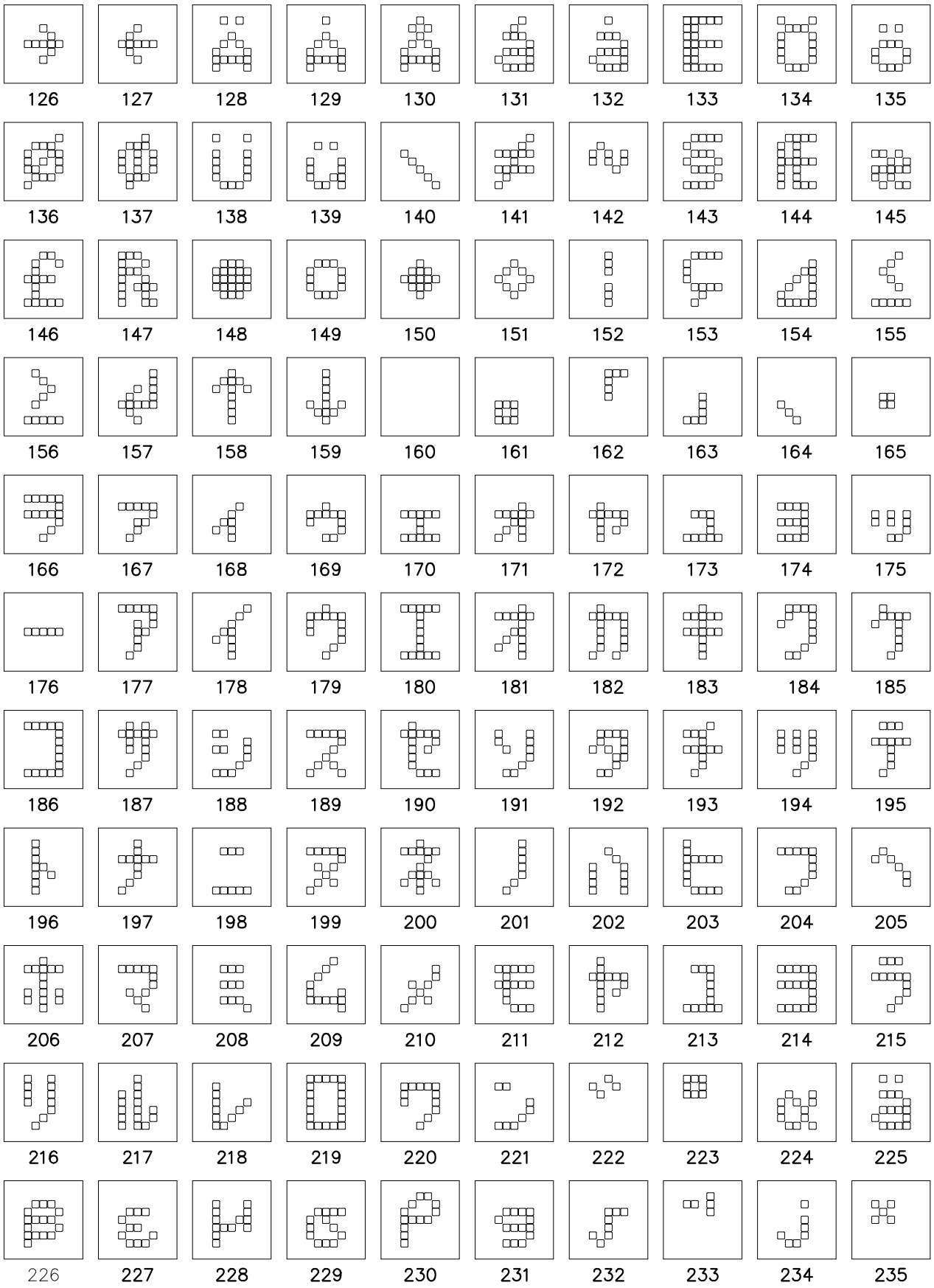
1. Improper interface setup, i.e., baud rate or PLC Type
2. Loose or improper cable connection.
3. Electrical interference through communication cable or power lines. Check routing

Appendix C: Special Screens

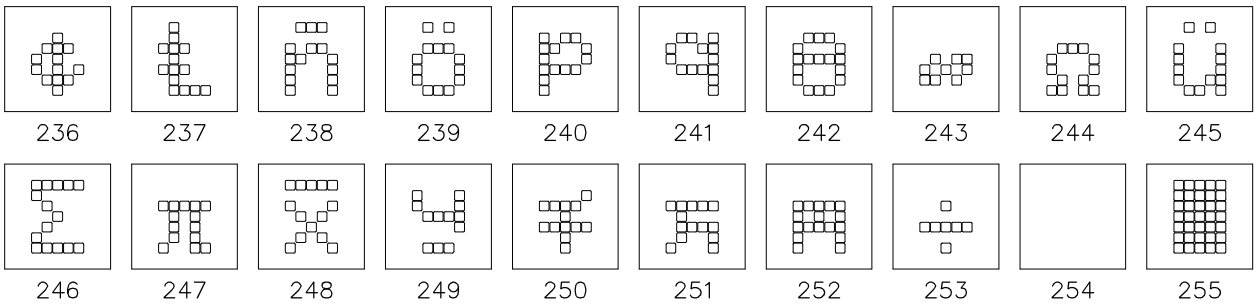
The 9900 provides 110 special graphic characters which may be used within any text string. The available characters are shown below. It is not recommended that these characters be used in screens that will be logged to a printer.

When creating a screen with ScreenMaker 9000 you can insert these characters within a field by holding down the **[Alt]** key while entering the three digit code using the **[NumPad]** keys. The number keys at the top of the computer keyboard will not work for this.

Appendix C: Special Characters



Appendix C: Special Screens



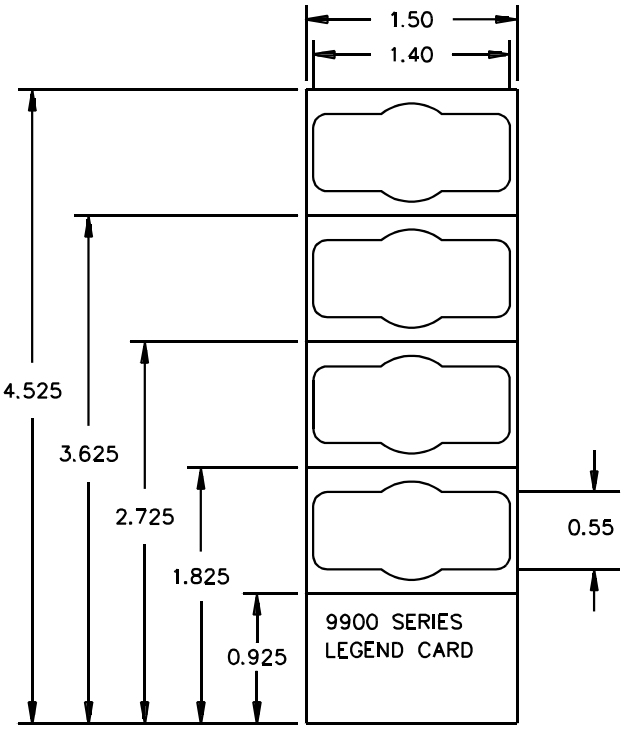
Appendix D: Legend Cards

Each of the eight user keys has a 9/16" x 1 3/8" legend area which allows the user to label each key. A set of legend cards is included with the 9900. The legend cards are kept clean by inserting them into a 'see through' pocket within the polyester overlay.

To gain access to the pocket in the overlay, it is necessary to remove the bezel. to do this, remove the rear gasket by pulling it up from the eight bezel studs. Once the gasket is removed the bezel should easily pull away from the electronic assembly.

Two legend card pockets are open at the bottom edge of the overlay. After labeling each legend card, carefully cut it to size and insert it into the correct pocket. Assemble the overlay to the bezel in the reverse order as removal.

Thickness: 0.010 inches



Quartech can provide custom legend cards produced to your specifications. Custom graphics and color may be included in each legend. Contact Quartech Customer Service for price and delivery.

Appendix E: Special Screens

Screen 0 User identification on power up. See Section 1, page 3.

Screen 720 Screen stack status. See Section 2, page 7 .

Screen 721 Real Time Clock setting and calibration. See Section 4, page 14.

Screen 722 Programmers Tool. See Section 2, page 13.

Appendix F: Installation

The 9900 is designed to be mounted in the door of an enclosure or on an operators console for ease of use. A template is provided to assist in the drilling and cutting of the mounting holes for the unit. Care should be taken to protect the unit from metal chips and conductive particles. Failure to protect the unit may cause damage when power is applied and may void warranty.

A minimum clearance of six inches should be kept between the unit and any other device that generates heat. In the event that the internal enclosure temperature periodically exceeds 55 degrees Celsius (131 degrees Fahrenheit), fans or a purge air system should be used to increase the air flow, and eliminate "Hot Spots" that occur within the panel.

Specifications:

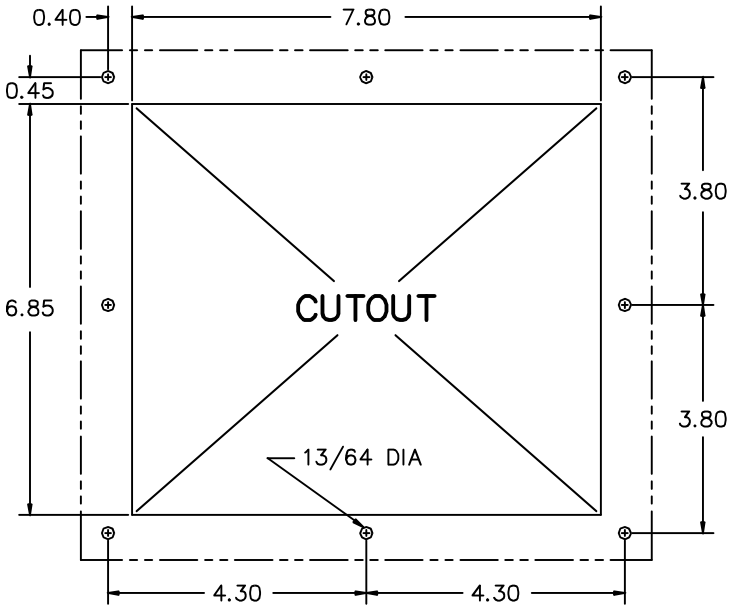
Display: . . . . . 4 character (2x2) Vacuum Fluorescent Display,
. blue/green color. 5mm character height
Keypad: . . . . . 24 tactile feedback keys rated for one million operations.
Memory: . . . . . EEPROM, 64,000 bytes, 719 screens max
Com1 Communications . . . . . RS-232, Peripheral Interface
Com2 Communications . . . . . RS-232 or RS-485, PLC Interface
AC Electrical . . . . . 115 VAC, ±10%, 50/60 Hz, @ ½ Amp
DC Electrical: . . . . . 24 VDC, ±5%, @ 1 Amp
Temperature: . . . . . 0°c to +55°c Operational, -20°c to +70°c Storage
Humidity . . . . . 10% to 95%, Non-condensing, Operational or storage
Vibration/Shock: . . . . . 0.5mm displacement (X,Y,Z axis), 10-55Hz, 40G shock
Weight: . . . . . 5 pounds
Mounting: . . . . . Maintains NEMA 4 and NEMA 12 enclosure rating.

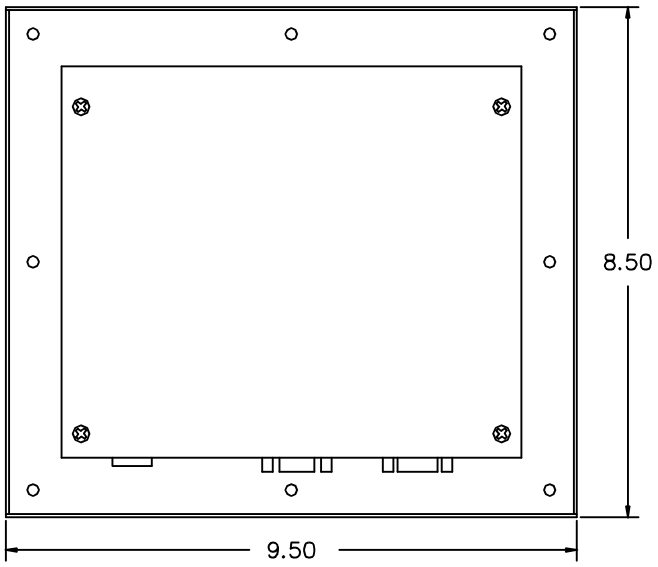
Wiring Considerations

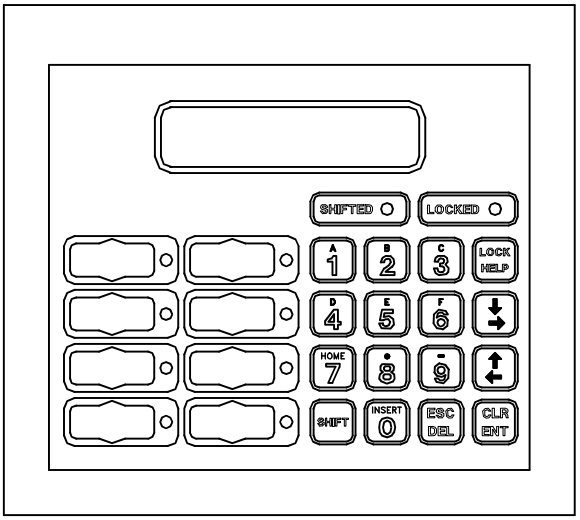
Care should be taken when routing DC power supply wires and the communication cable. Follow these guidelines for a trouble free installation. The DC power lines and communication cable must be kept away from AC power lines. Keep both at least one foot away from 115 VAC lines, and two feet away from higher voltage lines. This especially applies to the communication cable. If the cables must cross AC power lines, cross them at right angles (90°). Keep the cables away from sources of high energy fields such as arc welders, AC motors, motor starters, servo controllers, generators, induction heaters, and transformers.

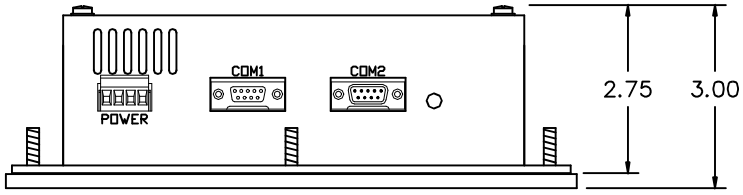
Appendix F: Installation

Mechanical Dimensions









Mounting studs are number 10-24. Mounting hardware is included.

All dimensions in inches

Appendix G: Allen-Bradley Drivers

Allen-Bradley Dialogue File

The following tables show the Dialogue File structure when the 9900 is used with a PLC-5 or SLC500 processor.

Dialogue File
NXXX is the Integer File number assigned.

ADDRESS	FUNCTION
NXXX:000	Command Register
NXXX:001	
NXXX:002	
NXXX:003	Red LEDs
NXXX:004	Switch Image
NXXX:005	Integer Trigger One
NXXX:006	Integer Trigger Two
NXXX:007	Integer Trigger Three
NXXX:008	Integer Trigger Four
NXXX:009 : NXXX:057	Bit Trigger Blocks & Clock/Calendar

Command Register
NXXX is Dialogue File number assigned.

ADDRESS	BIT	FUNCTION
NXXX:000	0	Lock Edit keys
NXXX:000	1	Lock User keys
NXXX:000	2	Window Field Lock
NXXX:000	3	Edit keys C_Locked
NXXX:000	4	User Keys C_Locked
NXXX:000	5	Window Field C_Locked
NXXX:000	6	Invalid Combination Entered
NXXX:000	7	Display Stack Screen
NXXX:000	8	Stack Request
NXXX:000	9	Stack is empty
NXXX:000	10	Stack is full
NXXX:000	11	Help key
NXXX:000	12	Value Modified
NXXX:000	13	Clear Stack
NXXX:000	14	
NXXX:000	15	Communication Active Flag

Allen-Bradley DF1 Interface

This 9900 offers a DF1 interface for communications with the PLC-5 and SLC500 processors. The DF1 port uses RS-232 signal levels and is intended for point to point communications, i.e., only a single peripheral device may be connected to the DF1 port.

PLC-5 processor configuration

Use Allen-Bradley programming software to configure the PLC-5 processor as shown below.

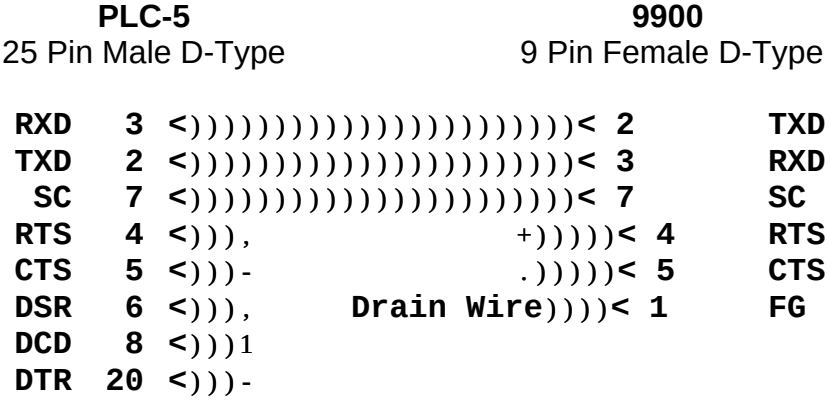
System Mode (DF1 Point to Point) Channel 0 Configuration

Diag. file:	0		
Remote mode change:	DISABLED	System mode char.:	S
Mode attention char.:	\0x1b	User mode char.:	U
Baud Rate:	19200	Parity:	NONE
Stop bits:	1		
Control line:	NO HANDSHAKING		
Duplicate Detect:	OFF	Error Detect:	CRC
ACK Timeout (20 ms):	500	NAK Retries:	3
		ENQ Retries:	3

Appendix G: Allen-Bradley Drivers

The following schematic shows the cable connections required between the 9900 and the PLC-5 DF1 port. This cable is available from Quartech in a standard length of ten feet. Cables up to fifty feet in length may be ordered.

Model 2138 Communication Cable



SLC500 processor configuration

Use Allen-Bradley programming software to configure the SLC500 processor as shown below.

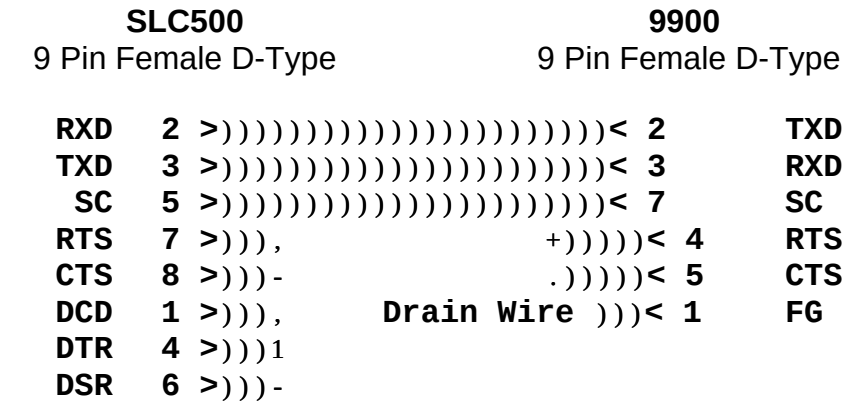
System Mode Channel 0 Configuration

Baud Rate:	19200	Parity:	NONE
Duplicate Detect:	DISABLED	Error Detect:	CRC
ACK Timeout [x20 ms]:	500	NAK Retries:	3
		ENQ Retries:	3
Control Line:	NO HANDSHAKING	Embedded Response:	ENABLED

The baud rate for the SLC500 and the 9900 may be set to 9600, however, 19200 is recommended.

The following schematic shows the cable connections required between the 9900 and the SLC500 DF1 port. This cable is available from Quartech in a standard length of ten feet. Cables up to fifty feet in length may be ordered.

Model 2135-10 Communication Cable



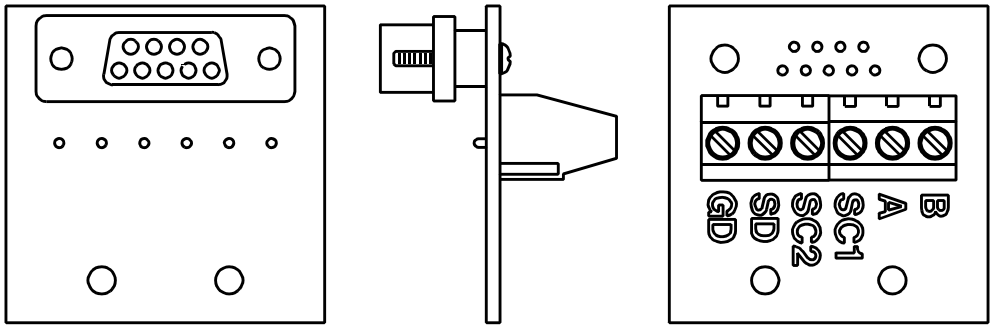
Appendix G: Allen-Bradley Drivers

Allen-Bradley DH485 Interface

The 9900 offers a DH485 Data Link network interface for communication with the Allen-Bradley SLC500 processor. The 9900 can communicate on the DH485 network along with other 9900's, other Quartech products, programmers, and any other devices that strictly follows the DH485 protocol. The 9900 must be assigned to a host PLC which is the PLC that its Dialogue File is located in. The 9900 can also display data from other PLCs within the network.

When connecting multiple devices on the network an Allen-Bradley 1747-AIC Isolated Link Coupler should be used between the SLC500 processor and the physical network. The 9900 is connected to the network through the Quartech 9106 Network Link Adapter.

Model 9106
Network Link Adapter



When connecting a single 9900 to a SLC500 processor a direct connection through the eight pin phone jack on the front of the processor may be preferable. The following schematic shows the cable connections required between the 9900 and the SLC500 DH485 port. This cable is available from Quartech in a standard length of ten feet. Cables up to fifty feet in length may be ordered.

Model 2125-10
Communication Cable

SLC500 8 Pin RJ45			9900 15 Pin Female D-Type	
RxTxB	1	<)))))))))))))))))))))))))))<	1	RxTxB
RxTxA	2	<)))))))))))))))))))))))))))<	2	RxTxA
SC	7	<)))))))))))))))))))))))))))<	6	SC
Send/Rec	5	<)))))))))))))))))))))))))))<	5	Send/Rec
		+)))))<	3	RXDB
		.)))))<	7	TXDB
		+)))))<	4	RXDA
		.)))))<	8	TXDA
		Drain Wire)))<	9	FG

DH485 Network Basics

The DH485 Data Link network uses a multiple master, token passing protocol. For this protocol, the devices on the network form a logical ring; that is, the devices assume an ordered sequence, with the last device in the sequence followed by the first. Each device knows the node address of the device following it (its successor). The physical ordering of the devices on the network is irrelevant and independent of the logical ordering.

Appendix G: Allen-Bradley Drivers

Each device on the network has the responsibility of periodically granting an opportunity for new devices to enter the network. Any time there exists a gap between a given device address and its successor's address, that device must periodically issue a "solicit successor" message to each potential node address between itself and its successor. The solicit successor message allows an opportunity for a new device to enter the network.

A total of 32 devices may share the DH485 Data Link network. When only a few devices are sharing the network the soliciting time can become considerable. To reduce unnecessary soliciting, a maximum poll address may be assigned in the 9900 and most other devices designed for use on the network. The 9900, and other devices utilizing this feature, will send a "solicit successor" message only to those device addresses that are in the gap between itself and its successor, and have an address less than or equal to its maximum poll address. Use of the maximum poll address can relieve the device with the highest node address from the burden of soliciting a large number of unused node addresses.

Choosing Device Node Addresses

It is imperative that each device on the network is assigned a unique node address. For best performance start node addresses at zero and increase sequentially, with no gaps between successive addresses. It is not important which device is assigned which address. The device with the highest address on the network should have its maximum poll address set equal to its own address.

For example: A DH485 network might include one SLC500, one programmer, and one 9900. Assigned node addresses could be as shown below.

- 9900 node address = 00
- Programmer node address = 01
- SLC500 node address = 02. Max. poll address = 02.

The network described above was set up for best performance. Sometimes it is desirable to leave gaps between devices addresses so that other devices can be easily added after the data link has been initialized. This is acceptable, however, it will result in a reduction of performance since some device will have to issue a solicit successor message to each unused address in the gap. If a gap is left it should be as small as possible to reduce the link initialization time. A gap of even one address will reduce network performance.

Transmission Lines

The DH485 Data Link network is designed to be wired in a point-to-point fashion. All devices are wired in-line, one after another, forming a single trunk line. Drop lines off the main trunk line are not recommended and may degrade or prevent network operation. As the trunk line length increases two factors become increasingly important. These factors are line resistance and line capacitance. In most applications the use of line terminating resistors will improve or allow satisfactory performance. Two terminating resistors are required for a network regardless of the number of devices in the network. One terminating resister is connected at each end of the network. The 9900 includes a terminating resistor that is switched into to the circuit by closing switch SW1 accessible through the cover. If the 9900 is at either end of the network this switch should be closed. Devices which are not at either physical end of the network must not have termination resistors switched into the circuit.

DH485 Termination Switch Settings

The termination switch (SW1) located next to the COM2 port is used to enable the termination resistors. Line termination is required to reduce signal reflections on a transmission line which are caused primarily by capacitive loading. Line termination becomes increasingly important as baud rate and length increase. In most applications the switch may be set on.

Appendix H: GE Fanuc Drivers

GE Fanuc Series 90 Dialogue File

The following tables show the Dialogue File structure when the 9900 is used with a Series 90 processor.

Dialogue File

Register (%R)	FUNCTION	Coil (%M, %T, %G)
%R0	Command Register	0 - 15
%R1		16 - 31
%R2		32 - 47
%R3	Red LEDs	48 - 63
%R4	Switch Image	64 - 79
%R5	Integer Trigger One	80 - 95
%R6	Integer Trigger Two	96 - 111
%R7	Integer Trigger Three	112 - 127
%R8	Integer Trigger Four	128 - 143
%R9 : %R56	Bit Trigger Blocks & Clock/Calendar	144 : 911

Command Register

BIT	FUNCTION
0	Lock Edit keys
1	Lock User keys
2	Window Field Lock
3	Edit keys C_Locked
4	User Keys C_Locked
5	Window Field C_Locked
6	Invalid Combination
7	Display Stack Screen
8	Stack Request
9	Stack is empty
10	Stack is full
11	Help key
12	Value Modified
13	Clear Stack
14	
15	Communication Active

GE Fanuc Series 90 Interface

The 9900 communicates with the Series 90 processor, through its programming port, using the Series Ninety Protocol (SNP). Communication parameters are fixed, at 19.2k baud, 8 data bits, odd parity, and 1 stop bit.

Communication Network

The Series Ninety Protocol allows for a single master / multiple slave communication network. The 9900 is always a master device, and the PLC is a slave. Using the PLC Port Setup function, you may set the CPU ID (i.e. the "name") of the host PLC where the 9900 Dialogue File will reside. Using ScreenMaker 9000 offline programming software, you can provided the 9900 with the CPU ID of other PLCs that may be on the network. The 9900 can then read and write data in those PLCs.

If the 9900 is NOT used on a network, its CPU ID should be set to <NULL>. This will allow it to communicate with any PLC, regardless of that PLC's name.

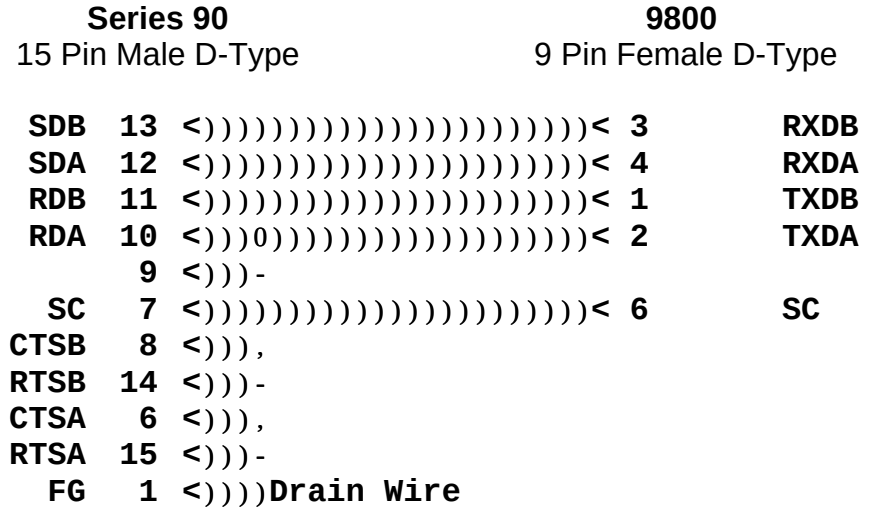
Series 90 Switch Settings

The termination switch (SW1) is used to enable the termination resistor. Line termination is required to reduce signal reflections on a transmission line which are caused primarily by capacitive loading. Line termination becomes increasingly important as baud rate and length increase. In most applications the termination switch may be set on.

Appendix H: GE Fanuc Drivers

The following schematic shows the cable connections required between the 9900 COM2 port and the Series 90 communication port. This cable is available from Quartech in a standard length of ten feet. Cables up to fifty feet in length may be ordered.

Model 2130-10



Appendix J: Modicon Drivers

Modicon Dialogue File

The following tables show the Dialogue File structure when the 9900 is used with a Modicon processor.

Dialogue File
XXXX is the First Register Address

ADDRESS	FUNCTION
XXXX +0	Command Register
XXXX +1	
XXXX +2	
XXXX +3	Red LEDs
XXXX +4	Switch Image
XXXX +5	Integer Trigger One
XXXX +6	Integer Trigger Two
XXXX +7	Integer Trigger Three
XXXX +8	Integer Trigger Four
XXXX +9 : XXXX +56	Bit Trigger Blocks & Clock/Calendar

Command Register
XXXX is the Dialogue File Address.

ADDRESS	BIT	FUNCTION
XXXX	16	Lock Edit keys
XXXX	15	Lock User keys
XXXX	14	Window Field Lock
XXXX	13	Edit keys C_Locked
XXXX	12	User Keys C_Locked
XXXX	11	Window Field C_Locked
XXXX	10	Invalid Combination Entered
XXXX	9	Display Stack Screen
XXXX	8	Stack Request
XXXX	7	Stack is empty
XXXX	6	Stack is full
XXXX	5	Help key
XXXX	4	Value Modified
XXXX	3	Clear Stack
XXXX	2	
XXXX	1	Communication Active Flag

Modicon Modbus Interface

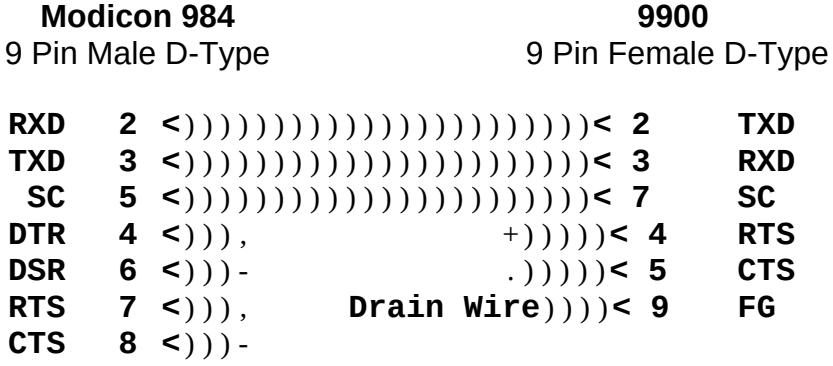
The 9900 communicates with the Modicon processor, through its programming port, using the Modbus RTU Protocol. Communication parameters are shown below.

RS-232 Signal Levels, Baud Rate = 9600 or 19200, RTU, 8 Data, 1 Stop, Even Parity

The following schematics show the cable connections required to connect the 9900 to various PLC models. These cables are available from Quartech in a standard ten foot length. Cables up to fifty feet can be provided.

Modicon 984

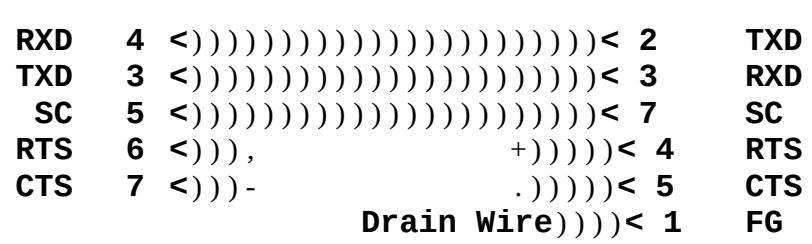
Model 2127-10
Communication Cable



Appendix J: Modicon Drivers

Modicon Micro

Model 2141-10
Communication Cable



Multiple Quartech devices may communicate through a single Modbus port by using the Quartech 8517 Port Multiplexer. The following schematic shows the cable required to connect the 9900 to a Quartech model 8517 port multiplexer. This cable is also available from Quartech. If the 9900 is located greater then fifty feet from the PLC or multiplexer then the Quartech Model 9104 RS-232 to RS-485 converter may be used.

Model 2129-10
Communication Cable