S3012
User's Manual

Systems Engineering Associates, Inc.
14989 West 69th Avenue
Arvada, Colorado 80007 U.S.A.
Telephone: (303) 421-0484
Fax: (303) 421-8108
www.sea-seg.com

02/2004

S3012
User's Manual

Revision 1, December 1991

CONTENTS

CONTENTS

CONTENTS

APPENDICES

SECTION 1
GENERAL DESCRIPTION

The S3012 Processor board is used as the primary processor in 4-card, 8-card, and 16-card S3000 systems. As the primary processor, the S3012 controls the S3000 bus, directing communications between the S3012 and other intelligent I/O boards, reads and writes all basic I/O boards in the system, and executes the user application program.

1.1 PROGRAM DEVELOPMENT

Programming is implemented using SYSdev, an IBM PC or compatible software package that allows the user to create, document, and compile the user application program as well as directly interface with the S3012 for program download and online monitoring. The program is developed off-line, compiled, then down loaded into the S3012 (S3012-BR only) or programmed into EPROMS for installation in the S3012 (S3012-EP only). SYSdev allows the S3012 to be programmed in a combination of languages: Ladder, High-level (subset of ‘C’) and Assembly (MCS-96).

1.2 PROGRAM EXECUTION TIMES

Typical program scan times are on the order of 0.25 milliseconds per 1K bytes program memory. This is true for the Ladder instructions as well as High-level instructions. The main program overhead execution time (I/O update, house keeping, etc.) is approximately 0.25 to 0.30 milliseconds. Thus main program scan times of under one millisecond are easily achievable (main program size less than 3K). Using the high speed timed interrupt, system through-puts as low as 0.25 milliseconds are also possible.

1.3 I/O ADDRESSING

I/O address capability is 16 I/O slots or 256 I/O points when using 16 point I/O boards. All basic I/O (16 point inputs, 16 point outputs, etc.) is automatically read and written at the beginning of the main program scan and saved in I/O image registers. In addition to the basic I/O boards, the S3012 can communicate to intelligent I/O boards (boards which contain their own processors) mounted in the S3000 rack. This is done in a free-form fashion using system functions, which allows any number of bytes to be transferred to and from the intelligent I/O.

SECTION 1
GENERAL DESCRIPTION

1.4 RS-232 PORTS

The S3012 contains two RS-232 ports: the PROG PORT and the USER PORT. The PROG PORT is dedicated for program download, online monitoring and general interface to an IBM PC or compatible running SYSdev. The USER PORT is available as a general RS-232 port for use as defined by the user. Under software control of the user application program, communications to any other RS-232 based device can be established. Typical applications are communications to operator workstations or displays for system status or data acquisition.

1.5 SERIAL NETWORK INTERFACE

When the optional serial network interface is installed, up to 32 S3012s can communicate with each other, effectively providing a means to expand the I/O capabilities of the S3012 beyond one 16 slot rack. The serial network is a high speed (344KBPS), twisted pair cable network configured in a master/slave topology.

1.6 FAULT DETECTION/DIAGNOSTICS

Internal to the S3012 are a series of comprehensive fault detection routines which verify the proper operation of the S3012 at all times. Each detected fault has a corresponding fault code which can be viewed using SYSdev, providing a description of the fault and recommended corrective action. In addition to the fault detection routines, a hardware confidence test is resident in the S3012. This test is the same test used at the factory to verify proper hardware operation and provides a complete hardware verification of the S3012 board. This test is initiated through SYSdev.

1.7 LED STATUS INDICATIONS

The following three status LEDs are located on the S3012 faceplate. PWR, RUN, and FLT. In addition, S3012s equipped with a network interface option board (SPB3012-1, etc.) are provided with a COMM LED. The definitions of these LEDs are as follows:

PWR: "On" when S3000 rack power is applied to the S3012.

RUN: "On" steady when the S3012 is executing a valid user's application program. "Off" when an internal fault is detected or when a valid user's program has not been loaded. The RUN led is flashed during program download and also when the S3012 hardware confidence test is executed.

FLT: "On" when an internally detected fault has occurred in the S3012. See section 7 for more details on the S3012 fault routine and error codes.

COMM: This LED is flashed every time an access to the S3000 serial network is made by any S3000 board on the network. If the LED is on solid, continuous communications is occurring on the network. If the LED is "off", no communications is occurring. This is not a fault LED but simply an indication of activity on the S3000 network.

1.8 S3012 VERSIONS (S3012-BR and S3012-EP)

Two versions of the S3012 are available: the S3012-BR and S3012-EP. The S3012-BR contains 44K bytes of battery backed CMOS RAM program memory while the S3012-EP contains 44K bytes of EPROM program memory (implemented with 2ea 27C256 EPROMS). The S3012-BR is used when faster program development times and ease of use are essential while the S3012-EP is used when program security is of the utmost importance. Both versions are 100% compatible with regard to user program development. Both versions contain 8K bytes of data memory in which 992 flags (single bit variables) reside, along with the remainder of data memory which can be referenced as bytes or words. All but 124 of the data bytes are battery backed for data retention at power-down.

The S3012 is also available in a third product, the S3013. This product is actually a combination of three boards: the S3012 processor board, the S3007 power supply, and the S3013 VME gateway board. The three boards are mounted together, as one module, which is used to provide a mechanism for the S3012 to communicate, at high speed, with VME based processors.

SECTION 1
GENERAL DESCRIPTION

(This Page Intentionally Left Blank)

2.0 PROGRAM STRUCTURE

The SYSdev programming language is a combination of Ladder, High-level (subset of C) and Assembly (MCS-96). All the files shown in the following are programmed in the same language format. Each file can be written in any combination of the language types. The typical S3012 user program consists of the following files:

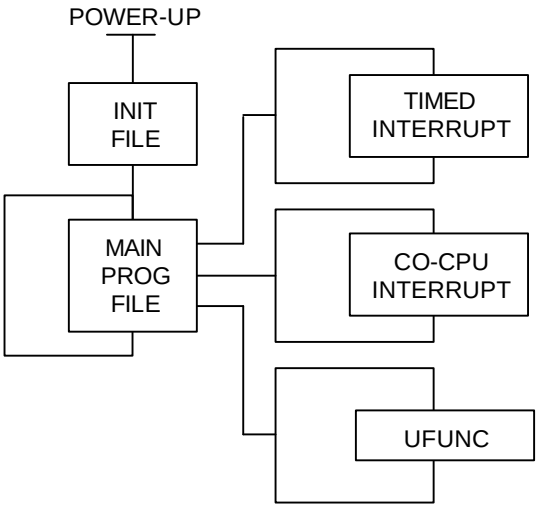
1) Initialization file (optional): executed once at power up.

2) Main Program file (required): scanned continuously.

3) Timed Interrupt file (optional): executed once every 0.250 to 65.000 milliseconds as set by the user.

4) CO-CPU communications Interrupt file (optional): executed in response to an intelligent I/O communications request.

5) User Function files (optional): up to 100 user defined subroutines which can be called from any of the above files.



Each file is executed sequentially from beginning to end. The main program file is executed continuously unless interrupted by the timed interrupt or CO-CPU interrupt. When an interrupt occurs, main program execution is suspended while the interrupt file is executed. At the completion of the interrupt, program execution resumes at the point in the main program where the interrupt occurred.

All basic I/O is updated (inputs read, outputs written) at the beginning of each main program scan. These updates are stored in the 'X' and 'Y' I/O images (see section 4.1). In addition, selected input boards (specified with the 'I' variable) are read at the beginning of the timed interrupt. Any outputs assigned in the timed interrupt are updated at the beginning of the timed interrupt execution.

Each file is implemented as a series of consecutive blocks. Each block is defined as one of the three programming languages: Ladder, High-level or Assembly. Blocks of the different languages can be intermixed as necessary within the file.

See the SYSdev Programming Manual for more details on the typical program structure.

SECTION 2
PROGRAM STRUCTURE

(This Page Intentionally Left Blank)

SECTION 3
SYSTEM CONFIGURATION

The system configuration defines the system or environment that the S3012 program will run in. This includes: defining the rack size, I/O slot assignments, whether the timed interrupt is used and the time interval if it is, whether the CO-CPU comm interrupt is used, the USER PORT baud rate and the serial network option. This parameters are all set through SYSdev when the program is developed. See the SYSdev Programming Manual for more details.

3.1 RACK SIZE

This is the rack size used in the system. Choices are 4, 8, and 16 slots. The rack size is the number of I/O boards that can be used, the S3012 and power supply is not included in the rack size. The corresponding S3000 part numbers for the various rack sizes are:

S3004CHR: 4 slot rack chassis
S3008CHR: 8 slot rack chassis
S3016CHR: 16 slot rack chassis

When using the hybrid VME/S3000 rack chassis (part numbers S30XXVMEX), select the 16 slot rack chassis for the rack size.

3.2 I/O SLOT ASSIGNMENTS

Each I/O slot in the rack must be assigned the board that will go in that slot. This is required in order for the compiler to generate the proper I/O reads and writes to the proper slots. Only the slots which actually contain inputs are read and only the slots that contain outputs are written. This reduces the overhead execution time by eliminating unnecessary I/O updates. It is also necessary to define the location of intelligent I/O such that communications with these boards can be enabled.

See the SYSdev manual for the I/O board selections.

3.3 TIMED INTERRUPT

If the timed interrupt file is to be used, it must be enabled in the configuration. This informs the compiler to look for and compile the timed interrupt file with the rest of the program. The timed interrupt time interval must also be set between 0.250 and 65.000 milliseconds. The resolution of this time is .001 milliseconds.

Note: The timed interrupt file execution time must be less than the timed interrupt time interval, otherwise a main program watchdog timer time out will occur.

SECTION 3
SYSTEM CONFIGURATION

3.4 CO-CPU COMM INTERRUPT

If any intelligent I/O boards in the system are to interrupt the S3012, via sfunc05, the CO-CPU comm interrupt must be enabled in the configuration. This informs the compiler to look for and compile the CO-CPU interrupt file along with the rest of the program.

3.5 USER PORT BAUD RATE

The USER PORT baud rate can be set to any of the following baud rates: 300, 600, 1200, 2400, 4800, or 9600. The USER PORT baud rate must match the baud rate of the user device connected to the USER PORT. The default baud rate is 9600.

3.6 NETWORK BAUD RATE

Three serial network baud rates are available:

344KBPS (bits per second)
229KBPS
106KBPS

Note: All the boards connected on the network must be set to the same baud rate, otherwise a communications error will occur.

For the most part, the baud rate is set as a function of the total network distance. The longer the network distance, the slower the baud rate. As a general rule, the baud rate can be set as follows:

344KBPS – Network distance of 1,000 feet or less.
229KBPS – Network distance of 2,000 feet or less.
106KBPS – Network distance of 4,000 feet or less.

The S3012 must have an SPB3012-1 network board installed in order to interface with the network.

SECTION 4
VARIABLE TYPES/MEMORY MAP

4.1 VARIABLES

Three classes of variables are used in the S3012. They are: bits, bytes, and words. Bits are a single bit in width and can have a value of 0 or 1. Bytes are 8 bits in width and can have a value between 0 and 255 decimal or 0 and ffH hex. Words are 16 bits in width and can have a value of 0 to 65535 decimal or 0 to ffffH hex. All numbers (values in variables and constants) are unsigned integer values. No signed or floating point numbers are supported. Numbers can be represented as decimal or hex (suffix 'H' following number).

Six different variable types are available in the S3012: flags (F), bytes (B), words (W), inputs (X), timed interrupt inputs (I) and outputs (Y).

4.1.1 FLAGS (F)

Flags are single bit variables which are generally used as internal coils or flags in the user program. Flags can have a value of "0" or "1". The S3012 contains 992 flags.

The format of the flag variable is:

Fzzz where: zzz is a three digit flag address (000 to 991).

Note: The leading 'F' must be a capital letter and that the flag address must be three digits (include leading zeros as necessary).

Examples: F000, F012, F991, etc.

4.1.2 BYTES (B)

Byte variables are 8 bit variables used as general purpose variables in the user program. Byte variables can have a value between 0 and 255 decimal or 0 and ffH hex. Byte variables are used as arithmetic variables in the High-level language, timer/counter presets and accumulators as well as shift register bytes in the ladder language. The S3012 contains 7,788 'B' variables.

The format of the byte variable is:

Bzzz where: zzz is the three or four digit byte address (032 thru 155 and 512 thru 8175).

Note: The leading ‘B’ must be a capital letter and that zzz must be a three or four digit address (include leading zeros as necessary).

Examples: B032, B150, B8000, etc.

Individual bits within the byte can also be referenced by simply appending a ‘.’ followed by the bit number (0-7) to the byte address. The form of this is:

Bzzz.y where: zzz is the byte address and y is the bit (0-7).

This allows any bit in the entire data memory to be referenced just as a flag is referenced. These “byte.bit” variables can be used in ladder blocks as contact and coil variables as well as in the High-level blocks. Execution times for instructions that use bits within a byte are longer than execution times for instructions using flags. Keep this in mind when using “byte.bit” references.

Examples: B080.0, B1000.7, B512.4, etc.

4.1.3 WORDS (W)

Word variables are 16 bit variables used as general purpose variables in the user program. Words can have a value between 0 and 65535 decimal or 0 and ffffH hex. Word variables are used as arithmetic variables in the High-level language, timer/counter presets and accumulators as well as shift register words in the ladder language. The S3012 contains 3,894 'W' variables.

The format of the word variable is:

Wzzz where: zzz is the three or four digit word address (032 thru 154 and 512 thru 8174).

Note: The leading ‘W’ must be a capital letter and that zzz must be a three or four digit address (include leading zeros as necessary). Also, word addresses are always an even number (divisible by 2).

Examples: W034, W600, W7500, etc.

4.1.4 INPUTS (X)

Input variables are bytes that contain the data read from the input boards during the main program I/O update. One 'X' byte is allocated for each rack input byte, thus an S3063 16-point input board has two 'X' bytes allocated for it, one byte for inputs 00 thru 07 and one byte for inputs 10 thru 17. The input bytes are allocated based on the I/O slot assignments made in the system configuration (see section 3.2). The input bytes reside in the I/O image table of data memory and can only be accessed using the 'X' variable designation.

The format for the input byte is:

Xaab where: aa is the two digit slot address (00-15) and b is the byte at the slot (0 or 1).

Note: The 'X' must be a capital letter and that the slot address must be two digits (add leading zeros as required). Also, 'X' variables can only be referenced for input boards that are actually included in the system configuration. Any reference to input variables that do not correspond to existing input boards will result in a compiler error.

As with byte variables, individual bits within the 'X' variable can be referenced. These bits correspond to the respective I/O point on the input board. The form of this is:

Xaab.c where: aa is the slot address, b is the byte at the slot and c is the bit or input point.

Examples: X010, X151, X020.5, X000.7, etc.

4.1.5 TIMED INTERRUPT INPUTS (I)

Timed Interrupt input variables are bytes that contain the data read from input boards at the beginning of the timed interrupt. Not all input boards are read at the beginning of the timed interrupt, only the boards which are referenced with the 'I' variable in the timed interrupt file. This provides a mechanism for the timed interrupt to obtain the most recent input data from selected high speed inputs. Any input board specified in the system configuration can be referenced using the 'I' variable. When any input point is referenced with the 'I' variable, the entire input board is read at the beginning of the timed interrupt. The 'I' variable can only be used in the timed interrupt file, any reference to the 'I' variable in the main program file will result in a compiler error.

The format for the 'I' variable is:

Iaab where: aa is the two digit slot address (00-15) and b is the byte at the slot (0 or 1).

Note: The 'I' must be a capital letter and that the slot address must be two digits (add leading zeros as required). Also, 'I' variables can only be referenced for input boards that are actually included in the system configuration. Any reference to input variables that do not correspond to existing input boards will result in a compiler error. ‘I’ variables can only be referenced in the timed interrupt file.

As with byte variables, individual bits within the 'I' variable can be referenced. These bits correspond to the respective I/O point on the input board. The form of this is:

Iaab.c where: aa is the slot address, b is the byte at the slot and c is the bit or input point.

Examples: I010, I151, I020.5, I000.7, etc.

4.1.6 OUTPUTS (Y)

Output variables are bytes which contain the data that is written to output boards at the beginning of the main program I/O update or timed interrupt execution. One 'Y' variable is allocated for each output byte, thus an S3073 16-point output board has two 'Y' variables allocated for it, one byte for outputs 00 thru 07 and one byte for outputs 10 thru 17. The output bytes are allocated based on the I/O slot assignments made in the system configuration (see section 3.2).

Output variables can only be assigned (used as coils) in the main program or timed interrupt file. If an output variable is assigned in the timed interrupt file, the entire output board will be updated at the beginning of the timed interrupt execution. This provides a mechanism for high speed outputs, assigned in the timed interrupt file, to be updated quickly as a function of the timed interrupt logic. If none of the output points in a given output board are assigned in the timed interrupt, then the output board is updated during the main program I/O update.

The format for the 'Y' variable is:

Yaab where: aa is the two digit slot address (00-15) and b is the byte at the slot (0 or 1).

Note: The ‘Y’ must be a capital letter and that the slot address must be two digits (add leading zeros as required). Also, 'Y' variables can only be referenced for output boards that are actually included in the system configuration. Any reference to output variables that do not correspond to existing output boards will result in a compiler error. 'Y' variables can only be assigned (used as coils) in the main program or timed interrupt file but can be referenced (used as contacts) in any file.

As with byte variables, individual bits within the 'Y' variable can be referenced. These bits correspond to the respective I/O point on the output board. The form of this is:

Yaab.c where: aa is the slot address, b is the byte at the slot and c is the bit or output point.

Examples: Y030, Y141, Y051.5, Y100.7, etc.

4.1.7 CONSTANTS

Constants are used as fixed numbers in High-level arithmetic and conditional statements as well as for presets in timer/counters in ladder blocks.

In High-level blocks, constants can be represented in decimal or hex. If the number is decimal, the constant is simply entered as the number to be referenced. No prefix or suffix is specified. If the number is hex, the suffix ‘H’ is added immediately following the hex number. Examples of both are:

```
25      (decimal)
25657   (decimal)
aeH     (hex)
f000H   (hex)
```

The hex letters (a,b,c,d,e,f) are case sensitive and must be typed as lower case letters. The hex suffix is also case sensitive and must be typed as a capital letter (H).

All constants are unsigned integers. When the variable class is byte, the range of values is 0 to 255 decimal or 0 to ffH hex. If the variable class is word, the range of values is 0 to 65535 decimal or 0 to ffffH hex.

In ladder blocks, the only constants allowed are in timer/counter presets. In this case, they are specified in decimal and preceded with the prefix ‘#’. If the timer/counter accumulator is a byte (B), the range of presets is 0 to 255. If the accumulator is a word (W), the range is 0 to 65535.

4.2 DATA MEMORY MAP

The memory map for the S3012 data memory is shown below:

Address	Valid Variable References			Battery Backed
0032	F000-F007	B032	W032	no
0033	F008-F015	B033	——	no
0034	F016-F023	B034	W034	no
0035	F024-F031	B035	——	no
thru	thru	thru	thru	
0154	F976-F983	B154	W154	no
0155	F984-F991	B155	——	no
0512	————	B512	W512	yes
0513	————	B513	——	yes
0514	————	B514	W514	yes
0515	————	B515	——	yes
thru	thru	thru	thru	
8174	————	B8174	W8174	yes
8175	————	B8175	——	yes

4.2.1 NON BATTERY BACKED DATA MEMEORY

The lower 124 bytes of data memory (B032 thru B155) are not battery backed and will not retain data at power down. At power-up or reset, these addresses are cleared.

Note: Flags F000 thru F991 are mapped into bytes B032 thru B155. Bytes B032 thru B155 are also mapped into W032 thru W154. These addresses can be referenced as any or all three of these variable types.

The flags are mapped into the bytes as shown as follows:

F000 = B032.0
F001 = B032.1
F002 = B032.2
F003 = B032.3
F004 = B032.4
F005 = B032.5
F006 = B032.6
F007 = B032.7
F008 = B033.0
F009 = B033.1
etc.

The bytes are mapped into the words with the even byte address as the low byte (lower 256 significance) of the respective word and the odd byte address as the upper byte (upper 256 significance) of the word as shown:

B032 = W032 (low byte)
B033 = W032 (high byte)

4.2.2 BATTERY BACKED DATA MEMORY (B512-B8175)

The upper 7,764 bytes of data memory (B512 thru B8175) are battery backed such that all data residing in this part of memory at power down is retained while power is off. At power up these addresses are not cleared, retaining the data that was present before power down. The data in this memory space can also be saved on disk using the “data upload” menu selection from the SYSdev Target Board Interface menu. The data saved on disk can be down loaded to other S3012s using the “data download” selection. See the SYSdev Programming Manual for details.

The upper group of memory is referenced as bytes (B) or words (W), no flags are resident in this area of memory. However any bit within this area can be referenced using the "byte.bit" format outlined in section 4.1.2. The byte (B) variables are mapped into the word (W) variables just as they are in the lower group of memory.

4.2.3 INTERRUPTING CO-CPU (B8175)

Byte address B8175 is a special function register that contains the slot number of the CO-CPU which initiated the CO-CPU comm interrupt. This address can be tested inside the CO-CPU comm interrupt file, with the appropriate sfunc06 executed based on the slot number in this register. B8175 should not be used by the user program for any other purpose. See section 6.1.1 for more details.

SECTION 5
PROGRAMMING REFERENCE

The following sections provide an overview of the SYSdev instruction set and the system functions available in the S3012. See the SYSdev Programming Manual for more details on the SYSdev programming language and the operation of the SYSdev software package.

5.1 INSTRUCTION SET

5.1.1 LADDER

The ladder language is generally used to implement the boolean logic of the user program. Networks of virtually any form (including nested branches) can be implemented. Ladder blocks are implemented as a 7 row X 9 column matrix. The following ladder instructions are available:

1) Contacts
   - Normally open
   - Normally closed
2) Coils
   - Standard
   - Latch
   - Unlatch
   - Inverted
3) Timers
   - 0.01 second time base
   - 0.10 second time base
   - 1.00 second time base
4) Counters
5) Shift Registers

Valid variables for contacts and coils are flags (F) or bits out of inputs (X), timed interrupt inputs (I), outputs (Y) and bytes (B).

Valid variables for timer/counter presets and accumulators are bytes (B) or words (W). Both the preset and accumulator must be of the same variable class (byte or word). If the class is byte, the maximum preset is 255. If it is word, the maximum preset is 65535.

Valid variables for shift registers are also bytes (B) or words (W). If the variable is a byte, the number of shifts per variable is 7. If the variable is a word, the number of shifts is 15.

5.1.2 HIGH-LEVEL (C)

The High-level language is a subset of the ‘C’ programming language. High-level is used for all arithmetic, comparisons, conditional program execution, program looping, calling user functions (subroutines) and calling system functions (I/O operations). High-level blocks are implemented as a 57 row X 80 column text array.

The High-level language incorporates the following:

1) Operators:

+:	add	++:	increment
-:	subtract	—:	decrement
*:	multiply	==:	equate
/:	divide	>:	greater than
%:	remainder	>=:	greater than or equal
<<:	left shift	<:	less than
>>:	right shift	<=:	less than or equal
&:	bitwise AND	!=:	not equal
|:	bitwise OR	~:	complement
^:	bitwise EX-OR	*:	indirection (unary)
&&:	logical AND	&:	address operator
||:	logical OR	=:	equal (assignment)

2) Statements:

- program statements (equations)
- conditional program execution (“if else-if else”)
- program looping (“for”, ”while”, and “do while” loops)
- unconditional program jumping (“goto”)
- user function calls (“ufuncXX” subroutines)
- system function calls (“sfuncXX” I/O operations)

5.1.3 ASSEMBLY

The Assembly language conforms to the Intel MCS-96 instruction set. The assembler syntax conforms to the UNIX system V assembler syntax.

5.2 SYSTEM FUNCTIONS

System functions provide the user with a means to perform extended I/O functions such as communication to intelligent I/O boards, communication through the RS-232 USER PORT, communication on the serial network, etc. A summary of the system functions available in the S3012 is as follows:

sfunc03: watchdog timer reset
sfunc05: intelligent I/O communications initiate
sfunc06: intelligent I/O communications respond
sfunc09: system fault routine
sfunc10: RS-232 USER PORT receive
sfunc11: RS-232 USER PORT transmit
sfunc12: intelligent I/O block communications
sfunc13: serial network communications
sfunc14: VME dual-port RAM block read/write
sfunc15: VME dual-port RAM byte read
sfunc16: VME dual-port RAM byte write
sfunc17: simultaneous sfunc status

System functions are entered in high-level blocks as text. Each system function has a parameter list associated with the system function call which defines such things as the address to read/write to, the number of bytes to send/receive, etc. In addition, some system functions return with an error code or function status which can be used to determine if the system function was successful, busy, etc.

5.2.1 SYSTEM FUNCTION TYPES

Two types of system functions exist in the S3012: suspended and simultaneous.

Suspended System Function: Suspended system functions actually suspend program execution while they are executed. Thus they are performed just as any other type of instruction, in order of sequence in which they occur.

Simultaneous System Functions: Simultaneous system functions are executed simultaneously to program execution. By their nature, simultaneous system functions may take multiple main program scans to execute. These are basically “back-ground” tasks which are executed while the user application program is executing, with insignificant impact on the user program scan time. This type of system function returns with one of four types of return values when called: "Not Busy", "Busy", "Done" or an error code representing a fault in the execution of the function. When the function is first executed, a return value of "Busy" is returned. This indicates the function is executing and is no longer available for use until it has completed. Subsequent calls to the same system function will result in a "Busy" return value until the function has completed. At that time, a call to the system function will result in either a "Done" return value or an error code value representing a failure of the function to execute. The system function is now available to execute again. See the individual system function formats following for more details on the return values and error codes pertinent to each system function.

5.2.2 sfunc03: WATCHDOG TIMER RESET

System function 03 resets the main program watchdog timer when called. The watchdog timer normally times out if the main program scan time is longer than 40msec. This function can be used to extend this time by 40msec every time sfunc03 is called. This desirable, for instance, if a long, intentional program loop ("for" loop, "while" loop, etc.) is executed which would exceed the normal 40msec scan time.

General form:	sfunc03();
Parameters:	none
Return value:	none
Type:	suspended
Valid files:	Initialization, Main Program, Timed Interrupt, CO-CPU comm interrupt and User functions.

5.2.3 sfunc04: ASCII STRING LOAD COMMAND

System function 04 is used to convert the characters in an ascii string to their equivalent ascii codes and store these codes in consecutive byte address in variable memory (Bxxx variables). System function 04 is typically used in conjunction with the User port sfunc 11 transmit system function to send ascii strings to operator interfaces, etc.

General form: sfunc04(dest,"string");

Parameters: dest = The address where the first ascii character of the string will be stored. The remaining ascii characters will be stored in consecutive byte addresses following the first byte address.

Variable Types: "B"

string = The string is from on to 60 printable characters. These characters will be converted to their equivalent ascii codes and stored in consecutive byte addresses starting at the dest byte address.

Note: The string must be enclosed with double quotes as shown (these double quotes are not stored as part of the string, however, are simply used as delimiters for the string).

Any printable character can be incorporated in the string with the exception of the double quote " or back slash \. If these two characters are to be incorporated in the string, they must be preceded wit the back slash (i.e. \" will incorporate the " only and \\ will incorporate just on \)

Return Value: none

Type: Suspended

Valid Files: Initialization, Main Program, Timed Interrupt, CO-CPU comm. Interrupt and User functions

Examples 1) sfunc04(B100,"example #1");

The above example will load the following byte addresses with the corresponding ascii codes (numbers):

B100 = 101	(ascii code for "e" = 101)
B101 = 120	(ascii code for "x" = 120)
B102 = 97	(ascii code for "a" = 97)
B103 = 109	(ascii code for "m" = 109)
B104 = 112	(ascii code for "p" = 112)
B105 = 108	(ascii code for "l" = 108)
B106 = 101	(ascii code for "e" = 101)
B107 = 32	(ascii code for " " = 32)
B108 = 35	(ascii code for "#" = 35)
B109 = 49	(ascii code for "1" = 49)

2) sfunc04(B2000,":");

   The above example will load B2000 with 58 which is the ascii code for ":".

3) sfunc04(B120,"MOTOR \"on"\"");

   The above example incorporates double quotes in the string and uses the back slash to designate that these double quotes are part of the string and not the string delimiters. The characters are stored in variable memory as follows:

B120 = 77	(ascii code for "M" = 77)
B121 = 79	(ascii code for "O" = 79)
B122 = 84	(ascii code for "T" = 84)
B123 = 79	(ascii code for "O" = 79)
B124 = 82	(ascii code for "R" = 82)
B125 = 32	(ascii code for " " = 32)
B126 = 34	(ascii code for " = 34)
B127 = 111	(ascii code for "o" = 111)
B128 = 110	(ascii code for "n" = 110)
B129 = 34	(ascii code for " = 34)

5.2.4 sfunc05 and sfunc06: INTELLIGENT I/O COMMUNICATIONS

System functions 05 and 06 are used for communications between the S3012 and other S3000 intelligent I/O (CO-CPU) boards. See section 6.1.1 for more details on the use of sfunc05 and sfunc06.

General forms: sfunc05(slot,#sent,srce,#rcve,dest);
sfunc06(slot,#rcve,dest,#sent,srce);

Parameters:

slot = slot the intelligent I/O board resides in.

Variable type: constant (0-15).

#sent = The number of bytes to be sent to the intelligent I/O board.

Variable types: constant (0-128), 'B', or indirect 'B'.

srce = The address of the first byte to be sent. A consecutive number of bytes(= #sent) is sent to the other board starting at this address.

Variable types: 'B 'or indirect 'B'.

#rcve = The number of bytes to be received from the other board.

Variable types: constant (0-128), 'B' or indirect ‘B’ (sfunc05 only).

#dest = The address where the first received byte is stored. A consecutive number of bytes (= #rcve) is received from the other board and stored in a stack starting with this address.

Variable types: 'B' or indirect 'B'.

Return value: none

Type: suspended

Valid files: sfunc05: Initialization, Main Program and Timed Interrupt
sfunc06: CO-CPU Comm file only

5.2.5 sfunc09: SYSTEM FAULT ROUTINE

System function 09 provides a means for the fault routine to be called in response to a software detected fault from the user application program. The fault routine is executed as described in section 7.1. The fault code will be set to 45H: sfunc09 generated fault.

Note: This function should only be called when a complete system shutdown is desired due to the fact that program execution will cease.

General form: sfunc09();

Parameters: none

Return value: none

Type: non-returning

Valid files: Initialization, Main Program, Timed interrupt, CO-CPU comm interrupt and User functions.

5.2.6 sfunc10: RS-232 USER PORT RECEIVE

System function 10 receives a consecutive number of bytes from the USER PORT. See section 6.2.1 for a detailed description of the use of sfunc10.

General form: sfunc10(#rcve,dest);

Parameters: #rcve = The number of bytes to be received thru the USER PORT.

Variable types: constant(1-250), 'B' or indirect 'B'.

dest = The address where the first byte received will be stored. A consecutive number of bytes(= #rcve) is received thru the USER PORT and stored in a stack starting with this address.

Variable types: 'B' or indirect 'B'.

Return Values:
0 = NOT BUSY/READY
1 = BUSY
2 = DONE (receive successful)
3 = TIME OUT (bytes not received)

Type: simultaneous

Valid files: Initialization and Main Program only

5.2.7 sfunc11: RS-232 USER PORT TRANSMIT

System function 11 transmits a consecutive number of bytes out the USER PORT. See section 6.2.2 for a detailed description of the use of sfunc11.

General form: sfunc11(#sent,srce);

Parameters:
- #sent = The number of bytes to transmit out the USER PORT.
  Variable types: constant (1-250), 'B' or indirect 'B'.
- srce = The address where the first byte transmitted is stored. A consecutive number of bytes (= #sent) is transmitted out the USER PORT starting with this address.
  Variable types: 'B' or indirect 'B'.

Return Values:
- 0 = NOT BUSY/READY
- 1 = BUSY
- 2 = DONE (transmit successful)
- 3 = TIME OUT (bytes not sent)

Type: simultaneous

Valid files: Initialization and Main Program only

5.2.8 sfunc12: INTELLIGENT I/O BLOCK COMMUNICATIONS

System function 12 is used to communicate with intelligent I/O boards equipped with a comm block buffer (versus the standard bus interface used with intelligent I/O boards communicating using sfunc05 and sfunc06). See section 6.1.2 for more details on the use of sfunc12.

General form: sfunc12(slot,#sent,srce,#rcve,dest);

Parameters:

slot = Slot the intelligent I/O board resides in.

Variable type: constant (0-15).

#sent = Number of words to be sent to the intelligent I/O board.

Variable types: constant (0-120), 'W' or indirect 'W'.

srce = The address where the first word to be sent is stored. A consecutive number of words (= #sent) is sent to the I/O board starting at this address.

Variable type: 'W' or indirect 'W'.

#rcve = Number of words to be received from intelligent I/O board.

Variable types: constant (0-120), 'W' or indirect 'W'.

dest = The address where the first word received will be stored. A consecutive number of words (= #rcve) is received from the other board and saved in a stack starting at this address.

Variable types: 'W' or indirect 'W'.

Return Values:

0 = NOT BUSY/READY
1 = BUSY
2 = DONE (send/rcve successful)
3 = TIME OUT (intelligent I/O board did not respond)
4 = BAD ACKNOWLEDGE (intelligent I/O board did not acknowledge communication attempt)

Type: simultaneous

Valid files: Initialization and Main Program only

5.2.9 sfunc13: SERIAL NETWORK COMMUNICATIONS

System function 13 is used to communicate to other S3012s or nodes on the serial communication network. See section 6.3 for details on the use of sfunc13 and a description of the serial network.

General form: sfunc13(slave,#sent,s_srce,s_dest,#rcve,r_srce,r_dest);

Parameters:

slave = Address of node to communicate with. This is the network address of the slave, each slave has a unique address.

Variable type: constant (1-32), 'B' or indirect 'B'.

#sent = Number of words to send to slave.

Variable types: constant (0-120),'B' or indirect 'B'

s_srce = Address of send stack in master which will be sent to slave. A consecutive number of words(= #sent) will be sent to the slave starting at this address.

Variable type: 'W' or indirect 'W'.

s_dest = Starting address of stack in slave where words sent from master will be stored.

Variable type: 'W' or indirect 'W'.

#rcve = Number of words received from slave.

Variable type: constant(0-120), 'B' or indirect 'B'.

r_srce = Starting address of stack in slave where words will be sent from slave to master.

Variable type: 'W' or indirect 'W'.

r_dest = Starting address in master where words sent from slave will be stored.

Variable type: 'W' or indirect 'W'.

Return values:

0 = NOT BUSY/READY
1 = BUSY
2 = DONE (comm with slave successful)
3-10H = ERROR CODE (see section 7.4.1 for serial network communication error code descriptions).

Type: simultaneous

Valid files: Initialization and Main Program only

5.2.10 sfunc14: VME DUAL-PORT RAM BLOCK READ/WRITE

System function 14 is used to read and write blocks of data to the VME dual-port RAM when the S3012 is packaged in an S3013 VME Gateway. See section 6.4 for more details on the use of sfunc14.

General form: sfunc14(#sent,s_srce,s_dest,#rcve,r_srce,r_dest);

Parameters:

#sent = Number of words transferred to the VME dual-port RAM from theS3012.

Variable types: constant (0-255), 'W' or indirect 'W'.

s_srce = Starting address of stack to be transferred to the VME dual-port RAM. A consecutive number of words (= #sent) is transferred starting with this address.

Variable types: 'W' or indirect 'W'.

s_dest = Starting address in VME dual-port RAM where the words sent are stored.

Variable types: constant (0-4094 even address) or indirect 'W'.

#rcve = Number of consecutive words transferred from the VME dual-port RAM to the S3012.

Variable types: constant (0-255), 'W' or indirect 'W'.

r_srce = Starting address in VME dual-port RAM where words are to be transferred from the VME dual port RAM to the S3012.

Variable types: constant (0-4094 even) or indirect 'W'.

r_dest = Starting address of stack inS3012 where the words from the VME dual-port RAM are stored.

Variable types: 'W' or indirect 'W'.

Return value:

0 = sfunc14 transfer successful.
ffH = sfunc14 transfer not successful. Data transferred may not be valid.

Type: suspended

Valid files: Initialization and Main Program only

5.2.11 sfunc15: VME DUAL-PORT RAM BYTE READ

System function 15 is used to read a single byte from the VME dual-port RAM when the S3012 is packaged in an S3013 VME gateway. See section 6.4 for more details on the use of sfunc15.

General form: sfunc15(srce,dest);

Parameters:
srce = The byte address in the VME dual port RAM to be read.
Variable types: constant (0-4095) or indirect 'B'.
dest = Byte address in S3012 where data from VME dual-port RAM is to be stored.
Variable types: 'B' or indirect 'B'.

Return values:
0 = VME byte read successful.
ffH = VME byte read not successful, data may be invalid.

Type: suspended

Valid files: Initialization and Main Program only.

5.2.12 sfunc16: VME DUAL-PORT RAM BYTE WRITE

System function 16 is used to write a single byte to the VME dual-port RAM when the S3012 is packaged in an S3013 VME gateway. See section 6.4 for more details on the use of sfunc16.

General form: sfunc16(dest,srce);

Parameters:
dest = The byte address in the VME dual port RAM to be written to.
Variable types: constant (0-4095) or indirect ‘B’.
srce = Byte address or data in S3012 to be written to VME dual-port RAM.
Variable types: constant (0-255)‘B’ or indirect ‘B’.

Return values:
0 = VME byte write successful.
ffH = VME byte write not successful, data in VME RAM may be invalid.

Type: suspended

Valid files: Initialization and Main Program only.

5.2.13 sfunc17: SIMULTANEOUS sfunc STATUS

System function 17 provides a means of checking the status of a simultaneous sfunc (sfunc10,11,12, and 13) without having to call the particular sfunc. The return value of sfunc17 is the return value of the specified sfunc (see return values for each type of simultaneous sfunc). Thus if the specified sfunc is "BUSY", sfunc17 returns with "BUSY" when called for that sfunc.

General form: sfunc17(sfunc#);

Parameters: sfunc# = The number of the sfunc status to be checked.

Variable types: constant (10,11,12, or 13).

Return value: return value of the specified sfunc (see each simultaneous sfunc for possible return values).

Type: suspended

Valid files: Initialization and Main Program only.

Example: If the status of sfunc13 is desired, the following program statement could be executed:

```
B100 = sfunc17(13);
```

The status (return value) of sfunc13 would be placed in B100. The possible range of return values would be the possible return values when sfunc13 is called (i.e. 0=NOTBUSY, 1=BUSY, 2=DONE, 3-10H=ERROR CODE). B100 could then be checked to see what the status of sfunc13 is.

This provides an easy way to check the status of sfunc13 (or any other simultaneous sfunc) without having to call sfunc13 again.

SECTION 6
EXTENDED I/O OPERATIONS

6.1 COMMUNICATIONS WITH INTELLIGENT (CO-CPU) I/O BOARDS

Intelligent I/O boards (here after abbreviated as “CO-CPUs”) are boards that contain their own processors (micro controllers) and execute their own programs independent of the program executed in the S3012. These boards reside in I/O slots of the S3000 rack just as I/O boards reside in the rack. The bus interface of these boards is, however, different then the basic I/O boards and thus communications with CO-CPU boards is different as well.

The S3012 uses system functions 5,6 and 12 to communicate with CO-CPU boards. This provides a free-form mechanism to pass information back and forth between the S3012 and CO-CPUs. These system functions specify a certain number of bytes (or words) to send to the CO-CPU from the S3012 and vice versa.

Two types of bus interfaces exist in CO-CPUs: the standard CO-CPU bus interface and the buffered CO-CPU bus interface. Standard bus interface CO-CPUs use sfunc05 and sfunc06 to communicate while buffered CO-CPUs use sfunc12. The standard CO-CPU does not contain a comm buffer and therefore handshakes data back and forth, at high speed, using the suspended sfuncs 05 and 06. Buffered CO-CPUs contain an on-board bus interface buffer that allows a larger amount of data to be transferred between the S3012 and CO-CPU using the simultaneous (“back-ground”) sfunc12. All CO-CPUs incorporate the standard bus interface unless otherwise indicated on the respective CO-CPU data sheet.

The following sections describe communications between CO-CPUs, with the different bus interfaces, using sfunc05,06, and 12.

6.1.1 STANDARD CO-CPU COMMUNICATIONS (sfunc05 and 06)

System functions 05 and 06 are used for communications with standard bus interface CO-CPUs. These system functions are primarily used to send control data between the S3012 and CO-CPUs and to initialize the CO-CPUs at power up. Communications (here after abbreviated as “comm”) between the two boards is achieved by one board initiating the comm request and the other board responding to the request. The two sfuncs are used in conjunction with each other where sfunc05 is used to initiate comm while sfunc06 is used to respond.

Comm between the S3012 and a CO-CPU board can be initiated from either board. The S3012 can initiate comm while the CO-CPU board responds, or the CO-CPU board can initiate comm while the S3012 responds. In both cases, the board which initiates the comm will do so using sfunc05 in it’s main program, while the board that responds will use the CO-CPU communications interrupt file to interrupt it’s main program and respond with sfunc06.

SECTION 6
EXTENDED I/O OPERATIONS

The following sequence of events occurs when an sfunc05/06 is performed:

1) Initiating board sends comm request to responding board.

2) Responding board interrupts it's main program and enters CO-CPU interrupt file. Responding board sends comm acknowledge to initiating board.

3) Initiating board sends a predefined number of consecutive bytes to responding board. Responding board receives these bytes.

4) Responding board sends a predefined number of consecutive bytes to initiating board.

5) Communications is complete, initiating board continues executing it's main program while responding board returns from CO-CPU interrupt and continues to execute it's main program.

The preceding sequence outlines that for each comm event, both the initiating board sends data to the responding board and the responding board sends data to the initiating board. Data is sent both directions regardless of which board initiated the comm request. The number of bytes sent between the two boards must be in agreement on both sides. In other words, if the initiating board is specified to send 6 bytes in it's sfunc05 call, the responding board must be set to receive 6 bytes in it's sfunc06 call.

All standard bus interface CO-CPU boards in the system must be initialized at power-up with the sfunc05/06 communications function. Each CO-CPU board is assigned an identifier such that when a CO-CPU board initiates a comm request with the S3012, the S3012 can determine which CO-CPU initiated the request. The identifier assigned to a given CO-CPU is the slot number it resides in and is automatically set during this initialization comm. The CO-CPU identifier is stored in address B8175 when a CO-CPU initiates a request, allowing the user CO-CPU interrupt file to poll B8175 and determine which CO-CPU initiated the interrupt. The initialization comm is implemented by placing an sfunc05 in the "init" file of the S3012 and placing an sfunc06 comm respond in the "init" file of the CO-CPU board.

If an error occurs when sfunc05 or sfunc06 is called in the S3012, the fault routine is automatically executed, saving the fault code and suspending S3012 program execution. See section 7 for details on the fault routine and sfunc05 and sfunc06 error codes.

See section 5.2.3 for the general formats, parameters and return values of sfunc05 and sfunc06.

Examples:

1) Communications initiated from S3012 (interrupting CO-CPU):

   S3012 main program:

   ```
   sfunc05(4,4,B100,2,B120);
   ```

   CO-CPU comm interrupt file:

   ```
   sfunc06(0,4,B080,2,B084);
   ```

   Execution: The S3012 initiates the comm request with a CO-CPU in slot 4, sends 4 bytes (B100, B101, B102 and B103) to the CO-CPU, which stores these at B080, B081, B082 and B083. The CO-CPU then sends 2 bytes (B084 and B085) to the S3012, which stores these at B120 and B121.

2) Communications initiated from CO-CPU (interrupting S3012):

   CO-CPU main program (CO-CPU in slot 3):

   ```
   sfunc05(0,0,B032,5,B080);
   ```

   S3012 comm interrupt file:

   ```
   if (B8175 == 3)
       sfunc06(3,0,B032,5,B110);
   ```

   Execution: The CO-CPU in slot 3 initiates comm with the S3012, causing the CO-CPU interrupt file to be entered in the S3012. The CO-CPU sends zero bytes to the S3012. The S3012 tests B8175 for CO-CPU identifier “3” (CO-CPU slot address 3), reads zero bytes from the CO-CPU then sends 5 bytes (B110, B111, B112, B113, and B114). The CO-CPU receives the 5 bytes and stores them at B080, B081, B082, B083, and B084 respectively.

6.1.2 BUFFERED CO-CPU COMMUNICATIONS (sfunc12)

System function 12 and the buffered CO-CPU comm interface was designed to allow larger amounts of low priority data to be transferred to and from CO-CPUs without any significant impact on program scan times. For this reason, sfunc12 is a simultaneous sfunc that is executed simultaneously to the user application program execution. The emphasis is not on the speed of transmission but instead on transmitting a larger amount of data with minimal impact on scan time. For this reason it may take multiple scans for sfunc12 to complete once it is initiated.

System function 12 communications between an S3012 and a CO-CPU board is always initiated from the S3012. CO-CPUs equipped with the comm buffer interface cannot initiate the CO-CPU comm interrupt in the S3012. For this reason, the sfunc12 is always placed in the main program of the S3012 initiating comm, while the sfunc12 in the responding CO-CPU is placed in the CO-CPU comm interrupt file.

The sequence of events in an sfunc12 comm event are as follows:

1) S3012 initiates comm with CO-CPU using sfunc12. Program execution in S3012 continues once sfunc12 is called without waiting for a response from the CO-CPU.

2) As the S3012 user application program execution continues, the words to be sent from the S3012 to the CO-CPU are transferred to the CO-CPU comm buffer. Both the S3012 and CO-CPU application programs continue to execute while this transfer takes place.

3) Once all the words to be sent to the CO-CPU are transferred into the comm buffer, the comm interrupt in the CO-CPU is initiated causing the CO-CPU interrupt file to be executed.

4) Inside the CO-CPU interrupt file, a corresponding sfunc12 is executed which reads all the words, sent from the S3012, in the comm buffer and stores them in internal memory. The CO-CPU then writes, to the comm buffer, the words that are to be sent back to the S3012. The CO-CPU then exits the comm interrupt file and returns to executing the main CO-CPU program.

5) When the S3012 detects that the CO-CPU comm buffer has been loaded with the words to be read from the CO-CPU, it begins reading these values from the comm buffer. This occurs while the application program continues to execute. Once all the words have been read from the buffer, the return value for sfunc12 is set to “DONE”. The sfunc12 comm event is now complete.

In the above sequence, once the sfunc12 in the S3012 is initiated, subsequent calls to the sfunc12 result in a return value of “BUSY” until all the words have been read from the CO-CPU in step (5). At that point, a return value of "DONE" or an "ERROR CODE" is returned at the next sfunc12 call. If the sfunc12 was successful, the return value is "DONE". If it was not, an error code is returned representing the nature of the fault. See section 5.2.7 for more details on the return values. System function 17 can also be used to read the status of sfunc12 to determine if it is "BUSY", "DONE", etc. See section 5.2.12 for a description of sfunc17.

The sfunc12 in the S3012 main program and the sfunc12 in the CO-CPU comm interrupt must also be in complete agreement on the number of words sent from the S3012 to the CO-CPU and vice versa. In other words, if the sfunc12 in the S3012 is set to send 20 words to the CO-CPU, the sfunc12 in the CO-CPU comm interrupt file must be set to receive 20 words, etc. Failure to conform to this requirement will result in an error code return value from the sfunc12.

Unlike the standard CO-CPU bus interface using sfunc05 and 06, the buffered CO-CPUs do not need to be initialized at power up. These boards do not have an identifier associated with them, but are instead simply addressed by the slot they reside in.

See section 5.2.7 for the general format, parameter list and return values of sfunc12.

Example:

1) Typical sfunc12 comm event:

S3012 main program:

```
sfunc12(7,30,W1000,20,W1100);
```

CO-CPU comm interrupt:

```
sfunc12(0,30,W040,20,W120);
```

Execution: The S3012 sends 30 words (W1000 thru W1058) to the comm buffer of the CO-CPU in slot 7. Once all the words have been loaded in the comm buffer, the comm interrupt of the CO-CPU is initiated, the CO-CPU reads the 30 words in the comm buffer and stores them in W040 thru W098. The CO-CPU then loads the comm buffer with 20 words (W120 thru W158) and exits the comm interrupt file. When the S3012 detects that the comm buffer has been loaded with the 20 words from the CO-CPU, it reads the 20 words from the comm buffer and stores them in words W1100 thru W1138.

The S3012 continued program execution through-out the entire data transfer. Calls to the sfunc12 made before the transfer was complete, resulted in a return value of "BUSY". Once the transfer was complete, the next call to sfunc12 resulted in a return value of "DONE", indicating the data from the CO-CPU had been loaded in words W1100 thru W1138.

SECTION 6
EXTENDED I/O OPERATIONS

6.2 USER PORT (RS-232) COMMUNICATIONS

The USER PORT is a general purpose RS-232 port available for connection to any RS-232 user devices. Typical applications include: S3012 connection to operator workstations, connection to IBM PC or compatibles for system data acquisition, etc. Communications through the USER PORT is achieved using sfunc10 (USER PORT read) and sfunc11 (USER PORT write). These sfuncs allow any ascii codes from 0 to 255 to be read from or written to the port.

The baud rate of the user port is programmable to 300, 600, 1200, 2400, 4800, or 9600 Baud. This is set in the system configuration (see section 3.5). The protocol of the port is fixed at: 1 start bit, 8 data bits, and 1 stop bit with no parity.

The hardware handshaking signals CTS (clear to send), RTS (request to send) and DTR (data terminal ready) are all available and used as generally defined. DSR (data set ready) is not used by the S3012 USER PORT.

6.2.1 RECEIVING THROUGH THE USER PORT (sfunc10)

Using sfunc10, from 1 to 250 consecutive bytes can be received from the USER PORT in one command. System function 10 is a simultaneous function such that once it is initiated, program execution continues without waiting for the sfunc to complete. Subsequent calls of sfunc10 result in a return value of "BUSY" until the sfunc completes (return = "DONE") or times out (return = "TIME OUT"). Since sfunc10 is a simultaneous function, the impact on the user application program scan time is negligible when an sfunc10 is executed.

The device connected to the USER PORT must send the data to the S3012 within a certain time period once sfunc10 is initiated in order to avoid a return value of "TIME OUT". In most applications, software handshaking will be required between the S3012 and user RS-232 device in order to assure the proper number of bytes is sent at the proper time.

The parameters specified in sfunc10 are: the number of bytes to receive and the starting address of the stack to store the bytes at. See section 5.2.5 for the general form, parameter list and return values of sfunc10.

6.2.2 TRANSMITTING THROUGH THE USER PORT (sfunc11)

Using sfunc11, from 1 to 250 consecutive bytes can be transmitted out the USER PORT in one command. System function 11 is a simultaneous function such that once it is initiated, program execution continues without waiting for the sfunc to complete. Subsequent calls of sfunc11 result in a return value of "BUSY" until the sfunc completes (return = "DONE") or times out (return = "TIME OUT"). Since sfunc11 is a simultaneous function, the impact on the user application program scan time is negligible when an sfunc11 is executed.

System function 11 uses the CTS (clear to send) signal to assure that the device receiving the data is ready to receive the data. If CTS does not become active within a certain time period after sfunc11 is initiated, a return value of "TIME OUT" is obtained in the subsequent call of sfunc11. If the user device does not use the CTS signal for hardware handshaking, then CTS must be jumpered to RTS (request to send). See appendix B for the USER PORT pin-out.

The parameters specified in sfunc11 are: the number of bytes to transmit and the starting address of the stack of bytes that will be transmitted. See section 5.2.6 for the general form, parameter list and return values of sfunc11.

Examples:

1) Receiving through the USER PORT:

   Main program:

   ```
   B050 = sfunc10(20,B100);
   ```

   Execution: The above receives 20 bytes from the USER PORT and stores them in B100 thru B119. The return value of sfunc10 is stored in B050. When the sfunc10 is first called, the return value will equal "BUSY" (B050 = 1). Subsequent calls of sfunc10 will result in a "BUSY" (B050 = 1) return value until all 20 bytes have been received, at which time a return value of "DONE" (B050 = 2) is obtained. If the device connected to the USER PORT does not send any or all of the 20 bytes, a return value of "TIME OUT" (B050 = 3) is obtained after a certain time period.

   Note: Program execution is not suspended while sfunc10 is executing. Once initiated, program execution continues with subsequent calls of sfunc10 or sfunc17(10) determining when all 20 bytes have actually been received. The time it takes for sfunc10 to complete is a function of the selected USER PORT baud rate and the number of bytes to be received.

2) Transmitting out the USER PORT:

Main program:

```
B060 = sfunc11(30,B1000);
```

Execution: The above transmits the 30 bytes between B1000 and B1029 out the USER PORT. The return value of sfunc11 is stored in B060. When the sfunc11 is first called, the return value will equal "BUSY" (B060 = 1). Subsequent calls of sfunc11 will result in a “BUSY” (B060 = 1) return value until all 30 bytes have been transmitted, at which time a return value of "DONE" (B060 = 2) is obtained. If the device connected to the USER PORT is not ready to receive (CTS not active) for a certain time period, a return value of "TIME OUT" (B060 = 3) is obtained.

Note: Program execution is not suspended while sfunc11 is executing. Once initiated, program execution continues with subsequent calls of sfunc11 or sfunc17(11) determining when all 30 bytes have actually been transmitted. The time it takes for sfunc11 to complete is a function of the selected USER PORT baud rate and the number of bytes to be transmitted.

6.3 SERIAL NETWORK COMMUNICATIONS

The serial network provides a means for multiple S3012s to communicate with each other. The network described in the following sections is the S3000-N1 network, but other S3000 networks conform to the same general principles. An order for an S3012 to communicate on the S3000-N1 network, an SPB3012-1 option board must be mounted to the S3012. See section 9.3.1 for details on adding the SPB3012-1.

The network operates in a master/slave topology. One S3012 acts as the master and controls all communications on the network. The remaining S3012s act as slaves and simply respond to communications requests from the master. The master can send up to 120 consecutive words and receive up to 120 consecutive words from a slave in one command. If data is to be sent from one slave to another slave, it must be done through the master (i.e. the master reads the data from the first slave and then sends it to the second slave).

Up to 32 S3012s (or other S3000 network compatible boards) can be installed on one network. These 32 nodes consist of the one master and up to 31 slaves. Each S3012 or node on the network is assigned a unique network address. This number is a number between 1 and 32. The network address is used to specify which slave the master is communicating to. The network address is set in the S3012 from the SYSdev Target board Interface menu and is down loaded directly to the S3012 from the IBM PC or compatible running SYSdev. See section 9.3.3.

6.3.1 COMMUNICATING ON THE NETWORK (sfunc13)

System function 13 is used to execute the communications command to the slave. The parameter list of sfunc13 contains:

1) Slave network address to communicate to
2) Number of words to be sent to slave
3) Starting address of stack, in master, of words which will be sent to slave.
4) Starting address of stack, in slave, where the words are to be stored.
5) Number of words to be received from slave
6) Starting address of stack, in slave, where the words will be sent from.
7) Starting address of stack, in master, where the words from the slave will be stored.

See section 5.2.8 for a complete description of the above parameters, the general form of sfunc13 and the return values possible with sfunc13.

Note: sfunc13 is used only in the master, the slaves respond to network communications completely transparently. No commands are added to the slave programs in order to implement the serial network. Thus, only one program (the master's) in the entire network has any commands pertaining to network communications.

System function 13 is a simultaneous function such that once it is initiated, program execution continues without waiting for the sfunc to complete. Subsequent calls of sfunc13 or sfunc17(13) result in a return value of "BUSY" until the sfunc completes (return = "DONE") or detects an error (return = "ERROR CODE"). See section 7.4.1 for a description of the serial network error codes. Since sfunc13 is a simultaneous function, the impact on the user application program scan time is negligible when executed. This is also true for the responding slave. Reception and transmission on the serial network occurs concurrently with program execution, no significant increase in the scan time of the slave occurs when a slave is communicated with.

The sequence of events in a serial network comm event are as follows:

1) Master S3012 initiates comm event by executing an sfunc13. Program execution in the master proceeds concurrently with the transmission of the words to the slave.

2) The slave receives the words from the master concurrently with it's program execution. Once all words are received from the master, the slave starts transmission of the words that are to be sent from the slave to the master. This also occurs concurrently with the slave program execution.

3) The master receives the words sent from the slave concurrently with it's program execution. Once all the words from the slave have been received, the subsequent call to sfunc13 results in a return value of "DONE". Until this step, calls to sfunc13 would have resulted in a "BUSY" return value.

See section 9.3 for details on installing and wiring the network.

Example:

1) Communicating from the master to a slave:

   Master S3012 main program:

   ```
   B080 = sfunc13(4,20,W1000,W5000,15,W5050,W1050);
   ```

   Execution: The above command transmits 20 words (W1000 thru W1038) in the master to the slave at network address 4, storing the data in W5000 thru W5038. The slave then transmits 15 words (W5050 thru W5078) to the master, storing this data at W1050 thru W1078. The transmission of the data was done concurrently with the program executions of both the master and the slave.

   The return value of the sfunc13 is stored in B080. Once the sfunc13 is initiated, the return value of the sfunc13 is "BUSY" (B080 = 1) until the transmission is complete. At that time, the return value is "DONE" (B080 = 2) or an error code (B080 = ERROR CODE) if an error occurred in transmission.

6.4 VME GATEWAY INTERFACE (S3013)

The S3013 VME Gateway module is a package which incorporates an S3012 processor board mounted to a VME gateway board. The S3013 provides a gateway or bridge between the S3012 processor/S3000 bus and a VME bus. The VME gateway itself is a 4K byte dual-port memory which both the S3012 can read/write to and a VME processor can read/write to. The package contains three boards: the S3012 processor board which connects to the S3000 back plane, an S3007 power supply which connects to the S3000 back plane and a VME gateway board which connects to the VME back plane.

The purpose of the S3013 is to provide a high-speed mechanism for passing data between the S3012 and VME based processors. The S3012 can pass data to the VME processor by writing the data to the gateway dual-port RAM, the VME processor then reads this data from the dual-port RAM. The VME processor passes data to the S3012 simply by writing the data to the gateway dual-port RAM where the S3012 can then read the data. Up to 4K bytes can be passed in one transfer cycle. Collisions in the dual-port RAM (access to the same dual-port RAM address by both sides simultaneously) is detected and handled by hardware on the VME side and detected by software on the S3012 side.

From the VME side, the S3013 simply appears as 4K bytes of memory which can be located any where in the VME address space. The base VME address of the S3013 is selected via dip switches on the S3013. Accesses to the gateway from the S3012 side are implemented using sfunc14, 15, and 16.

See the S3013 data sheet for more details.

6.4.1 S3012 ACCESS TO VME GATEWAY (sfunc14,15 and 16)

System functions 14, 15 and 16 are used to interface with the VME gateway dual-port RAM. System function 14 allows up to 255 words to be written and up to 255 words to be read from the dual-port RAM in one command. System function 15 allows one byte to be read from the dual-port RAM and sfunc16 allows one byte to be written to the dual-port RAM. All three system functions suspend program execution when they are executed, thus they are executed just like any other instruction.

The three system functions return with the same return values when executed. If the transfer was successful (no dual-port RAM collision), the return value is zero. If the transfer was not successful (collision with VME side occurred), the return value is ffH. If the return value is ffH, the sfunc should be executed again, the data written or read may not be valid.

SECTION 6
EXTENDED I/O OPERATIONS

System functions 15 and 16 can be used to implement a software handshaking mechanism between the S3012 and VME processor for zero collision data transfers. As an example, using these system functions, the S3012 could “acquire” the dual-port RAM memory by writing a command to a predefined dual-port RAM memory location. This would tell the VME processor that further accesses to the dual-port RAM should be suspended until the S3012 has loaded the dual-port RAM using sfunc14. Once the RAM is loaded, the S3012 would then set the command byte to tell the VME processor to go ahead and read the RAM. This could be implemented for both directions such that the VME could send data to the S3012 using a similar method.

See section 5.2.9 for a detailed description of sfunc14, 15 and 16 general form, parameter list and return values.

Examples:

1) Reading a byte address in the VME gateway:

    S3012 main program:

        B100 = sfunc15(200,B140);

    Execution: The above reads the VME gateway byte address 200 and stores the data in B140. The return value is stored in B100. The return value should be checked for a read collision (B100 = ffH), and if the collision occurred, the sfunc15 should be performed again, the data in B140 may not be valid.

2) Writing a byte to the VME gateway:

    S3012 main program:

        B110 = sfunc16(1200,B150);

    Execution: The above writes the data in B150 to VME gateway address 1200. The return value is stored in B110. The return value should be checked for a write collision (B110 = ffH), and if the collision occurred, the sfunc16 should be performed again, the data stored in gateway address 1200 may not be valid.

3) Transferring a block of data to and from gateway:

    S3012 main program:

        B060 = sfunc14(100,W1000,500,50,800,W2000);

    Execution: The above writes 100 words (W1000 thru W1198) to VME dual-port RAM address 500 thru 698. The sfunc then reads 50 VME dual-port RAM addresses (800 thru 898) and stores them at W2000 thru W2098 in the S3012. The return value is stored in B060 and should be checked for a collision (B060 = ffH). If a collision did occur, the sfunc14 should be executed again, some of the data may be invalid.

6.4.2 VME ACCESS TO GATEWAY

The VME side of the VME gateway is a simple slave 4K byte dual-port RAM memory. The S3013 gateway can be accessed using the following address modes: A16, A24 or A32. Data transfers can be D08(EO) or D16. The gateway can be accessed using any of the following address modifiers:

09H: Extended Non-Privileged Data Access
0DH: Extended Supervisory Data Access
29H: Short Non-Privileged Access
2DH: Short Supervisory Data Access
39H: Standard Non-Privileged Data Access
3DH: Standard Supervisory Data Access

The S3013 will respond to any and all of the above address modifiers. Accesses to the gateway occur using the data transfer bus only. The gateway does not use the interrupt bus or perform any bus arbitration. The memory is read/written to by the VME master using the commands pertinent to the particular VME master board.

The 4K bytes of the S3013 VME gateway can be mapped anywhere (within 4K byte boundaries) in the A16, A24 or A32 VME address space. This is done using dip switches mounted on the S3013 gateway board (see section 9.4). The switches select the base address (byte 0 of the 4K dual-port RAM) of the board.

SECTION 6
EXTENDED I/O OPERATIONS

(This Page Intentionally Left Blank)

SECTION 7
FAULT DETECTION

The S3012 contains comprehensive fault detection routines which verify the proper operation of the S3012 at all times.

7.1 FAULT ROUTINE EXECUTION

When a fault is detected, the following fault routine is executed:

1) User program execution is suspended.
2) If possible, all outputs in the system are disabled.
3) "FAULT" LED on the S3012 faceplate is illuminated.
4) "RUN" LED on S3012 is extinguished.
5) Fault interlock to PS3007 power supply is activated.
6) Fault code representing the detected fault is saved in internal S3012 memory for viewing with SYSdev.

The PS3007 power supply interlock can be interlocked to the system to provide a complete system shut-down if desired. It is recommended that this interlock at least be used to remove power from the S3000 output boards (field wiring side). For most S3012 faults, the outputs are disabled through the S3012. However, some severe S3012 faults may result in unknown or undesirable output states. See the PS3007 power supply data sheet for more details on this interlock.

7.2 VIEWING FAULT CODES WITH SYSDEV

When a fault occurs, an IBM PC or compatible, running SYSdev, can be connected to the PROG PORT of the S3012 to view the fault codes. To view the fault codes, perform the following:

1) Connect IBM PC "COM1" port to S3012 "PROG PORT" using the appropriate cable (see appendix B).

2) Initiate SYSdev from the DOS prompt and select the user program currently running in the S3012.

3) From the main menu, select "Target Board Interface".

4) From the Target Board Interface menu, select "Target Board Fault Codes/Status".

SECTION 7
FAULT DETECTION

The SYSdev fault display reads the fault codes from the S3012 and displays the following:

S3012 Internal Fault Code
1) Curr Flt:
2) Last Flt:
3) Co-cpu slot:
4) Corrective action:

S3012 Communications Network Error Code
5) Current comm error:
6) Last comm error:

Curr Flt: This is the S3012 fault code corresponding to the current detected fault along with a short description of the fault. This fault code is cleared at power-up or it can be cleared, by the user, after it is displayed in the SYSdev fault display.

Last Flt: This is the last S3012 fault code detected, shown just as the Curr Flt is shown. Unlike the Curr Flt, this fault code is not cleared at power-up. This field retains the last detected fault even when power to the S3012 is cycled. This fault code can only be cleared, by the user, after it is displayed in the SYSdev fault display.

Co-cpu Slot: This field is used in conjunction with the Intelligent I/O fault codes. This field contains the slot number of the intelligent I/O with which the fault occurred.

Corrective Action: This field contains a short description of the action which can be taken to correct the particular fault that was detected.

Current Comm Error: This field displays the current serial network comm error along with a short description describing the error. This field is cleared as soon as the current comm error clears.

Last Comm Error: This field displays the last error displayed in the Current comm error field. Unlike the Current comm error, this field retains the error code even after the error condition clears. This provides a history of the last comm error to occur.

The user has the option of clearing the fault codes (but not the comm errors) when exiting the SYSdev fault display.

7.3 FAULT CODES

The following is a list of the fault codes and descriptions, as displayed in the SYSdev fault display, detected by the S3012:

Code	Description
00H	No internal fault has occurred
01H	No response from co-cpu board - timeout
02H	Co-cpu did not send verification
03H	Co-cpu comm buffer hardware failure
04H	Co-cpu comm data integrity error
05H	Co-cpu did not respond with data
06H	Co-cpu did not release comm control
12H	Co-cpu did not send request - timeout
13H	Co-cpu did not send data
14H	Co-cpu comm buffer hardware failure
15H	Co-cpu did not send verification
16H	Co-cpu comm data integrity error
17H	Co-cpu did not send comm complete
20H	No response from S3040 - timeout
21H	S3040 comm buffer hardware failure
22H	S3040 comm data integrity error
23H	S3040 did not send data
24H	S3040 comm buffer hardware failure
30H	No response from co-cpu - timeout
31H	Invalid comm release from co-cpu
32H	Invalid comm complete from co-cpu
40H	Primary watch dog failure - timeout
41H	Secondary watch dog failure - timeout
42H	Cannot communicate with target board
43H	RAM battery low - program corrupted
44H	Program memory checksum error
45H	User program system fault sfunc09 call

SECTION 7
FAULT DETECTION

Code	Description
50H	Slave micro did not initiate at reset
51H	Slave micro did not ack initiate
52H	Slave micro did not ack cmnd intrpt
53H	Slave micro did not finish pri command
54H	Slave micro did not ack command ack
55H	Unrecognized slave micro command intrpt
56H	DPR write fault from master micro
57H	DPR read fault from master micro
58H	Unimplemented opcode executed
59H	Program execution out of bounds
5AH	Address out of program memory range
5BH	Invalid interrupt
5CH	Program invalid - execution suspended
5DH	Program dump timeout - program not sent
5EH	Address error - non data space address
70H	No initiate from master micro
71H	No initiate ack from master micro
72H	No command ack from master micro
73H	No timed intrpt ack from master micro
74H	Bad input look-up table entry
75H	Bad output look-up table entry
76H	Invalid Co-cpu interrupt request
77H	No co-cpu intrpt ack from master micro
78H	Bad co-cpu look-up table entry
79H	DPR write fault from slave micro
7AH	DPR read fault from slave micro

7.3.1 INTELLIGENT I/O (CO-CPU) FAULTS (01H-32H)

Fault codes 01H through 32H represent communication faults with intelligent I/O (CO-CPU) boards. In all cases, the faults represent a failure of the S3012 to communicate with the CO-CPU. When the fault code is viewed on the SYSdev fault display, the slot of the CO-CPU involved with the fault will be displayed in “Co-cpu slot:”. The cause of the faults range from a mismatch in the number of bytes specified to send in sfunc05 and receive in sfunc06, to hardware failures of the CO-CPU boards or S3012 board.

Trouble-shooting:

1) Verify the CO-CPU board is installed in the slot specified in the sfunc05/06/12 function calls.

2) Verify the CO-CPU is correctly seated in the rack.
3) Verify that no mismatches on the number of bytes to send and receive occur between the sfunc05, sfunc06 or sfunc12 calls in the S3012 and CO-CPUs. See section 6.1 for more details.

4 If the problem still persists, replace the CO-CPU in the slot involved with the fault.

5) If the problem still persists, replace the S3012.

7.3.2 WATCHDOG TIMER TIMEOUT (40H AND 41H)

The watchdog timeout faults occur when the main program scan time exceeds 40 milliseconds or when the time to execute the support functions (I/O updates, sfuncs, etc.) exceeds 25 milliseconds. The cause of these faults range from an unintentional infinite loop entered in the user program, to a timed interrupt which has an execution time longer then the time interval set for the timed interrupt.

Trouble-shooting:

1) Check the user program for any unintentional infinite loops. These are loops where the exit condition of the loop can never be satisfied. This can occur in "for", "while" and "do-while" loops. Also check for any "goto" jumps that cause the program to jump to a previous location in the program with no condition to stop executing the "goto".

2) Check for any loop instructions that may take longer than 40 milliseconds to execute (a large number of iterations through the loop). This situation can be corrected by inserting an sfunc03();, watchdog timer reset, in the loop such that the watchdog timer is reset every iteration of the loop.

3) Verify that the timed interrupt file execution is not too long for the time interval set for the timed interrupt. This is verified by making the time interval longer and then running the program to see if the watchdog timeout still occurs. The source of this problem is due to the program spending so much time executing the timed interrupt, that no time is left to execute the main program.

4) Verify that the rate of CO-CPU comm interrupts is not so high that the S3012 spends all it's time executing the comm interrupt file. This is verified by disabling the comm interrupt in the system configuration.

5) If the above all verifies, replace the S3012 and try again.

7.3.3 IBM PC TO S3012 COMMUNICATIONS FAILURE (42H)

If an attempt to read the fault codes from the S3012 results in an error code of "42H: Cannot communicate with target board", the PC cannot communicate with the S3012. This is not an internal S3012 fault but instead a fault detected by SYSdev. The cause of this fault ranges from catastrophic failure of the S3012 to a misconnection of the PC to the S3012.

Trouble-shooting:

1) Verify the "PWR" LED on the S3012 is "on" and that either the "RUN" or "FLT" LED is also "on". If not, verify that power is on to the S3012.

2) Verify that the RS-232 cable is connected to "COM1" on the PC and "PROG PORT" on the S3012.

3) Verify that the RS-232 cable connecting the PC to the S3012 is wired correctly. See appendix B for the pin out of the cable.

4) If the above verifies, replace the S3012 and try again. If the problem still persists, verify the "COM1" port for proper operation (see manual from PC manufacture).

7.3.4 INVALID PROGRAM FAULTS (5CH AND 5DH)

The "Program invalid" (5CH) fault occurs when the S3012 does not contain a valid user program. This typically occurs when a new board is installed which has never had a user program downloaded to it or after the hardware confidence test is performed, which erases the program memory. The "Program dump timeout" (5DH) fault occurs when program download to the S3012 is interrupted while program download is in progress.

Trouble-shooting:

1) Dump the user program to the S3012. These faults will clear once the S3012 is loaded with a valid user program.

2) If re-loading the S3012 with the user program does not clear the fault, replace the S3012 and try again.

7.3.5 USER PROGRAM AND sfunc09 SYSTEM FAULT CALL (45H)

This fault code is set when the user program performs an sfunc09(); system function fault call. See the user program for the purpose of the system fault call. See section 5.2.4 for details on sfunc09.

7.3.6 INTERNAL S3012 FAULTS (43H, 44H, 50H-5BH, 5EH, 70H-7AH)

The remainder of the fault codes detected by the S3012 represent an internal failure of the S3012. These can range from the RAM battery low to invalid interrupt requests.

Trouble-shooting:

1) Perform the hardware confidence test on the S3012. It may be desirable to remove the suspect S3012 from the system and to install another S3012 to get the application being controlled back up and running. The hardware confidence test can be performed in any S3000 rack. See section 8 for details on the test.

2) Based on the results of this test, repair S3012, return S3012 for repair, or re-install S3012 in system.

7.4 SERIAL NETWORK COMMUNICATION ERRORS

Unlike the system faults, the serial network communication errors do not cause an S3012 shut-down, but instead are simply logged into the Current and Last comm error registers, with user program execution continuing. The Current comm error represents an error that is present at the time the fault codes are viewed, while the Last comm error represents the last comm error detected. The comm error codes are viewed from the SYSdev fault display, see section 7.2 for more details.

The error codes saved in the Current and Last comm error registers are the same error codes returned from the sfunc13 call. The return values from the sfunc13 calls should be saved in separate 'B' variables such that when a comm error occurs, the slave that it occurred with can be determined.

SECTION 7
FAULT DETECTION

7.4.1 SERIAL NETWORK COMM ERROR CODES

The following is a list of the detected serial network communication errors:

Code	Description
00H	No network comm error
03H	More than one bus master detected
04H	sfunc13 xmitt timeout - no response
05H	sfunc13 receive timeout - no response
06H	Invalid command received from master
07H	Receive overflow
08H	Receive collision detected
09H	Receive alignment error (bad frame)
0AH	Receive CRC error
0BH	Unknown (undefined) error
0CH	Transmit no acknowledge
0DH	Transmit underrun error
0EH	Transmit collision detected
0FH	Address error (outside data memory)
10H	Unexpected slave responding

7.4.2 NO RESPONSE FROM SLAVE (04H AND 05H)

The no response errors occur when the master executes an sfunc13 addressed to a particular slave but receives no response from that slave. For every execution of sfunc13, the slave will always respond to the request, even if no data is to be sent from the slave to the master. This verifies that the slave did, in fact, receive the data sent to it.

Trouble-shooting:

1) Verify that the network continuity is good between the master and the slave. This can be done by observing the "COMM " LEDs on the network interface boards. Every time sfunc13 is executed, the "COMM"" LEDs will flash (or be on solid for continuous communications).

2) Verify that the master and all slaves on the network are set to the correct network address they have been assigned. For each node on the network, the address must be a number between 1 and 32 and must be unique. See section 9.3.3.

3) If the problem persists, replace the network interface board on the slave where the problem is occurring. Next replace the network interface board on the master. If the problem persists, replace the slave S3012.

7.4.3 SERIAL NETWORK INTEGRITY ERROR (03H, 06H-0EH, 10H)

The serial network integrity errors occur when corruption of the transmitted frame is detected. The sources of these errors range from multiple masters attempting communications on the network to excessive induced EMI on the network.

Trouble-shooting:

1) Verify that only one master is communicating on the network. The master is defined as the node which is executing the sfunc13 system functions. If two nodes are executing sfunc13s simultaneously, a network collision will occur with the corresponding corruption of data.

2) Verify that the network wiring is isolated from other high voltage wiring which could induce EMI into the network. The network should be routed in a conduit separate from other wiring.

3) Replace the network interface board at the slave with which the error occurred. If the problem persists, replace the S3012 at the slave node.

7.4.4 ADDRESS OUTSIDE RANGE (0FH)

This error occurs when an attempt to write to memory outside the data memory range occurs in either the master or slave. Verify the corresponding sfunc13 call specifies the proper data range. The range of addresses must be W032-W154 and W512-W8174.

SECTION 7
FAULT DETECTION

(This Page Intentionally Left Blank)

SECTION 8
CONFIDENCE TEST

The hardware confidence test, in conjunction with the ST3099 test board, allows the entire S3012 hardware to be verified for proper operation. The test is resident in all S3012s and is initiated through SYSdev96. The ST3099 test board is only required for the S3000 I/O bus test. If the board is not on hand, the remainder of the tests can still be performed. The hardware confidence test is the same test used at the factory to initially test the production S3012 boards, and therefore provides the same 100% hardware test as provided at the factory.

The test is provided to the user to verify whether the S3012 hardware is functional or not. Not as a tool to repair S3012s. If a fault is detected, the S3012 should be returned to the factory for repair. Any attempt to repair an S3012 will void the warranty.

8.1 TESTS PERFORMED

The following is a list of the tests performed by the hardware confidence test:

1) Micro controller RAM test
2) EPROM memory address test
3) Dual-port RAM memory test
4) Internal Fault detection test
5) RAM memory test
6) I/O (S3000 bus) test
7) VME dual-port RAM test (S3013)
8) RS-232 ports test
10) Fault interlock test

Tests 6,7,8, and 10 are all optional and can be individually enabled or disabled. Test 6, the I/O (S3000 bus) test, requires the ST3099 test board to successful execute. Test 7, the VME dual-port RAM test, can only be executed when an S3013 VME gateway module is being tested, the standard S3012 does not contain the VME dual-port RAM. Test 8, the RS-232 ports test, and test 10, the Fault interlock test, are both interactive tests requiring action by the test technician when performed. The remainder of the tests are automatic and require no action by the test technician once initiated.

Each test performs a 100% check of the respective hardware area of the S3012 board. If a fault is detected, the test is stopped and a test fault code is displayed to indicate the nature of the hardware failure.

SECTION 8
CONFIDENCE TEST

8.2 PERFORMING THE HARDWARE CONFIDENCE TEST

WARNING: The hardware confidence test should not be performed in an S3012 installed in a users control system. Unpredictable output states may result while the test is being performed. The hardware confidence test should only be performed in a separate (none control system) rack with no I/O boards installed.

8.2.1 EQUIPMENT REQUIRED

In order to perform the S3012 hardware confidence test, the following is required:

1) IBM PC or compatible with SYSdev installed.

2) RS-232 interface cable to connect “COM1” on the PC to “PROG PORT” on the S3012 (see appendix B).

3) ST3099 test board (only if test 6 is to be performed).

4) Separate S3000 rack (S3004CHR, S3008CHR, or S3016CHR) with PS3007 power supply and no I/O boards installed.

5) S3012 to be tested.

8.2.2 EXECUTING THE TEST

To execute the test, perform the following steps:

1) S3012-EP only: install user application program EPROMs in S3012. Any valid user program will do. See section 9.2.

2) Install ST3099 test board in any slot of rack. Remove all other I/O boards from rack. Any I/O boards left in the rack, other than the ST3099 test board, will cause a fault in the I/O S3000 bus test (test 6). This step is only necessary if test 6 will be executed.

3) Install S3012 to be tested in the processor slot of the S3000 rack. Power up rack. If the PS3007 fault interlock is interlocked with the power source to the rack, it will have to be by-passed. As a normal part of the test, the PS3007 fault interlock is toggled which will drop power to the rack.

4) Power up PC and enter SYSdev96 from the DOS prompt. Enter any user program name to proceed to the SYSdev96 Main Development Menu.

5) Connect Interface cable to "COM1" on PC and "PROG PORT" on S3012.

6) Select "Target Board Interface" from the Main Development Menu.

7) Select "Target board Hardware Confidence Test" from the Target board Interface Menu.

8) Select "S3012/S3013 Confidence Test" from the Confidence Test Selection Menu.

9) From the S3012 Main Test Menu, select the board to be tested: S3012-BR, S3012-EP, S3013-BR or S3013-EP.

10) Select "Initiate test mode" from the S3012 Main Test Menu.

    Note: Proceeding with this will set the S3012 into test mode, erasing program memory on S301X-BRs. The user application program will have to be downloaded to the S301X-BR once the test is complete.

    Press any key to initiate test mode, "ESC" to return to the S3012 Main Test Menu.

11) Select "Configure Test Routine" from the Test Functions Menu. Enable the tests to be executed by answer "y" to the respective prompts.

    Note: Test 1-5 are unconditionally performed.

12) Select "Perform Test" from the Test Functions Menu and then "ENTER" to start the test. Once the test is initiated, all tests enabled will be executed repeatedly starting with test1 thru the last enabled test until any key is depressed.

If no faults are detected, the tests will continue to execute repeatedly, displaying "test passed" messages after the successful completion of each test. Test 8 and test 10 are interactive tests requiring input from the test technician. Follow the instructions when prompted for by these tests.

If a fault does occur, the test will stop and display the following:

Fault Code = XX (test fault code and description)

Address of fault:	(memory address or I/O address where fault occurred)
Actual data at fault:	(data actually obtained at address of fault)
Expected data at fault:	(data that should have been obtained at address of fault)
Diagnostics test number:	(for factory use only)

Once a fault occurs, exit back to the Main Test Menu and re-initiate the test to reset the fault code.

Once testing is complete, exit back the Main Test Menu and then into the previous SYSdev menus. On S301X-BR boards, the user application program will have to be re-loaded into the S3012, the test clears all program memory. The data memory of both the S301X-BR and S301X-EP is also cleared. This memory will have to be loaded from disk if the data for this memory has been preset (previously saved on disk).

SECTION 8
CONFIDENCE TEST

8.3 INTERACTIVE INTERFACE

The interactive interface menu contains selections to read the fault code (same as displayed when a fault is detected), perform diagnostics routines (for use by the factory only) and to read and write, via the RS-232 ports, to any address in the S3012. In general, all these selections are for factory use and are of little significance to the user.

SECTION 9
INSTALLATION

The following sections describe installation of the S3012 in the rack, installation of the program EPROMs in the S3012-EP, and the installation of the serial network.

CAUTION: The internal components of the S3012 are susceptible to damage by static discharge, just as any electronic components are. When installing eproms in the s3012-ep or installing the serial network option board, the s3012 should be handled at an approved anti-static work station. This includes a grounded static dissipative work surface and grounding of personnel handling the board using a grounding wrist strap. When handling the s3012 otherwise, the board should be handled by the faceplate only and preferably in a static shielding bag.

9.1 INSTALLING S3012 IN S3000 RACK

The S3012 must be installed in the processor slot of the S3000 rack (the slot to the immediate right of the PS3007 power supply). The S3012 is physically wider than the other I/O boards used in the system and thus does not fit correctly in any other slot. Install the S3012 as follows:

1) Install program EPROMs (S3012-EP only). See section 9.2.

2) Turn power to the S3000 rack "off".

3) Install S3012 in rack by aligning the board with the card guides and sliding in until firmly seated. The board is held in the rack via captive screws located on the faceplate.

4) Turn power to the S3000 rack "on".

5) Down-load user application program to board (S3012-BR only) using the "Download program to target board" SYSdev menu selection. See the SYSdev programming manual for more details.

6) Down-load user data file, if one exists, to the S3012 using the "Download data to target board" SYSdev menu selection. See SYSdev programming manual for more details.

7) If the S3012 is equipped with a network option board (SPB3012-1, etc.) and is connected to an S3000 network, set the network address of the particular S3012. See section 9.3.3. Connect the S3012 to the network by plugging the network field wiring connector into the network comm port, observing the proper keying of the connector.

To remove the S3012 from the rack, perform the following:

1) Turn power to the S3000 rack "off".

2) If the S3012 is equipped with a network option board (SPB3012-1, etc.), pull the network field wiring connector from the comm port.

3) Loosen the captive screws located on the faceplate and gently pull the board out of the rack using the handles located on the faceplate.

Note: When installing or removing the S3012, power to the rack must be off.

9.2 INSTALLING USER PROGRAM EPROMS IN S3012-EP

When using the S3012-EP, user program EPROMs must be installed in the S3012 prior to installing the S3012 in the rack. Two 27C256 EPROMs constitute the EPROM program memory and are programmed from the SYSdev96 Main Development Menu "Program EPROM" selection. See the SYSdev Programming Manual for details on programming the EPROMs. The EPROMs are programmed in split mode for a full 16-bit wide bus. This means the first EPROM is programmed with all the even byte addresses (low order bytes of the 16-bit words) and the second EPROM is programmed with all the odd byte addresses (high order bytes of the 16-bit words).

To install the EPROMs, perform the following:

1) Remove S3012-EP from rack (see section 9.1). Be sure to follow the anti-static procedures outlined in the beginning of the installation section when installing the EPROMs.

2) IC socket U18 is used for the low order byte address (even addresses - first EPROM programmed) and IC socket U14 is used for the high order byte address (odd addresses - second EPROM programmed).

3) Remove existing EPROMs if any are installed. Take care not to pull the IC sockets off the board while removing the EPROMs.

4) Install EPROMs by aligning pin 1 indicator on EPROM (dot next to pin 1 or notch at top of EPROM) with the pin 1 indicator of the socket (notch in socket next to pin 1). Make sure pins seat properly in socket (no bent pins under EPROM).

5) Install S3012-EP back in rack (see section 9.1).

9.3 SERIAL NETWORK INSTALLATION

The serial network installation consists of installing the serial network option boards on the S3012s used in the network, wiring the network and setting each S3012 on the network with a unique network address. Up to 32 S3012s can be installed on one network.

9.3.1 INSTALLING SERIAL NETWORK OPTION BOARD (SPB3012-1)

The SPB3012-1 serial network board is an option board purchased separately and installed on the S3012. In addition, the factory can install this board if specified by the customer. The SPB3012-1 implements the S3000-N1 network (see section 6.3). The SPB3012-1 can be installed in any of the S3012 family of boards: S3012-BR, S3012-EP, S3013-BR and S3013-EP.

To install the SPB3012-1:

1) Remove S3012 from rack if installed. Follow all anti-static handling procedures outlined in the beginning of the Installation section when installing the SPB3012-1.

2) Remove cover plate on S3012 faceplate where SPB3012-1 is to be installed by loosening captive screws on cover plate.

3) Install SPB3012-1 by sliding SPB3012-1 down black faceplate mounting brackets, making sure the 6 male connector pins on the underside of the SPB3012-1 mate with the 6 pin female connector on the S3012.

4) Secure the SPB3012-1 to the S3012 by tightening the captive screws on the SPB3012-1 faceplate to the faceplate mounting brackets on the S3012.

5) Re-install the S3012 in the rack.

9.3.2 WIRING THE SERIAL NETWORK

Refer to figure 1 for a typical schematic of the network and for the pin outs of the field removable network interface connectors. When wiring the network, the following rules must be followed:

1) Wire the network using Belden #9182 single-shielded twisted pair cable or an equivalent data communications cable meeting the following spec:

   Wire gauge: 22AWG
   Nom. impedance: 150 ohms/ft.
   Nom. attenuation at 1MHZ: .004 db/ft.
   Twisted pair, single-shielded

2) The total wire length of the network cannot exceed 1000 ft.

3) The maximum number of nodes connected to one network is limited to 32 nodes.

4) The shield of the cable should be carried through the entire network, using the shield tie points on the interface connectors to achieve this. The shield tie-points on the connectors are not internally tied to anything, they are strictly tie points. One of these tie points should then be tied to earth ground.

5) The two extreme ends of the network must be terminated with 150 ohm resistors as shown in figure 1.

6) The network wiring should be isolated from other high voltage wiring by routing the network in a separate conduit dedicated to the network.

7) The network should be wired directly to the network comm port connectors. No intermediate terminations or splices should be used. The network should be wired in a direct connect topology as shown, not in multi-drop or cluster topologies.

   Note: The network comm interface connectors contain two sets of + and - terminals. The two sets of terminals are tied together internally on the board (+ to +, - to -) and are provided as tie points to ease wiring. Communications across the network will continue even if one of the nodes has failed provided all the connectors are installed in their respective board. However, if a connector is pulled from it's board, communications to the boards downstream will be lost (the internal tie point will be broken). If it is desired, this situation can be avoided by wiring the connector as shown in figure 2.

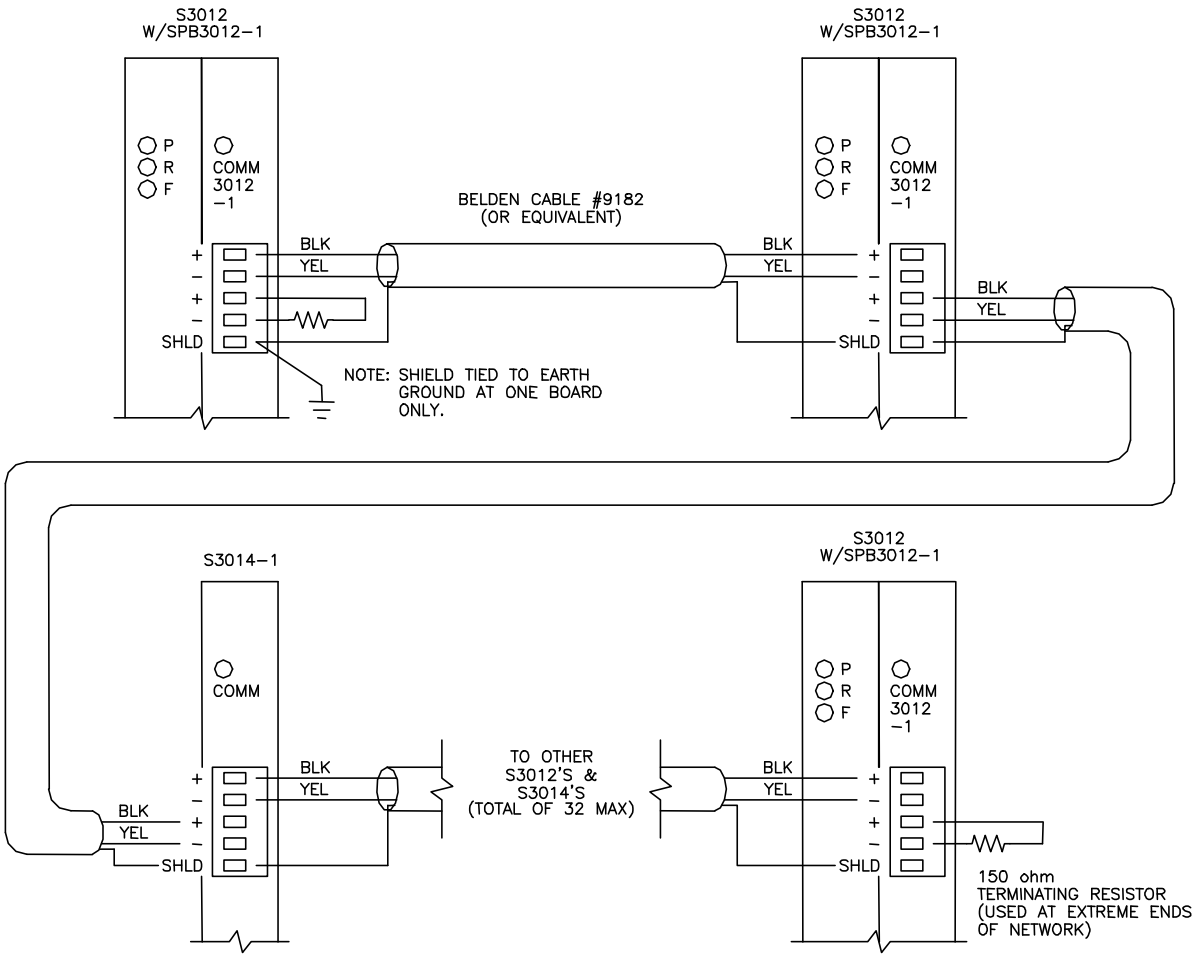


Figure 1 – Typical Network Wiring

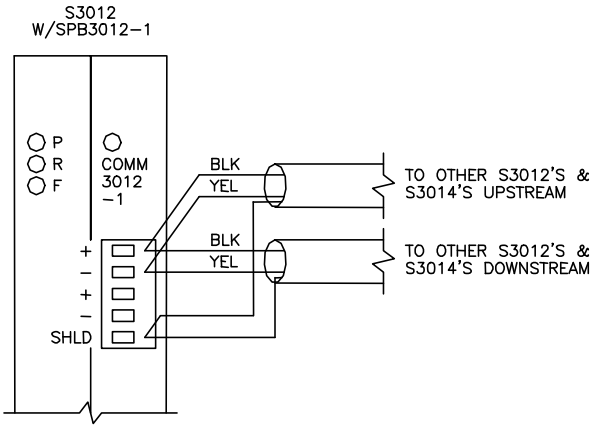


Figure 2

9.3.3 SETTING THE NETWORK ADDRESSES

Each S3012 on the network must be set with a unique network address between 1 and 32. This is how the S3012s can distinguish one node from another. To set the network address for a particular S3012, perform the following:

1) Connect an IBM PC or compatible running SYSdev96 from "COM1" on the PC to "PROG PORT" on the S3012 using the RS-232 interface cable (see appendix B).

2) From the SYSdev Main Development Menu, select "Target Board Interface".

3) From the Target board Interface Menu, select "Target board Network Address".

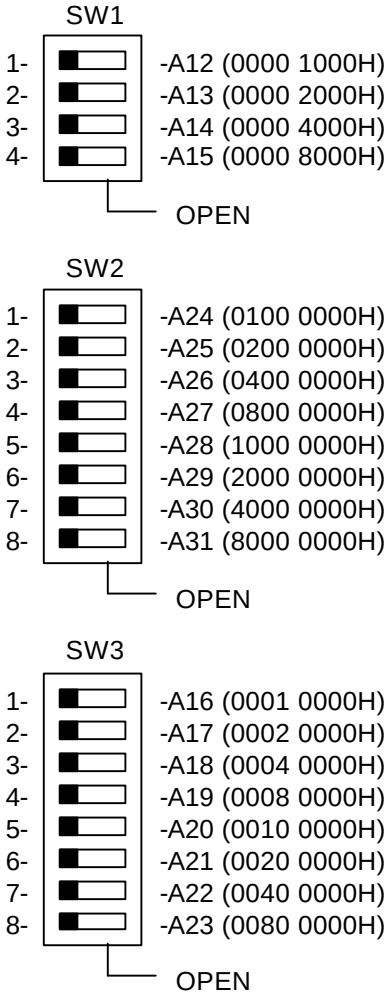
4) SYSdev will read the current network address of the S3012 and display it in the network display. If the network address is to be changed, follow the directions displayed and enter the new address.

5) Once this is done, power the S3012 down and then power it back up or reload the user application program in the S3012. This resets the S3012, re- initializing the S3012 with the new network address.

The above steps must be done for all S3012s on the network. This is true when the network is first installed, and when a new S3012 is added or replaced (that S3012 must have the network address set it in).

9.4 SETTING THE VME GATEWAY BOARD ADDRESS (S3013 only)

The 4K bytes of the VME dual-port RAM on the S3013 can be mapped anywhere in the A16, A24, or A32 VME address space. This is done using dip switches SW1, SW2, and SW3 located on the S3013. This switches must be set prior to installing the S3013 in the rack. The switches select the base address (byte 0 of the 4K dual-port RAM) of the gateway. The address is selected as shown below:



Note: Setting the switch on the open side selects the respective bit address, setting it on the opposite side deselects it.

SECTION 9
INSTALLATION

(This Page Intentionally Left Blank)

Location of S3012 In RACK: Proc Slot (next to PS3007)

Board Size:

Length:	9.15"
Height:	6.30"
Width:	1.20"

Memory:

Program (S3012-BR):	44K bytes battery backed CMOS RAM
Program (S3012-EP):	44K bytes EPROM (2ea. 27C256s with access time of 150nsec or less)

Data:

Flags:	992 (volatile)
Bytes:	124 (volatile) 7,664 (battery-backed)
Words:	62 (volatile) 3,832 (battery-backed)

Execution Times:

Scan Time:	.25msec per 1K bytes (typical)
Main program overhead:	.25msec-.30msec (typical)
Minimum Through-put:	.25msec (using timed interrupt)

I/O Address Capability:

I/O slots in S3000 rack:	16
I/O points in rack:	256

Interface Ports:

PROG PORT:	
Type:	RS-232
Comm Rate:	9600 BAUD
USER PORT:	
Type:	RS-232
Comm Rate:	300,600,1200,2400,4800,9600 BAUD
Start bits:	1
Data bits:	8
Stop bits:	1
Parity:	none

SECTION 10
SPECIFICATIONS

Serial Network:

S3000-N1:

Type:	RS-485
Comm Rate:	344KBPS
# of nodes (max):	32
Isolation:	2000 VRMS
Distance:	1000 ft.
Protocol:	Proprietary

Power Requirements:

Icc (+5VDC):	1.20 amps (MAX)
Icc (+12VDC):	0.10 amps (MAX)
Icc (-12VDC):	0.10 amps (MAX)

Temperature Range:

Storage:	0 to 85 degrees C
Operating:	0 to 60 degrees C

Relative Humidity:

5 to 95% (non-condensing)

APPENDIX A
S3012 PROGRAMMING EXAMPLE

The following is an S3012 program example. The program contains various examples of ladder and high-level block. The name of the program is S3012E1 and it was copied into a directory named EXAMPLES (which is a sub-directory of SYS96) by the installation program when SYSdev was installed on your hard drive. To view the program in SYSdev, perform the following:

1) From the root directory of the drive you installed SYSdev on, type SYSDEV and press ENTER. SYSdev will be invoked, displaying the directories and programs in the root directory of the current drive.

2) Select the SYS96 directory using the F3: Select Dir command.

3) Select the EXAMPLES directory using the F3: Select Dir command.

4) The programs in the EXAMPLES directory will be displayed in the Program Selections menu. Select the S3012E1 program and press F2: Edit Prog.

5) The main development menu will be displayed. Select 1: Edit program/On-line Funcs and then the F1: Main Prog to view the program

APPENDIX A
S3012 PROGRAMMING EXAMPLE

S3012 Example: Network and VME comm.
System Configuration: S3012E1.LCF

System Configuration

Target Board:	S3012 processor board
Rack Size:	16
Timed Interrupt Enable:	Yes
Timed Interrupt Time:	00.250msec
CO-CPU Communications Interrupt Enable:	Yes
USER PORT Baud Rate:	9600
Network Option:	SPB3012-1

I/O Slot Assignments

0:	S3040	- Resolver Interface
1:	*****	
2:	S3021	- Co-processor I/O board
3:	S3021	- Co-processor I/O board
4:	S3063	- 16 point 10-30vdc input (source)
5:	S3068	- 8 input/8 output 10-30vdc (source)
6:	S3073	- 16 point 10-3-vdc output (source)
7:	--------	
8:	--------	
9:	--------	
10:	--------	
11:	--------	
12:	--------	
13:	--------	
14:	--------	
15:	--------	

APPENDIX A
S3012 PROGRAMMING EXAMPLE

S3012 Example: Network and VME comm.
Initialization File: S3012E1.LIN

The following is an example of an S3012 program. This particular program assumes the S3012 is implemented in an S3013, which includes a VME dual-port RAM gateway. The program shows as examples the following:

1) Communications with intelligent I/O boards (sfunc05 and sfunc06).

2) Communications to two other S3012's via the S3000 serial network (sfunc13).

3) Communications to a VME system using the S3013 dual-port RAM gateway (sfunc14, sfunc15 an sfunc16).

4) An implementation of both the timed interrupt and CO-CPU comm interrupt.

5) Typical ladder block implementations.

Initialization:

The following blocks are used to perform the initial communications with the intelligent I/O boards:

S3040 in slot 0
S3021 in slot 2
S3021 in slot 3

The initial communications with these boards is required to pass initialization parameters to the boards and set the board identifier (slot #) in each board. The board identifier is set automatically when the sfunc05 communications function is performed in the initialization file.

APPENDIX A
S3012 PROGRAMMING EXAMPLE

```
************************************************************************
block:   1 – High-level

 0:
 1:   /* Initial communications to S3040.  The S3040 must have       */
 2:   /* four bytes sent to it at power up.  These are the scale     */
 3:   /* factor and offset.  Early versions of the S3040 actually    */
 4:   /* saved the scale factor and offset in the S3012.  Later      */
 5:   /* versions save these values in the S3040 itself.  This       */
 6:   /* initial communications is required for conformity           */
 7:   /* between the two S3040 versions                              */
 8:
 9:   W4000 = 360;
10:   W4002 = 0;
11:
12:   sfunc05(0,4,B4000,0,B4000);         /* initiate comm. with  */
13:                                       /* S3040 in slot 0 and  */
14:                                       /* send four bytes.     */
15:
16:
17:   /* Initial communications with S3021 in slot 2 which is     */
18:   /* running ADV10, a program developed with SYSdev.  This    */
19:   /* program expects to receive 3 bytes at initialization.    */
20:   /* These are defined below:                                 */
21:
22:   B100 = 15;     /* on response time of 15msec       */
23:   B101 = 30;     /* off response time of 30msec      */
24:   B102 = 128;    /* total counts between index       */
25:
26:   sfunc05(2,3,B100,0,B100);     /* initiate comm. with  */
27:                                 /* S3021 in slot 2 and  */
28:                                 /* send three initial   */
29:                                 /* bytes.               */
30:

B0100    Co-cpu  initial byte #1
B0101    Co-cpu  initial byte #2
B0102    Co-cpu  initial byte #3
B4000     S3040  initial word #1
W4000     S3040  initial word #1
W4002     S3040  initial word #2
```

```
************************************************************************
block:   2– High-level

 0:
 1:   /* Initialize S3021 in slot 3. This S3021 is also running   */
 2:   /* ADV10 and is initialized in a similar fashion.           */
 3:
 4:   B100 = 1;      /* These are the values sent to the S3021.   */
 5:   B101 = 2;      /* In most applications, these would be      */
 6:   B102 = 3;      /* some kind of initialization parameters.   */
 7:
 8:   sfunc05(3,3,B100,0,B100);  /* initialize the S3021 */
 9:                              /* in slot 3            */
10:

B0100    Co-cpu  initial byte #1
B0101    Co-cpu  initial byte #2
B0102    Co-cpu  initial byte #3
```

APPENDIX A
S3012 PROGRAMMING EXAMPLE

S3012 Example: Network and VME comm.
Main Program: S3012E1.LMN

The main program executes the majority of the user program. The tasks implemented in the main program are generally low priority, lower speed tasks. High speed tasks are usually implemented in the timed interrupt file (with through-puts as low as 0.25msec) or in intelligent I/O boards dedicated to particularly complex tasks.

The blocks shown in the main program demonstrate communications between other S3000 boards via the serial network, communications to a VME master via the S3013 dual-port RAM gateway and various examples of ladder blocks. Most application programs will have much more code in the main program then this example.

The following block is an example of communications between a master and two slaves on the S3000 serial network. This program resides in the master and controls all communications between the master and two slaves. The slave boards have no program code pertaining to this communications. For the sake of this example, it is assumed that the master is set to network address 1 and the two slaves are set to network addresses 2 and 3 respectively.

The communication is implemented as follows:

1) The master sends 20 words, starting at W1000 to the slave at network address 2, storing these 20 words at W2000 through W2038 in the slave.

2) The master receives 25 words from slave #2, starting at address W2100 in the slave and saving these words in W1100 through W1148 in the master.

3) The master sends 20 words, starting at W1200 to the slave at network address 3, storing these 20 words at W2000 through W2038 in the slave.

4) The master receives 25 words from slave #3, starting at address W2100 in the slave and saving these words in W1300 through W1348 in the master.

5) The master takes turn communicating with the slaves, first talking with slave #2, then slave #3 and back to slave #3 continuously by toggling flag F100. Flag F100 is initially set to “0”, which enables the sfunc13 with slave #2, Once this sfunc13 completes, either by a return value of “DONE” (2) or an error code (3-10H), flag F100 is set to a “1” which enables the sfunc13 with slave #3. Once this sfunc13 completes, F100 is reset to a “0” which enables the sfunc13 with slave #3 again and so on.

Note: The sfunc13 is a simultaneous system function, such that once initiated, program execution continues without waiting to complete. Subsequent calls of the sfunc13 returns a value of “BUSY” (1), “DONE” (2) or an error code (03-10H). By examining this return value the user can determine whether the sfunc13 is complete and successful (return = “DONE”) or failed (return = error).

```
************************************************************************
block:   1 – High-level

 0:if (F100 == 0)          /* comm with slave #2? */
 1:   {                    /* yes, execute sfunc13 with slave #2 */
 2:   B040 = sfunc13(2,20,W1000,W2000,25,W210,W1100);
 3:   if (B040 != 1)       /* done yet? Return == done or error? */
 4:      F100 = 1;         /* yes, enable comm with slave #3 */
 5:   if (B040 >= 3)       /* return == error code? */
 6:      B041 = B040;      /* yes, save error code */
 7:   }
 8:else
 9:   {                    /* execute sfunc13 with slave #3 */
10:   B040 = sfunc13(3,20,W1200,W2000,25,W200,W1300);
11:   if (B040 != 1)       /* done yet? Return == done or error? */
12:      F100 = 0;         /* yes, enable comm with slave #2 */
13:   if (B040 >= 3)       /* return == error code? */
14:      B042 = B040;      /* yes, save error code */
15:   }
16:


F100 (044.4)  comm    with   slve #3
B0040        sfunc13  return  value
B0041        slave 2  error   code
B0042        slave 3  error   code
W1000        slave 2  send    stack
W1100        slave 2 receive  stack
W1200        slave 3  send    stack
W1300        slave 3 receive  stack
W2000         slave  receive  stack
W2100         slave   send    stack
```

APPENDIX A
S3012 PROGRAMMING EXAMPLE

The following block is an example of communications between an S3012, implemented as part of an S3013 VME gateway and VME master. The S3013 VME gateway is a module which contains an S3012 processor and S3013 VME dual-port RAM which allows an S3012 and a VME master to communicate with on another using this shared memory.

The communication is implemented as follows:

1) The S3012 uses sfunc15 to read the gateway address 0, looking for a "data ready" (55) command from the VME master. This byte will be set to 55 by the VME master, once the VME mater has loaded gateway address 200 through 248 with the data to be sent to the S3012.

2) When the command is set to "data ready" (55), the S3012 writes 30 words to gateway addresses 100 through 158, starting from W3000 in the S3012. The S3012 then reads 25 words from the gateway starting address 200 and stores them at W3100 through W3148 in the S3012. This entire process is performed by the one sfunc14.

3) If no collision was detected when sfunc14 was executed, the S3012writes "OK" (22) to gateway address 2. If a collision did occur, the S3012 writes "FAIL" (99) to gateway address 2. This address is essentially an acknowledge from the S3012 that it did send and receive the data without a collision. The VME master reads this address and then either reads the data from gateway addresses 100 through 158 ("OK") or retries the entire communications if the "ack" was "FAIL". Since the VME master uses the "command" and "ack" bytes in the gateway to handshake with the S3012, a collision when the sfunc14 is executes is essentially impossible, thus the return value of the sfunc14 should always be "0" (no collision).

   Note: "FOR" loops were used to implement the sfunc15 and sfunc16 which read the command from the VME and write the acknowledge. This is done because it is very likely that a collision can occur during the execution of these two sfuncs. Both the S3012 and VME master are reading and writing to these bytes simultaneously thus a collision is entirely possible. The "FOR" loop allows a finite number of retries if a collision does occur and is used to verify that the data is valid.

```
************************************************************************
block:   2 – High-level

 0:for (B050 = 0, F101 = 0; B050 < 30 && F101 == 0; ++B050)
 1:   {
 2:   if (sfunc15(0,B151) == 0)        /* read command byte from gateway */
 3:      F101 = 1;                     /* if no collision, don = YES */
 4:   }
 5:
 6:if (B051 == 55 && F101 == 1)        /* valid data ready from VME? */
 7:   {                                /* transfer data to and from VME */
 8:   sfunc16(0,0);                    /* reset VME command register */
 9:   B052 = sfunc14(30,W3000,100,25,200,W3100);
10:   if (B052 == 0)                   /* did collision occur? */
11:      B053 = 22;                    /* no, ack with OK (22) */
12:   else
13:      B053 = 99;                    /* yes, ack with FAIL (99) */
14:
15:   for (B050 = 0, F101 = 0; B050 < 30 && F101 == 0; ++B050)
16:       {                            /* send ack to VME gateway */
17:       if (sfunc16(2,B053) == 0)    /* did collision occur? */
18:          F101 = 1;                 /* no, ack complete */
19:       }
20:   }
21:

F101 (044.5)  sfunc   15/16   done
B0050          sfunc   15/16   count
B0051        command  from     VME
B0052        sfunc14  return  value
B0053          VME   gateway   ack
W3000          VME    send    stack
W3100          VME   receive  stack
```

APPENDIX A
S3012 PROGRAMMING EXAMPLE

The following block generates both a leading edge single shot (F000) and a trailing edge single shot (F001) on the input from slot 4, bit 0. Flag F000 is “ON” for one scan when input X040.0 goes from “off” to “ON”. Flag F001 is “ON” for one scan when input X040.0 goes from “ON” to “off”.

```
**************************************************************************
block:   3 – High-level

   xinp040 xinp040                                                 xinp040
    bit 0   bit 0                                                   bit 0
   var doc  state                                                  L.E.S.S
   X040.0   F002                                                    F000
0:+--] [--+--]/[--+-------+-------+-------+-------+-------+-------+--( )--
          (032.2)                                                 (032.0)

   xinp040 xinp040                                                 xinp040
    bit 0   bit 0                                                   bit 0
   var doc  state                                                  T.E.S.S
   X040.0   F002                                                    F001
1:+--]/[--+--] [--+-------+-------+-------+-------+-------+-------+--( )--
          (032.2)                                                 (032.1)

   xinp040                                                         xinp040
    bit 0                                                           bit 0
   var doc                                                          state
   X040.0                                                           F002
2:+--] [--+-------+-------+-------+-------+-------+-------+-------+--( )--
                                                                   (032.2)
```

APPENDIX A
S3012 PROGRAMMING EXAMPLE

The following block implements a 119 bit shift register. As can be seen, by cascading the shift register instructions, any number of shifts can be generated.

Note: The input to the shift register "ck" is a leading edge single shot. The shift register shifts all the bits of the register left on bit every scan that the "ck" input is a "1".

Thus if a leading edge single shot was not used, the shift register would be clocked every scan that X040.0 was a "1", which is generally not what is desired. Also, word variables and byte variables were interchangeably used in the shift register instructions. Each word variable is worth 15 shifts, while, each byte variable is worth 7 shifts.

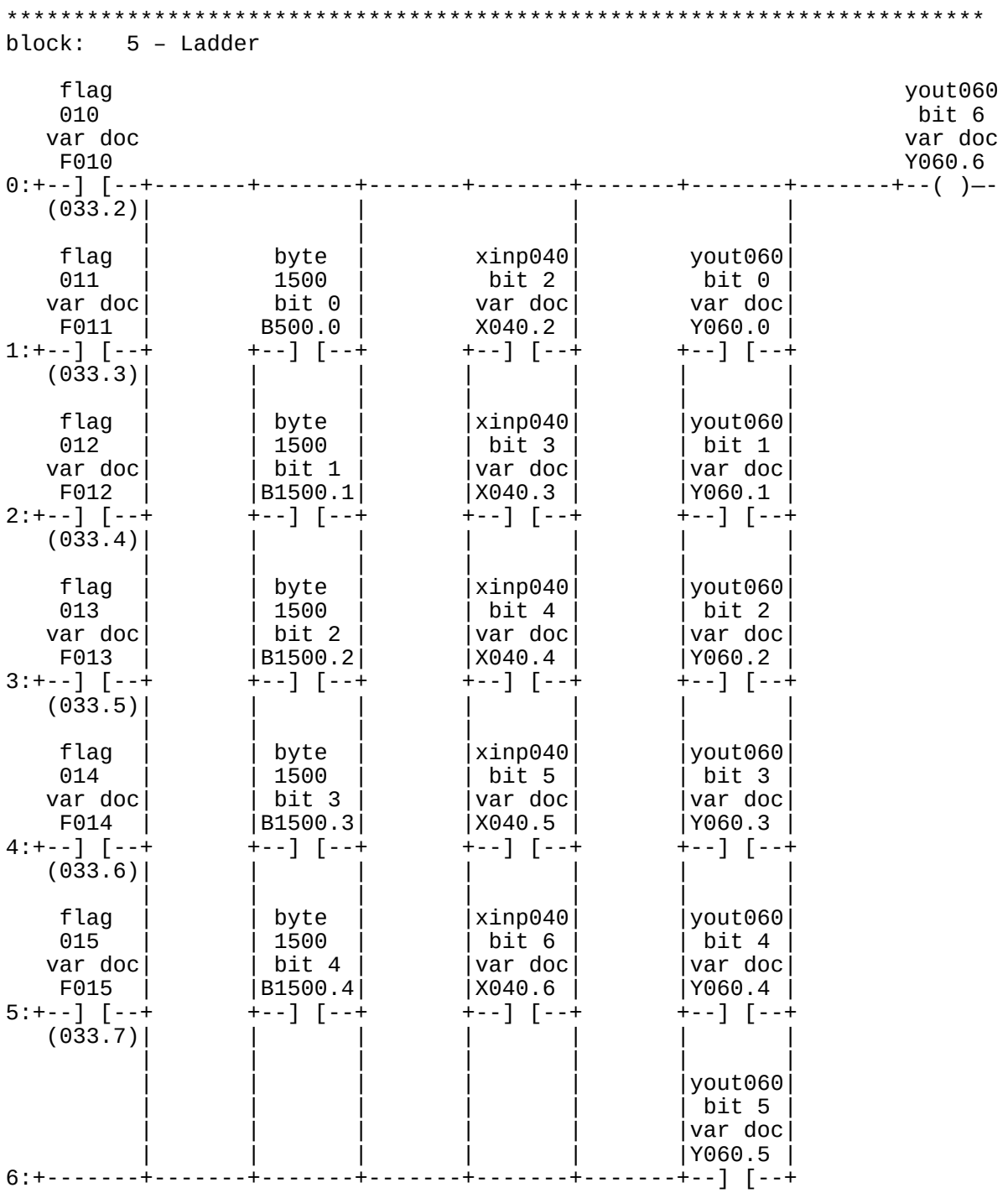
Various bits of the shift register were referenced in the next rung as normally open contacts. This shows how any bit of the shift register can be used elsewhere in the program.

```
*****************************************************************************
block:   4 – Ladder



0:        +-------+-------+-------+-------+
          |               |               |
          |               |               |
   xinp040|               |               |
    bit 0 |               |               |
   L.E.S.S|     Shift     |     Shift     |     Shift
    F000  |ck+---------+  |ck+---------+  |ck+---------+
1:+--] [--+--|         |  +--|         |  +--|         |
   (032.0)   | 1:W0080 |     | 1:W0086 |     | 1:W0090 |
             | 2:W0082 |     | 2:B0088 |     | 2:W0092 |
   xinp040   | 3:W0084 |     | 3:B0089 |     | 3:W0094 |
    bit 1    |         |     |         |     |         |
    (si)     |  shift  |     |  shift  |     |  shift  |
   X040.1  si|   reg   |so si|   reg   |so si|   reg   |so
2:+--] [--+--| word #1 |--+--| word #4 |--+--| word #6 |--
             +---------+     +---------+     +---------+

    shift   shift   shift                                                 flag
     reg     reg     reg                                                  003
   bit #7  bit #78 Bit#110                                               var doc
   B0080.7 B0090.4 B0094.6                                               F003
3:+--] [--+--] [--+--] [--+-------+-------+-------+-------+-------+--( )--
          |                                                              (032.3)
          |
    shift |
     reg  |
   bit #12|
   b0081.4|
4:+--] [--+
```

APPENDIX A
S3012 PROGRAMMING EXAMPLE

The following is an example of 22 contacts “OR’d” together. This shows that even though the ladder block is 7 rows by 9 columns, large “OR” statements can still be entered.

Note: Bit references such as “B1500.0” are made. This shows how any bit in the entire memory space, not just flags, can be referenced.



This block implements a flasher circuit which flashes output Y060.7 “off” and “ON” at a rate preset in variables W1600 and W1602. These variables are located in battery-backed data memory (address 512 thru 8175 and therefore can be changed at run time if desired and still maintain their presets during power down. These presets could be set from 0 to 65535 resulting in times between 0 and 655.35 seconds (a 0.01 second time base was selected).

```
**********************************************************************
block:   6 – Ladder


   flasher                                                      flasher
    reset       Timer                                           output
    F016     +---------+                                        Y060.7
0:+--] [--+--|         |--+-------+-------+-------+-------+-------+--( )—-
   (034.0)|  | P:W1600 |  |
          |  | TB:0.01 |  |
          |  | A:W0110 |  |
          |  |         |  |                                     flasher
          |  | flasher |  |     Timer                            reset
          |  |  “off”  |  |  +---------+                         F016
1:        |  |  accum  |  +--|         |--+-------+-------+-------+--( )—-
          +--|---------+     | P:W1602 |                         (034.0)
             |               | TB:0.01 |
             |               | A:W0112 |
             |               |         |
             |               | flasher |
2:           |               |   “on”  |
             |               |  accum  |
             |               +---------+
```

APPENDIX A
S3012 PROGRAMMING EXAMPLE

S3012 Example: Network and VME comm.
Timed Interrupt: S3012E1.LTD

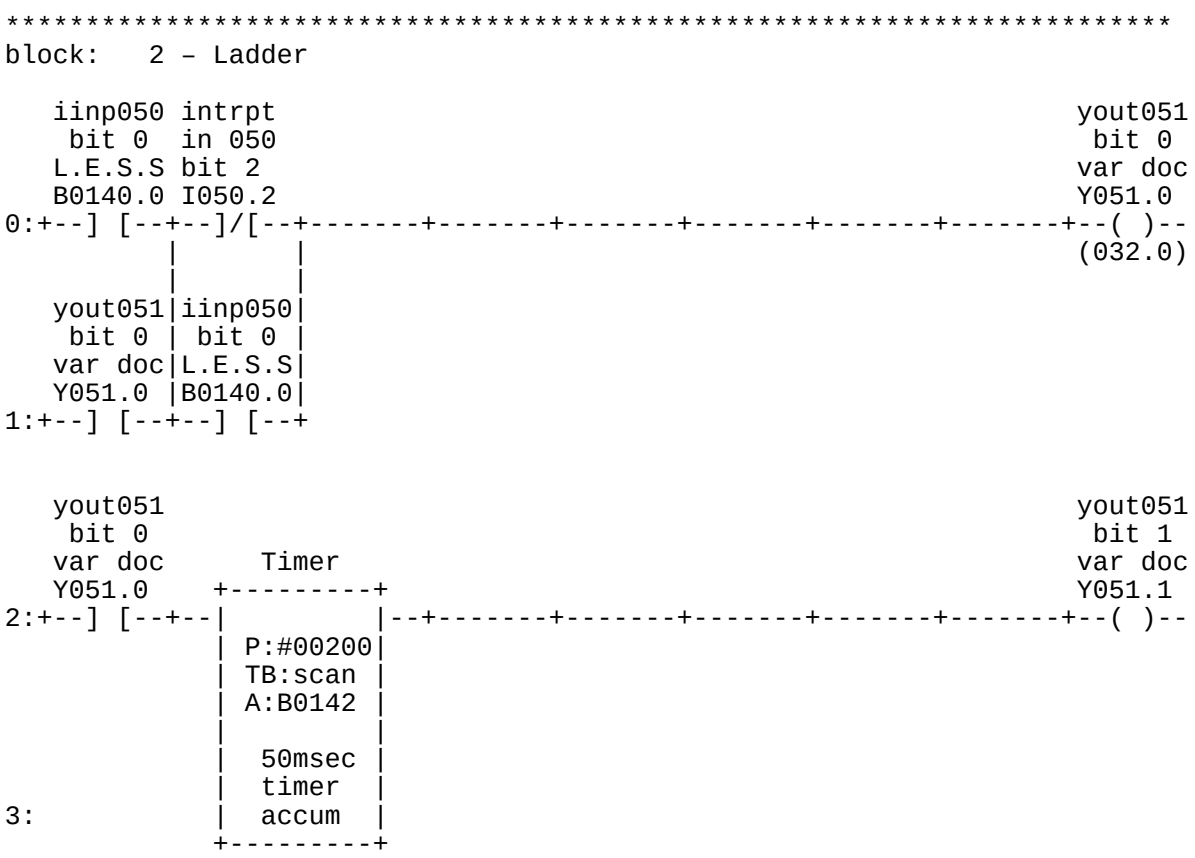
The timed interrupt in this example is used to show how a timed interrupt can be used to process a high speed critical task. The time interval was set at 0.25 milliseconds in the system configuration. In this example. The 8 inputs of the S3068 in slot 5 are considered high speed inputs which are used to update the logic in the timed interrupt.

Note: these inputs are referenced with the "I" variable. This designates these inputs as timed interrupt inputs and thus are automatically read at the beginning of the timed interrupt. This provides the latest state of these inputs prior to executing the timed interrupt logic. Also, any output "Y" variable used as an output in the timed interrupt will be updated every timed interrupt, not at the main scan output update. This allows these specific outputs to be updated at high speed, rather than having to wait for the main scan output update.

Even if just one input point of an input board is referenced as an "I" variable in the timed interrupt, the entire input board (all 8 or 16 points) will be read at the beginning of the timed interrupt. The same is true of outputs. If any output point is referenced as a coil in the timed interrupt, the entire output board will be updated at the timed interrupt.

```
************************************************************************
block:   1 – High-level

 0:/* The following generates leading edge single shots off all */
 1:/* eight bits of the timed interrupt input I050 at one time  */
 2:/* and stores them in B140.                                  */
 3:
 4:B140 = I050 & ~B141;    /* The bits in B140 are the leading edge */
 5:B141 = I050;            /* single shots of the inputs on the     */
 6:                        /* S3068 in slot 5, which were read at   */
 7:                        /* the beginning of the timed interrupt. */
 8:


B0140         intrpt  inp 050 L.E.S.S
B0141         intrpt  inp 050  status
I050           timed   intrpt  in050
```

The following block uses the inputs read and the single shots generated in the previous block to perform some high speed logic function. Y051.0 is set in a network that forms a ‘D’ type flip flop that is clocked with the leading edge of timed interrupt input I050.0. The input I050.2 is clocked into the flip flop. The next rung comprises a timer that times for 50msec prior to activating Y051.1 when Y051.0 is “ON”.



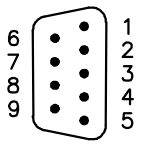
APPENDIX A
S3012 PROGRAMMING EXAMPLE

S3012 Example: Network and VME comm.
CO-CPU Interrupt: S3012E1.LCM

This is the CO-CPU communications interrupt file and is executed in response to a communications interrupt from either the S3021 in slot 2 or the S3021 in slot 3. The S3021's initiate the interrupt by executing an sfunc05 in their main programs. The slot that initiated the interrupt occurs. This variable is used to decode which board initiated the interrupt.

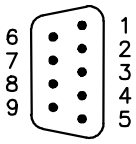
```
**************************************************************************
block:   1 – High-level

 0:/* The S3021's in slot 2 and 3 are executing ADV10. This program */
 1:/* interrupts the S3012 to get one status byte from the S3012.   */
 2:/* No information is sent to the S3012 by ADV10. The following   */
 3:/* lines show how the interrupting slot is decoded by testing    */
 4:/* B8175 and then executing the corresponding sfunc06 to respond */
 5:/* to that interrupt. If an invalid slot initiates the interrupt */
 6:/* (no Co-cpu in that slot), the sfunc09 system fault function   */
 7:/* is executed, which suspends program execution.                */
 8:
 9:
10:if (B8175 == 2)               /* S3021 in slot 2 interrupting?   */
11:   sfunc06(2,0,B103,1,B103);  /* yes, respond to S3021 in slot 2 */
12:else if (B8175 == 3)          /* S3021 in slot 3 interrupting?   */
13:   sfunc06(3,0,B104,1,B104);  /* yes, respond to S3021 in slot 3 */
14:else
15:   {
16:   B105 = 99;                 /* invalid interrupt, execute system fault */
17:   sfunc09();                 /* routine                                  */
18:   }
19:


B0103          S3021   slot 2  status
B0103          S3021   slot 3  status
B0105         invalid intrpt   error
B8175         Co-cpu  intrpt   slot
```

APPENDIX B
RS-232 PIN OUTS/CABLES



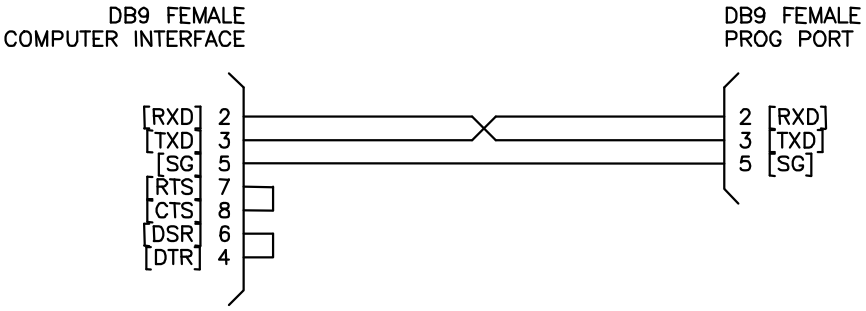
1: NOT USED
2: RXD (RECEIVE DATA – IN)
3: TXD (TRANSMIT DATA –OUT)
4: NOT USED
5: SG (SIGNAL GROUND)
6: NOT USED
7: NOT USED
8: NOT USED
9: NOT USED

PROG Port Pin Out

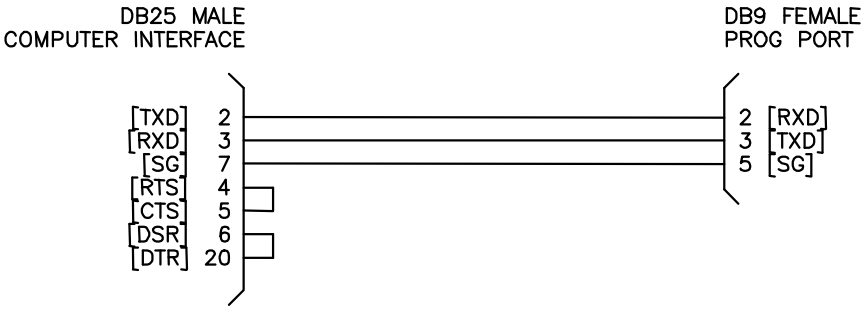


1: NOT USED
2: RXD (RECEIVE DATA – IN)
3: TXD (TRANSMIT DATA –OUT)
4: DTR (DATA TERMINAL READY – OUT)
5: SG (SIGNAL GROUND)
6: NOT USED
7: RTS (REQUEST TO SEND – OUT)
8: CTS (CLEAR TO SEND – IN)
9: NOT USED

USER Port Pin Out



DB9 (com1) to PROG Port Cable



DB25 (com1) to PROG Port Cable