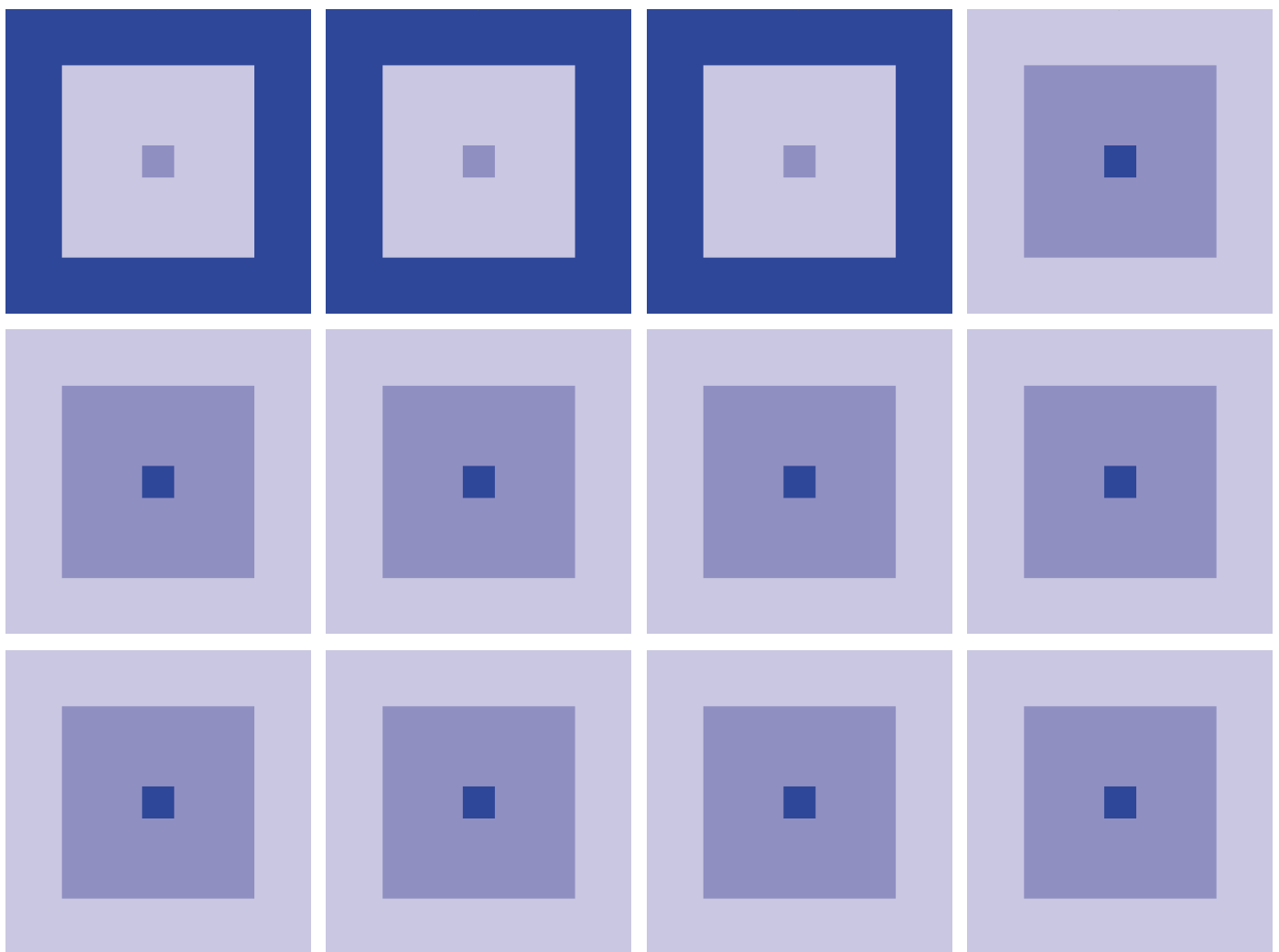


Intelligent Network Controller for Embedded System
S1S60K Series
Host I/F Manual



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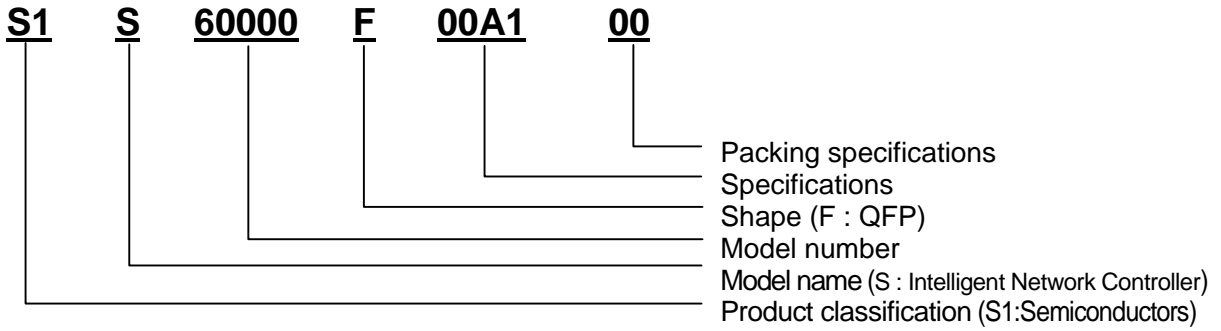
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Configuration of product number

●DEVICES



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1. HARDWARE INTERFACE

1.1 Description

When connecting the host CPU to a network by use of S1S60K series IC (“S1S60K”), commands and data are communicated via the host interface (“host I/F”). Following illustrates the connection diagram between the host CPU and S1S60K.

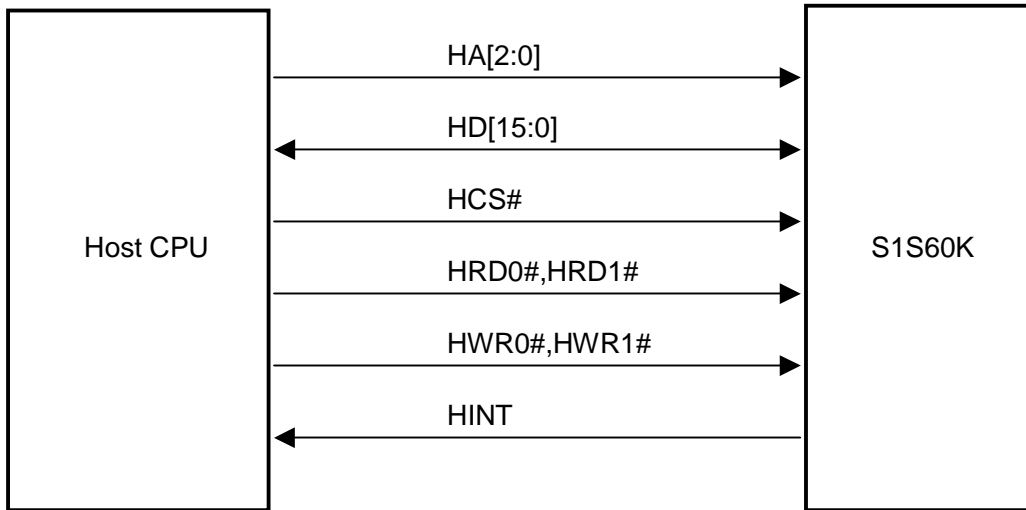


Figure 1.1 Host Interface Connection Diagram

The host CPU establishes communication with S1S60K by transmitting and receiving data using I/O access (memory access in case of memory mapped I/O). HINT is an interrupt signal from S1S60K to the host CPU.

S1S60K connects or disconnects the host CPU to and from a network according to the commands from the host. S1S60K informs its internal state to the host CPU by use of the status resulting from the status read request. Input and output of data as well as the option part of a command or status are implemented via the transmitting and receiving ports.

1.2 Input and Output Ports

Communication between S1S60K and the host CPU is carried out via the following three ports. A port to be accessed is specified by the state of HA [2:0] when HCS# is 0 (low level).

- (1) **Command/status port (8bit mode: HA [2:0] = 000, 001 / 16bit mode:HA [2:0] = 00x)**
 A command from the host CPU to S1S60K is written to this port (in Write operation).
 And the status sent from S1S60K is read from the port (in Read operation).
 Since this port is 16-bit wide, two times of access (to the upper and lower addresses) are required for 8-bit interface.
 For contents of data, refer to 2.1.1.
- (2) **Data port (8bit mode: HA [2:0] = 010, 011 / 16bit mode: HA [2:0] = 01x)**
 Data from the host CPU to S1S60K is written to the port (in Write operation).
 And, data from S1S60K is read from the port (in Read operation).
 Since this port is 16-bit wide, two times of access (to the upper and lower addresses) are required for the 8-bit interface.
 Option parameters of the command/status are also transmitted or received via this port. For details, refer to “2.1.3 Transmitted and Received Data”.

(3) Flag port (HA [2:0] = 1xx)

It is used to indicate the processing state of command, status and data on the host interface. Two types are assigned by the setup of EXTINT (bit7).

When EXTINT = 0, the state of bit [1:0] becomes the cause to activate HINT signal and when either bit is 1, the HINT signal becomes the active state (polarity of signal can be changed). When the status or data is read on the host side, the corresponding cause is cleared and when all causes are cleared, the HINT signal becomes the inactive state. Also, when checking S1S60000 internal data processing state from the host interface, decide it with bit [3:2] state.

When EXTINT = 1, the state of bit [3:0] becomes the cause to activate HINT signal and when either bit is 1, the HINT signal becomes the active state (polarity of signal can be changed). It can be cleared by writing 1 into the corresponding bit position on the host side, and HINT signal becomes inactive state if all causes are cleared.

Since this port is 8-bit wide, when the 16-bit interface is used or when two times of access (to the upper and lower addresses) are made with the 8-bit interface, the same data is read from the upper and lower addresses.

Table 1.1 Bit Assignment on Flag Port

Bit	EXTINT=0	EXTINT=1
7	EXTINT 0:Extended interrupt is not used (conventional compatibility) 1:Extended interrupt is used	
6:5	Reserved. Value is 0.	
4	HSTREN 0:Data port receive circuit on S1S60000 is invalid 1:Data port receive circuit on S1S60000 is valid	
3	H2CDV State of processing written data (R/O) 0: Enable to read data 1: Waiting for Data read	H2CDC Data read end notification (Read) 0: Waiting for data read or no data 1: Last data read completed (Cleared by writing 1)
2	H2CCV Command processing state (R/O) 0: Enable to write a command 1: Waiting for a command processed	H2CCC Command processing end notification (Read) 0: Command unprocessed or no command 1: Last command processing completed (Cleared by writing 1)
1	C2HDV Read data preparatory state (R/O) 0: Read data is not present 1: Read data is present	C2HDV Read data preparatory state (Read) 0: Read data is not present 1: Read data is present (Cleared by writing 1)
0	C2HSV Status preparatory state (R/O) 0: Read status is not present 1: Read status is present	C2HSV Status preparatory state (Read) 0: Read status is not present 1: Read status is present (Cleared by writing 1)

Note: When the host interface is 16-bit mode, the same content as bit [7:0] is output for the bit [15:8]. Only writing to the bit [7:0] is valid.

1.3 Setup of Host Interface

1.3.1 Setup Procedure

S1S60K allows specifying the host I/F's bus type, bus size, endian type, polarity of interrupt line and polarity of WAIT signal depending on the model of the host CPU connected to it. Setup is implemented in the following order of priority.

- (1) Setup on the internal registers
- (2) Setup by use of EEPROM data
- (3) Setup with the setup pins

For details of the setup, refer to the product specification or technical manual of respective ICs.

(1) Setup on internal registers

In this approach, data is directly written to the S1S60K registers. Access to the registers is made directly from the core CPU program.

(2) Setup by use of EEPROM data

In this approach, the data written to a specific address on the external 3-wire EEPROM is automatically selected at reset (including the software reset). The specified setup becomes valid when HIFSEL [2:0]=111.

(3) Setup with setup pins

Setup is done by state of HWPOL, HINTPOL, HENDIAN, HSIZE and HIFSEL [2:0] pins at the reset (including the software reset). The specified setup becomes valid when HIFSEL[2:0] are not 111.

1.3.2 Setup Options

You can specify following items for the host interface on S1S60K.

- (1) Bus type
- (2) Bus size
- (3) Endian
- (4) Polarity of WAIT signal

(1) Bus type

Bus type is specified with EEPROM data HIFCR [10:8] or HIFSEL [2:0] pin.

You can select a desired type from the following. Some CPUs not listed below may be connected if the signal type is similar. For details, refer to the product specification or technical manual of respective ICs.

Table 1.2 Bus Type

Setting	Type
000	SH3, SH4, EPSON S1C33 Series
001	MC68000,MC68010
010	MC68030,MC68040
011	Generic
100	Reserved
101	MIPS,ISA
110	PCMCIA
111	Setup by use of EEPROM data

(2) Bus size

You can specify 8-bit or 16-bit using EEPROM data HIFCR [11] or HSIZE pin.

Table 1.3 Setup of Bus Size

Setting	Bus size
0	16bit
1	8bit

When you have selected the 8-bit interface, access to the command/status port becomes valid as two cycles are made at HA [2:0]=000 and HA [2:0]=001. Likewise, access to the data port becomes valid as two cycles are made at HA [2:0]=010 and HA [2:0]=011. Repeated access to the same address does not make the access valid. The order of access to the two is optional.

Access to the flag port is always valid as long as it is made at HA2=1.

(3) Endian

You can specify big or little endian for the host I/F by use of EEPROM data HIFCR [12] or HENDIAN pin. Selecting an appropriate endian enables processing the command without changing the bit order or byte order from the software.

Table 1.4 Selection of an Endian

Setting	Endian type
0	Little endian
1	Big endian

Little endian

When little endian is selected, the host CPU and S1S60K communicates lower 8 bits and upper 8 bits of 16-bit data at the lower address and upper address of the port, respectively. Little endian is used when the host CPU is Intel x86 series or equivalent.

Big endian

When big endian is selected, the host CPU and S1S60K communicates lower 8 bits and upper 8 bits of 16-bit data at the upper address and lower address of the port, respectively. Big endian is used when the host CPU is Motorola 68 series or equivalent.

(4) Setup of Interrupt signal

You can specify polarity of HINT interrupt signals by use of HIFCR register bit14 or HINTPOL pin.

Table 1.5 Polarity of Interrupt Signal

Setting	Polarity of interrupt signal
0	Low active
1	High active

2. SOFTWARE INTERFACE

Software interface of S1S60K series employs a common format. This format will be used as the base when additions/modifications are conducted on the physical layer or the interface is expanded to support IPv6 in the future.

2.1 Input and Output Format

Writing to or reading from S1S60K is implemented in one of the following formats.

- (1) Writing a command
 Following format applies to commands other than **open** and **send**.

Content	Command
Port	Command port Write

- (2) Writing a command + option parameter
 Following format applies to **open** command.

Content	Command	Option parameter
Port	Command port Write	Data port Write

- (3) Writing a command + option parameter + send/receive data
 Following format applies to **send** command.

Content	Command	Option parameter	Outgoing data
Port	Command port Write	Data port Write	Data port Write

- (4) Reading a status
 Following format applies to status other than the **read**, **error** and **event**.

Content	Status
Port	Status port Read

- (5) Reading a status + option parameter
 Following format applies to the **error status** and **event status**.

Content	Status	Option parameter
Port	Status port Read	Data port Read

- (6) Reading a status + option parameter + send/receive data
 Following format applies to the **read status**.

Content	Status	Option parameter	Incoming data
Port	Status port Read	Data port Read	Data port Read

2.1.1 Format of Command and Status

Following formats apply to commands sent via the command port and status received via the status port, respectively.

Table 2.1 Format of Command

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Data	Sequence number								End Point number				Command number			

Table 2.2 Format of Status

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Data	Sequence number								End Point number				Status number			

2.1.1.1 Sequence Number

Length of the sequence number is fixed to 8 bits. The host CPU can select any number in the range of 0 to 255 as the command sequence number. As for the status, either the number selected by the host CPU for the command or 0 (a status for which corresponding command does not exist) is assigned. Thus, the host CPU is capable of identifying a corresponding command by checking the sequence number of the status.

2.1.1.2 End Point Number

Length of the End Point number is fixed to 4 bits. This number, being selected in the range of 0 to 15, indicates the intended application of the End Point. End Points are classified into four categories - for the system, data link layer, TCP layer and UDP layer - according to their applications. See the following table.

Table 2.3 List of End Points

Number	Name	Application
0	SYSTEM	Used to communicate data with the system (S1S60K)
1	DATALINK	Used to communicate data with the data link layer
2	TCP0	Used to communicate data with TCP layer
3	TCP1	
4	TCP2	
5	TCP3	
6	UDP0	Used to communicate data with UDP layer
7	UDP1	
8	UDP2	
9	UDP3	
10	SNMP	Used when expanding SNMP on the host CPU
11 to 15		Reserved

SYSTEM is used when communicating data between S1S60K itself and the host CPU in order to, for example, control hardware contained in S1S60K (such as I2C, GPIO and EEPROM).

DATALINK is used for sending or receiving already assembled packets without resorting to protocol processing inside S1S60K. The built-in FCS generation/check circuit is usable in this case, too.

TCP0 to TCP3 and UDP0 to UDP3 are used when transmitting or receiving data using TCP/IP processing function of S1S60K.

SNMP is used when the host CPU adds Private MIB (Message Information Base) to MIB of S1S60K.

Each End Point is independent allowing you to use them at the same time.

2.1.1.3 Command Number

Length of the command number is fixed to 4 bits. This number, being selected in the range of 0 to 15, identifies a specific command.

Table 2.4 shows the list of commands and Table 2.5 shows the command usable at respective End Point.

Table 2.4 List of Commands

Number	Name	Description
0	open	Used to initialize and start using a End Point
1	send	Used to send data from a End Point
2	receive	Used to receive data from a End Point
3		Reserved
4	close	Use to terminate utilization of a End Point
5	abort	Use to abort utilization of a End Point (for emergency)
6	stop	Used to cancel a command that is currently turning on data transfer at a End Point
7	status	Used to obtain information that can vary depending on status of the End Point
8	init	Used to initialize S1S60K
9	info	Used to obtain status-independent information from a End Point
10 to 15		Reserved

Table 2.5 Combination of End Point and Command

End Point		Command								
		0	1	2	4	5	6	7	8	9
No.	Name	open	send	receive	close	abort	stop	status	init	info
0	SYSTEM									
1	DATALINK									
2	TCP0									
3	TCP1									
4	TCP2									
5	TCP3									
6	UDP0									
7	UDP1									
8	UDP2									
9	UDP3									
10	SNMP									

Allowable combination

Unallowable combination

If the host issues a not combinable command, S1S60K will return the invalid status.

2.1.1.4 Status Number

Length of the status number is fixed to 4 bits. This number, being selected in the range of 0 to 15, indicates a specific status.

Table 2.6 shows the list of status and Table 2.7 lists the status returned responding to respective commands.

Table 2.6 List of Status

No.	Name	Description
0		Reserved
1	write	A command received. Write into the data port.
2	read	A command received. Read from the data port.
3	ok	A command received. Process is completed normally.
4	working	A command is unacceptable. Status of the End Point is illegal.
5	invalid	A command is unacceptable. Status of S1S60K is not supported.
6	error	A command is unacceptable. Read out the data port for detail.
7	busy	The command is unacceptable. Resources are in shortage.
8	cancel	A command has been received, however the succeeding asynchronous process ended unsuccessfully.
9		Reserved
10	event	Read a notice from S1S60K at the data port.
11	boot	S1S60K has been started.
12		Reserved
13	arrive	S1S60K has received data.
14	sleep	S1S60K entered into the sleep mode.
15	wake	S1S60K operates normally.

Table 2.7 Combination of Status and Command

Command		Status number												
		1	2	3	4	5	6	7	8	10	11	13	14	15
No.	Name	write	read	ok	working	invalid	error	busy	cancel	event	boot	arrive	sleep	wake
0	open													
1	send													
2	receive													
3														
4	close													
5	abort													
6	stop													
7	status													
8	init													
9	info													

The status returned responding to the command.

The status not returned responding to the command.

2.1.2 Format of Option Parameters

As for certain commands, you must specify option parameters to execute them. For instance, when using **open** command for TCP layer, you must specify the IP address of the destination as well as the port to be connected. Some status also contain the option parameters.

Length of the option parameters is fixed to 16 bytes. Two bytes of them are used to indicate byte count of the outgoing/incoming data and remaining 14 bytes contain the information unique to the given command or status.

Option parameters are read or written via the data port.

Table 2.8 Common Format of Option Parameters

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Data	Byte count of sent/received data		Area containing information unique to given command/status													

The option parameters can contain data of four different types - numeric type, bit map type, IP address type and data row type. These data types are respectively stored in the option parameter in the following formats.

Table 2.9 Data Type of Option Parameter

Data type	Storing format
Numeric type	Length of data of this type is fixed to 8 bits, 16 bits or 32 bits. Upper bits are stored in BYTE0 or above of the option parameters. Lower bits are stored in BYTE 15 or below of the option parameters.
Bit map type	Length of data of this type is fixed to 8 bits, 16 bits or 32 bits. Role of the data is defined on bit basis.
IP address type	Length of data of this type is fixed to 32 bits. Upper bits are stored in BYTE0 or above of the option parameters. Lower bits are stored in BYTE 15 or below of the option parameters.
Data row type	Length of data of this type is defined for respective parameters. Beginning bytes are stored in BYTE0 or above of the option parameters. Ending bytes are stored in BYTE 15 or below of the option parameters.

Send/receive data is 16-bit long numeric data. When a command or status does not contain the send/receive data, 0 must be set in this field.

2.1.3 Send/Receive Data

Send/receive data is read or written via the data port. Length of send/receive data is variable. Its byte count is indicated by the starting two bytes of option parameters.

2.1.3.1 Data Length

Length of data to be transmitted or received with a command varies from 0 to the maximum data length defined by a respective End Point. At the End Point for TCP, for instance, data can be transmitted or received in the range of 0 to 536 bytes. Table 2.10 lists length of data transmittable and receivable at respective End Point.

By issuing an **info** command, the host CPU can get the maximum data length indicated by the Table 2.10.

Table 2.10 Length of Send/Receive Data

End Point	End Point number	Minimum data length (byte)	Maximum data length (byte)
SYSTEM	0	0	256
DATALINK	1	0	1518
TCP	2 to 5	0	536
UDP	6 to 9	0	548
SNMP	10	0	484

Note, however, that S1S60K may return the error status for **send** command if it sends the maximum length of data depending on the option parameters of **open** command or **send** command. For further information, refer to the sections handling **open** and **send** commands.

2.1.3.2 Send/Receive Data for System End Point

Data for the System End Point varies according to the embedded hardware.

- EEPROM: (read) No transmitting data exists. Received data are 16-bit wide (Big Endian) and from EEPROM. The data length of the received data is 2.
- EEPROM: (write) Data to be transmitted are data to be written into EEPROM, and they are 16-bit wide (Big Endian). The data length of the transmitted data is 2. No received data exists. Refer to the technical manual for the detail of EEPROM write data.
- I2C: (read) Transmitting data consists of one byte data to be output via the I2C bus and dummy data read from the I2C-but in the range of 1 byte to 8 bytes as a result of the data output. Receiving data consists of one byte data which has been transmitted to the I2C bus and data read from the I2C bus in the range of 1 byte to 8 bytes as a result of the data output.
- Flash ROM: (write) Transmitting data consists of the first data (byte 0) to be written into the flash ROM and up to the last data specified by the maximum length of the SYSTEM End Point. No receiving data exists.

Note that there is no transmitting / receiving data for GPIO, internal registers and Flash ROM (read).

2.1.3.3 Send/Receive Data for DATALINK End Point

When the communication physical media is Ethernet, transmitting / receiving data starts with a destination MAC address field of DIX and ends at the last data. It may contain FCS (Frame Check Sequence) completely if options of **open** command of DATALINK End Point specifies so.

2.1.3.4 Send/Receive Data for TCP End Point

The send/receive data of TCP End Point corresponds to data part of TCP segment. In case of SMTP or FTP which is a protocol over TCP, the whole segment is included in the sending / receiving data.

2.1.3.5 Send/Receive Data for UDP End Point

The send/receive data of UDP End Point corresponds to data part of UDP datagram. In case of DNS and NTP which is a protocol over UDP, the whole segment is included in the sending / receiving data.

2.1.3.6 Send/Receive Data for SNMP End Point

The send/receive data of SNMP End Point corresponds to VarBind of VarBind List of SNMP message. Data from the beginning of the SNMP message which is the type (SEQUENCE) to the data of VarBind List which is the type (SEQUENCE) and to the length field are not included in the send / receive data.

The send / receive data may include plural VarBind.

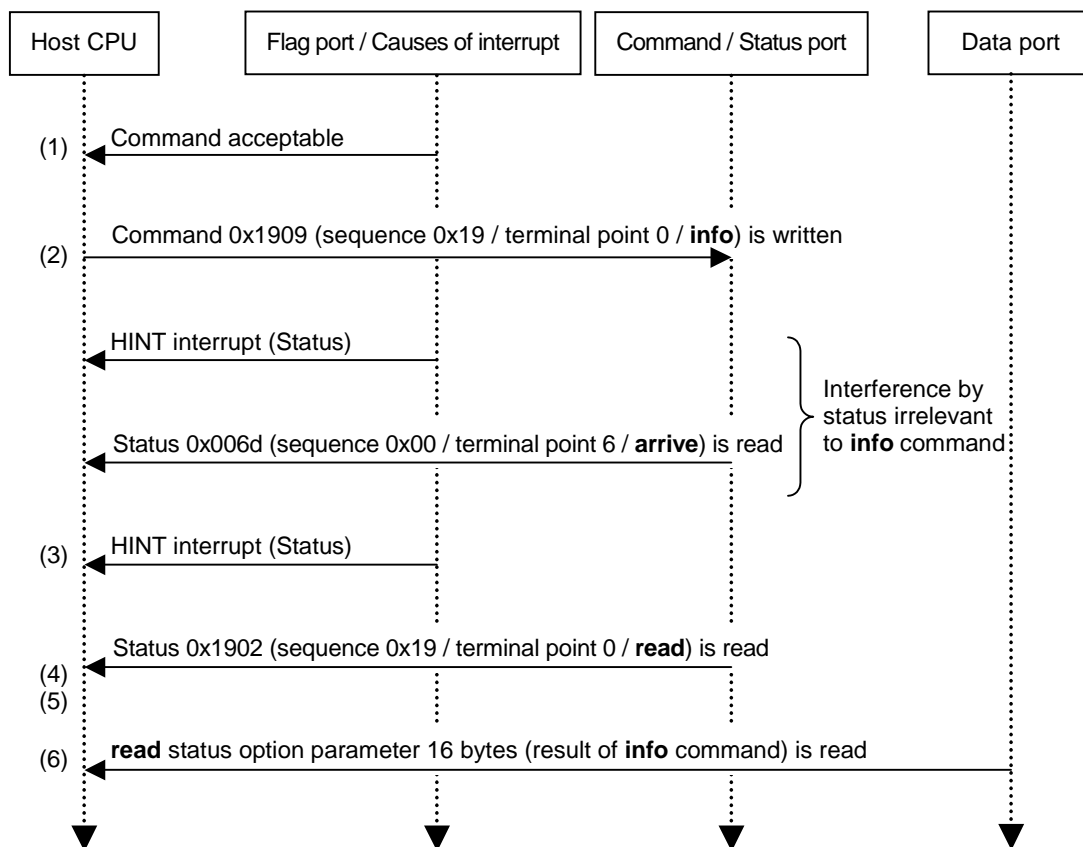
2.2 Issuing a Command and Obtaining Resulting Information

2.2.1 Commands Written to the Command Port Alone

When issuing a command that is to be written to the command port alone, the host CPU implements the following procedures.

- (1) Reads the flag port to check whether or not the command is acceptable (bit2=0).
- (2) Writes the command to the command port.
- (3) Checks HINT interrupt signal or flag port's status bit (bit0) to make sure that the status has been set.
- (4) Reads the status from the status port.
- (5) Checks the sequence number/End Point number of the status to identify to what command the status is returned.
- (6) Recognizes the result obtained from the command referring to the status number and contents of the data port.

For example, when the host CPU issued **info** command, the host CPU and S1S60K exchanges information as shown below until the result is obtained.



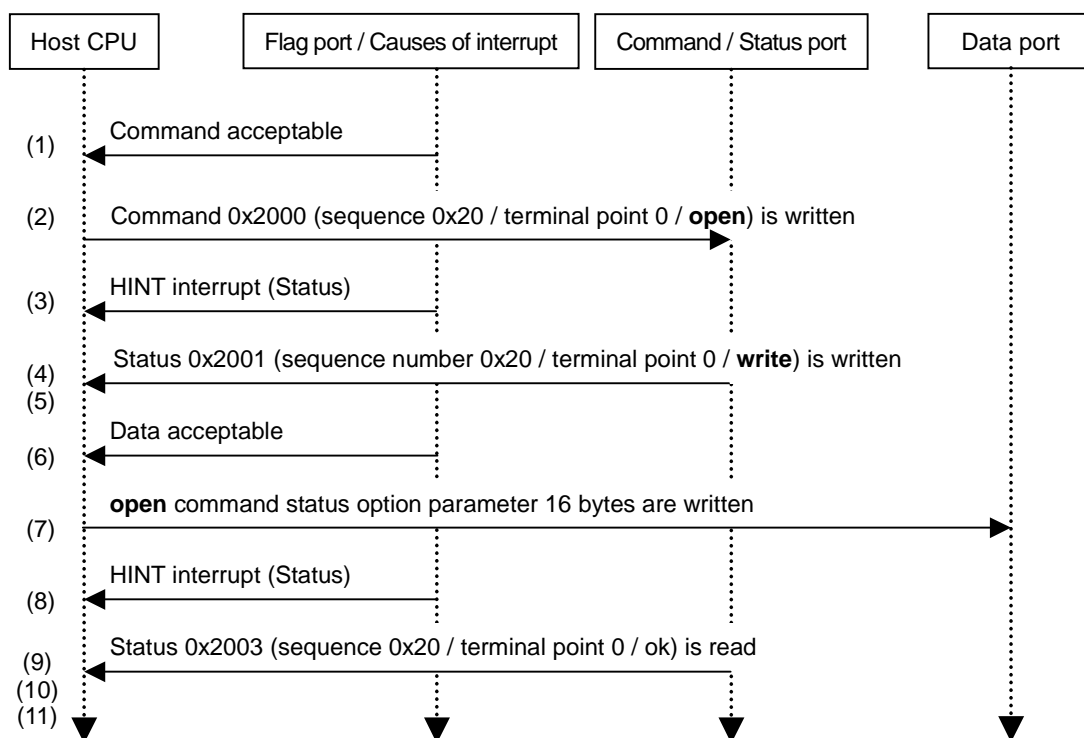
In the above example, a status irrelevant to **info** command (“**arrive**” status at End Point 6) is once read after **info** command has been written and before the corresponding HINT interrupt is caused. In this case, the status corresponding to **info** can be obtained by checking the sequence number.

2.2.2 Commands to be written to both the Command Port and Data Port

When the host CPU issues a command to be set on the data port, it implements the following procedures.

- (1) Reads the flag port to confirm if the port can accept the command (bit2=0).
- (2) Writes the command to the command port.
- (3) Checks HINT interrupt signal or flag port's status bit (bit0) to make sure that the status has been set.
- (4) Reads the status from the status port.
- (5) Checks the sequence number/End Point number of the status to identify to what command the status is returned.
- (6) Reads the flag port to confirm whether the data is acceptable (bit3=0).
- (7) Writes data to the data port.
 Above (6) and (7) are repeated every data is sent out.
- (8) Checks HINT interrupt signal or flag port's status bit (bit0) to make sure that the status has been set.
- (9) Reads status from the status port.
- (10) References the sequence number/End Point number of the status to identify to what command the status is returned.
- (11) Recognizes result of the command referencing the status number and contents of the data port.

For example, when the host CPU issued **info** command, the host CPU and S1S60K exchanges information as shown below until the result is obtained.



2.3 Initial Settings

When a boot status is returned right after S1S60K boots up or as a result of **init** command execution, the host CPU should issue **open** command to System End Point to initialize S1S60K. By setting the option of **open** command, S1S60K can be set to one particular state from the three different states shown below;

- A state which does not use S1S60K internal communication protocol
- A state which enables S1S60K internal communication protocol to get an IP address with DHCP
- A state which enables S1S60K internal communication protocol without DHCP

Please refer to **open** command section for the detail of **open** command options.

2.3.1 To Set Up with Internal Communication Protocol Disabled

When **open** command is issued to System End Point with setting a bit 7 “DATALINK layer is used”, the internal communication protocol of S1S60K is disabled. In this case, the host CPU must handle the communication protocol.

When the internal communication protocol is disabled, only System End Point and DATALINK End Point are usable. TCP/UDP/SNMP End Points are not usable.

2.3.2 To Enable DHCP

When **open** command is issued to System End Point with resetting bit 7 “DATALINK layer is used” and bit 6 “enable own IP address”, the internal communication protocol of S1S60K starts working. Then S1S60K tries to set up own IP address, subnet mask and default gateway. If the try is successfully done, S1S60K issues an **event** status (IP address enabled) to the host CPU. By using **status** command, setting information of IP address, subnet mask and default gateway can be confirmed. S1S60K also extends the lease period of IP address automatically.

In this case, System/TCP/UDP/SNMP End Points are usable. DATALINK End Point is not usable.

2.3.3 To Disable DHCP

When **open** command is issued to System End Point with setting bit 7 “DATALINK layer is used”, setting bit 6 “enable own IP address”, the internal communication protocol of S1S60K starts working. Then S1S60K sets own IP address, subnet mask and default gateway which are set by the host CPU into the command option. DHCP does not work in this case.

In this case, System/TCP/UDP/SNMP End Points are usable. DATALINK End Point is not usable.

3. FORMAT OF COMMANDS AND STATUS

Following describes the format of the commands and status in the order of the code.

3.1 open Command

This command is used to initialize and start using a End Point.

[Command number] 0x0000

[Command option]

open command requires use of the option parameter. Table 3.1 shows configuration of the option parameter.

Table 3.1 open Command Option Parameters

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
SYSTEM	0	Flag	0	Own IP address				Subnet mask				Default gateway					
DATALINK				0													
TCP0 to TCP3				IP address of destination				Port number of destination		Own port number		Timeout		0			
UDP0 to UDP3				Community name										enterprise code			
SNMP																	

Command option: Flag (Common 2nd byte)

Flag is an 8-bit long bit map type data. Set/reset of a function or enable/disable of the field in an option parameter is set on the bit basis.

Detailed roles of respective bits of a flag are described in Tables 3.2, 3.3, 3.4 and 3.5. Specify reset (0) for the bits whose corresponding functions are reserved.

Table 3.2 Flag of open Command (SYSTEM)

Bit	7	6	5	4	3	2	1	0
Reset (0)	Does not use the DATALINK layer	Disables own IP address	Disables the subnet mask	Disables the default gateway	Reserved			
Set (1)	Use the DATALINK layer	Enables own IP address	Enables the subnet mask	Enables the default gateway				

Note: Bits 6, 5 and 4 are enabled only when bit 7 is reset (does not use DATALINK).

Table 3.3 Flag of open Command (DATALINK)

Bit	7	6	5	4	3	2	1	0
Reset (0)	Send data does not contain FCS	Receives broadcast frames	Receives multicast frames	Reserved				
Set (1)	Send data contains FCS	Receives every frame irrespective of destinations	Does not receive multicast frames					

Note: Bit 5 is enabled only when bit 6 is reset (receives broadcast frames)

Table 3.4 Flag of **open** Command (TCP/UDP)

Bit	7	6	5	4	3	2	1	0
Reset (0)	passive open	Disables IP address of destination	Disables port number of destination	Disables own port number	Reserved	Disables timeout	Reserved	
Set (1)	active open	Enables IP address of destination	Enables port number of destination	Enables own port number		Enables timeout		

Note: When communicating with TCP0 - TCP3, be sure to set bits 6 and 5 whenever bit 7 is set (active open).

Table 3.5 Flag of **open** Command (SNMP)

Bit	7	6	5	4	3	2	1	0
Reset (0)	Reserved			Disables the community name when the bit is set	Disables the community name when the bit is get	Disables timeout	Private MIB unavailable	Disable enterprise code
Set (1)				Enables the community name when the bit is set	Enables the community name when the bit is get	Enables timeout	Private MIB is present	Enables enterprise code

Note: Bit 0 is enabled only when bit 1 is set (Private MIB available).

Command option: Own IP address (SYSTEM 4th to 7th bytes)

It is an IP address type data being enabled only when DATALINK is not used. It is used to specify equipment's own IP address including S1S60K. When the host CPU does not specify its own IP address, S1S60K requests DHCP server to assign an IP address.

Instead of directly specifying an IP address, the host CPU can specify the address indirectly by indicating the element number of DADR (numeric 24-bit data). When specifying the IP address indirectly, enter 0 to the starting byte of the IP address and then enter the element number of DADR to the remaining 3 bytes. S1S60K regards the value being read from the corresponding DADR element as the IP address specified by the host CPU. If, in this case, the element number of DADR is beyond the DADR range, S1S60K returns the error status for the specified IP address. For DADR, refer to the product specification or technical manual of respective ICs.

If an IP address specified by the host CPU meets any of the following conditions, S1S60K returns the error status.

- Value of the starting byte of the IP address is 127 or greater than 224.
- All bits are set to 0 in the network address of the IP address.
- All bits are set to 0 or 1 in the host address of the IP address.

The network address and host address of the IP address are determined from the subnet mask.

“**status**” command allows referencing own IP address specified here.

Command option: Subnet mask (SYSTEM 8th to 11th bytes)

It is an IP address type data being enabled only when DATALINK is not used. In this case, 1 is set on the bit corresponding to the network address in the own IP address and 0 is set on the bit in the host address. For instance, if the host CPU sets its own IP address as 192.168.0.1 and that of subnet mask as 255.255.255.0, S1S60K recognizes that the network it belongs to is 192.168.0.0.

When the host CPU does not specify a subnet mask, S1S60K determines the subnet mask by applying the value of the starting byte of its own IP address to the table shown below.

Table 3.6 IP Address and Subnet Mask

Value of starting byte of IP address	Subnet mask
0 to 127	255.0.0.0
128 to 191	255.255.0.0
192 to 223	255.255.255.0

When the subnet mask is obtainable from DHCP server along with the IP address, S1S60K will use the value obtained from the server.

If the subnet specified by the host CPU meets any of the following conditions, S1S60K returns the error status.

- All bits in the subnet mask are 1.
- Value of the uppermost 8 bits of the subnet is not 0 or 255.

“status” command allows referencing the subnet mask set here.

Command option: Default gateway (SYSTEM 12th to 15th bytes)

It is an IP address type data being enabled only when DATALINK is not used. It is used to specify the IP address of another equipment connected to the network to which the equipment itself (including S1S60K) is currently connected. The host CPU can specify the IP address of that equipment indirectly as it does for its own. When data is to be sent to a destination IP address belonging to a different network, S1S60K will send data to the default gateway if it is specified on S1S60K.

When the default gateway is not specified, S1S60K attempts to send the data directly to the destination.

If the default gateway specified by the host CPU meets any of the following conditions, S1S60K returns the error status.

- Network address of the IP address is not identical with that of the own IP address.
- All bits in the host segment of the IP address are 0 or 1.
- The IP address is identical with the own IP address.

When the default gateway is available from DHCP server along with the IP address, S1S60K uses the value obtained from DHCP server.

“status” command allows referencing the default gateway being specified here.

Command option: IP address of destination (TCP/UDP 4th to 7th bytes)

It is an IP address type data. It is used to specify the IP address of the destination of this End Point.

As the own IP address, this address can also be specified indirectly.

Role of bit 6 depends on the intended use of the End Point and state of bit 7 of the flag as shown below.

Table 3.7 IP Address of Destination of open Command (TCP/UDP)

Intended use of End Point	Bit 7 of flag	Bit 6 of flag	
		Enables destination IP address (1)	Disables destination IP address (0)
For TCP	active open (1)	Establishes connection with the destination IP address	The error status is returned to the host CPU since the address must be enabled.
	passive open (0)	Does not respond to the request for connection from any address other than the destination IP address.	Responds to the request for connection from any IP address.
For UDP	active open (1)	Does not receive data from any address other than the destination IP address.	Receives data from any IP address.
	passive open (0)	(Not used while processing of the command is taking place)	(The address may remain disabled)

If the destination IP address specified by the host CPU is invalid (value of the starting byte is 0 or 127, or greater than 240), S1S60K returns the error status.

And, at the End Point for TCP, S1S60K returns the error status if any of the following conditions is met. Here, the network address and host address of the destination IP address are determined from Table 3.6.

- Value of the starting byte of the IP address is greater than 224.
- All bits of the network address of the IP address are 1.
- All bits of the host address of the IP address are 1.
- The destination IP address is identical with the own IP address.

“**status**” command allows referencing the destination IP address here.

Command option: Port number of destination port (TCP/UDP 8th and 9th bytes)

It is a 16-bit numeric type data. It is used to specify the port number of the destination of this End Point. Role of bit 5 (as bit 6 in the IP address) depends on the intended use of the End Point and state of bit 7 of the flag as shown below.

Table 3.8 Destination Port Number of **open** Command (TCP/UDP)

Intended use of End Point	Bit 7 of flag	Destination port number (bit 5 of flag)	
		Enable (1)	Disable (0)
For TCP	active open (1)	Establishes connection with the destination port number.	The error status is returned to the host CPU since the port number must be valid.
	passive open (0)	Does not respond to the request for connection from any other than the destination port number.	Respond to the request for connection from any port number.
For UDP	active open (1)	Does not receive data from any port other than the destination port.	Receives data from any port.
	passive open (0)	(Not used as long as processing of open command is taking place)	(The port number may remain disabled)

If the host CPU specifies 0 for the destination port number, S1S60K returns the error status.

“**status**” command allows referencing the destination port number specified here.

Command option: Own port number (TCP/UDP 10th and 11th bytes)

It is a 16-bit numeric type data. This data is used to specify the port number of the End Point itself. If the host CPU specifies 0 for the port number, S1S60K returns the error status.

When the own port number is invalid (flag’s bit 4 is reset), a number currently not used for the same purpose is selected in the range of 49152 to 65535 as the port number.

“**status**” command allows referencing the own port number specified here.

Command option: Timeout (TCP/UDP/SNMP 12th and 13th bytes)

It is a 16-bit numeric type data. This data is used to specify the timeout period (in seconds) for various types of processing to be done at the End Point. Specifically, it is used for the following purposes.

- TTL(time to live) of datagram to be sent.
- The duration until active open of TCP is given up.
- The duration until receiving ACK to the data sent on TCP.
- The duration until the response is returned from the host CPU to the received SNMP request.

If the timeout specified by the host CPU is 0 or invalid (flag’s bit 2 is reset), the default 64 seconds are selected.

“**status**” command allows referencing the timeout specified here.

Command option: Community name (SNMP 4th to 11th bytes)

It is an 8-bit byte data row type data. When the data length is less than 8 bytes, setup is started from byte 4 and 0 is set for the remaining bytes. This data is used to restrict access from network to SNMP function contained in S1S60K.

If the community name is enabled in the “set” operation, S1S60K won’t respond to SNMP message (PDU type 3) if its community name is not identical with one being specified by the host CPU. Likewise, if the community name is enabled in the “get” operation, S1S60K won’t respond to SNMP message (PDU type 0 or 1) if its community name is not identical with one being specified by the host CPU. When the host CPU does not enable the host name or when the End Point of SNMP is not made open, “public” will be selected for the community name.

“status” command allows referencing the community name selected here.

Command option: enterprise code (SNMP 14th and 15th bytes)

It is a 16-bit numeric type data being enabled only when the host CPU is supporting Private MIB. This data is set to the node number under iso.org.dod.internet.private.enterprise (1.3.6.1.4.1) of MIB. This node number is defined in RFC1700 as SMI Network Management Private Enterprise Codes. If enterprise code specified by the host CPU is 0, S1S60K returns the error status.

When the host CPU is supporting Private MIB and the enterprise code is disabled, S1S60K makes inquiry on every Variable Binding below Private MIB to the host CPU regarding that 1.3.6.1.4.1 itself is set for OID. If, for instance, the host CPU selects 345 for the enterprise code, S1S60K makes inquiry to the host CPU on every Variable Binding whose OID is below 1.3.6.1.4.1.345.

“status” command allows referencing the enterprise code specified here.

[Status]

Responding to **open** command issued by the host CPU, S1S60K returns the status shown in the table below.

Table 3.9 Status Returned responding to **open** Command

No.	Name	S1S60K returns status in the following situations	Processing to be done by host CPU
1	write	Received open command. Send an option parameter.	Writes a 16-byte long option parameter to the data port.
3	ok	Processing of open command and option parameters is successfully ended.	None.
4	working	The End Point is already open.	None.
5	invalid	Specified End Point has not accepted open command. The End Point number is illegal.	Employs another End Point.
6	error	The option parameter of open command contains an error.	Reads the 16-byte option parameter in the error status from the data port in order to check what is specifically wrong. Corrects the option parameter of open command and then attempts to open the End Point again.
7	busy	Internal resources of S1S60K are insufficient.	Issues receive command when the host CPU has not received some data yet. The host CPU attempts to open the End Point again after a certain period of time.

For the option parameters of the error status, refer to the section describing the error status.

[Remarks]

As S1S60K is started, the host CPU should issue **open** command to SYSTEM End Point. In this case, if you set flag's bit 7 (use DATALINK), DATALINK layer becomes usable. If the bit is reset (don't use DATALINK), TCP0 to TCP3 and UDP0 to UDP3 become usable.

If the flag's bit 7 is set (sending data contains FCS) when **open** command is issued to DATALINK End Point, the host CPU must place FCS on the sending data. In this case, the maximum length of the sending data is 1518 bytes including four bytes for FCS.

When the flag's bit 7 is reset (sending data does not contain FCS), the host CPU does not have to place FCS on the sending data. S1S60K will calculate and add FCS. Length of the send data, in this case, must not exceed 1514 bytes.

When **open** command is issued to any of the End Points TCP0 to TCP3, S1S60K returns the ok status before connection with TCP is established. You can identify whether connection with TCP is established or not from the option parameter of the read status that is returned responding to receive command. For the detail, refer to the section describing receive command.

When open command is not issued to the End Point SNMP, the host CPU does not receive status from this End Point. If S1S60K receives OID below the specified Private MIB (Message Information Base) node when open command is not issued, S1S60K hands the data including OID to the host CPU. The host CPU analyzes OID to send necessary data to S1S60K. Sending the data means that the host CPU has added Private MIB to S1S60K.

3.2 send Command

This command is used to send data from the End Point.

[Command number] **0x0001**

[Command option]

The option parameter must be added to send command. Table 3.10 shows configuration of the option parameter.

Table 3.10 send Command Option Parameter + Send Data

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	n
SYSTEM	Send data length	Flag	0	PDU	Operation	Object	Offset		Unique-to-object field								Send data
DATALINK					0												
TCP0 to TCP3					0				Control flag	0							
UDP0 to UDP3					Destination IP address				Destination port number		0		Total data length				
SNMP							P1	P2	Request ID								

Command option: Send data length (0th and 1st bytes are common)

It is a 16-bit numeric type data. This data is used to specify byte count of the send data to be coded succeeding to the command option parameter.

Command option: Flag (2nd byte is common)

It is an 8-bit long bit map type data. This data is used to set or reset functions on bit basis, or to enable or disable the fields in the option parameter.

Table 3.11 shows detailed role of respective bits when data is to be sent from UDP0 to 3. Table 3.12 shows their roles when the target is TCP0 to 3. All bits of the flag for SYSTEM, DATALINK and SNMP are reserved. Select reset (0) for the reserved bits.

Table 3.11 Flag of send Command (UDP)

Bit	7	6	5	4	3	2	1	0
Reset (0)	Data end	Disables the destination IP address	Disables the destination port number	Sends own IP address	Normally 0	Reserved		Disables the total data length
Set (1)	Data continued	Enables the destination IP address	Enables the destination port number	Sends 0.0.0.0				Enables the total data length

Table 3.12 Flag of send Command (TCP)

Bit	7	6	5	4	3	2	1	0
Reset (0)	Normally 0				Disables the control flag	Reserved		Normally 0
Set (1)					Enables the control flag			

Command option: Operation (SYSTEM 4th byte)

It is an 8-bit numeric type data. This data is used to specify operations such as Read and Write.

Table 3.13 List of Operations

Value	Type
0	Read
1	Write (Read-modify-Write)
2	Erase (flash only)

End of Read operation is notified by the read status option of receive command.

Command option: Object (SYSTEM 5th byte)

It is an 8-bit numeric type data. This data is used to specify the target of operation. Specifiable objects are as shown below.

Table 3.14 List of Objects

Value	Type	Data size
0	EEPROM	16bit
1	I2C	8bit
2	GPIO	16bit
3	Flash ROM	8bit
4	S1S60K (built-in register)	16bit

Command option: Offset (SYSTEM 6th and 7th bytes)

It is 16-bit numeric type data. When an object is divided into two or more targets of operation, this data is used to designate the target. Table 3.15 details the offset for respective objects.

Table 3.15 Details of Offset Designation

Object		8	9
Number	Type		
0	EEPROM	Designates R/W address	
1	I2C		
2	GPIO	0	
3	Flash ROM	Designates R/W address	
4	S1S60K	Designates R/W address	

Command option: Unique-to-object field (SYSTEM 8th to 15th bytes)

Contents to be specified depend on the target object of operation.

Table 3.16 Unique-to-Object Field

Object		8	9	10	11	12	13	14	15
No.	Type								
0	EEPROM	0							
1	I2C	Designates the slave device		0					
2	GPIO	0			Bit mask		Bit pattern		
3	Flash ROM	0							
4	S1S60K	0			Bit mask		Bit pattern		

Command option: Designation of slave device (SYSTEM - I2C 8th and 9th bytes)

It is a 16-bit long bit map type data. This data is used to specify the address of the slave device to be accessed by S1S60K. The address is specified with 7 or 10 bits.

Table 3.17 Slave Device Designation Format

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
7bit	0										Specifies Slave address					
10bit	1	0				Specifies Slave address										

Command option: Bit mask (SYSTEM - GPIO, S1S60K 12th and 13th bytes)

It is a 16-bit long bit map type data. In the Write (Read-modify-Write) operation, this data is used specify the bit mask by setting 1 on the target bit of the operation and 0 on the non-target bit.

If the target contents of operation D, the host CPU-specified bit mask M and the host CPU-specified bit pattern P are present, S1S60K writes result of the bit operation of ((D and (not M)) or (M and P)) to the target of operation. When writing the specified bit pattern as is, S1S60K specifies 0xffff as the bit mask.

In case of GPIO, BIT15 and BIT0 correspond to GPIO15 and GPIO0, respectively. Target GPIO ports are classified into 3 groups and accessed in the predetermined order as shown in the following table.

Table 3.18 GPIO Group (S1S60000)

GPIO group	GPIO port	Access order
1	0,1,2,12,13,14,15	1 (First)
2	3,8,9,10,11	2
3	4,5,6,7	3 (Last)

Ports belonging to the same GPIO group are accessed at the same time. Access interval between the groups is not predetermined.

When, for instance, Write operation is conducted on GPIO14, GPIO4 and GPIO1, GPIO is accessed in the following procedure.

- (1) GPIO1 and GPIO14 are read at the same time.
- (2) GPIO4 is then read.
- (3) Writing is done on GPIO1 and GPIO14 at the same time.
- (4) Writing is done on GPIO4.

Command option: Bit pattern (SYSTEM - GPIO, S1S60K 14th and 15th bytes)

It is a 16-bit long bit map type data. This data is used to specify the bit pattern in Write (Read-modify-Write) operation.

As for GPIO, BIT15 and BIT 0 when the offset is 0 correspond to GPIO15 and GPIO0, respectively.

Bits, except for when the offset is 0, are reserved for the future expansion.

For example, when setting GPIO14 to 0, GPIO4 to 1 and GPIO1 to 1, bit mask is specified as 0x4012 (0100_0000_0001_0010) and the bit pattern is specified as 0x0012 (0000_0000_0001_0010).

Command option: Control flag (TCP 10th and 11th bytes)

It is a 16-bit long bit map type data. If the host CPU sets 0x0000 on the control flag, S1S60K sends the data as a normal TCP segment. If the host CPU sets 0x0008 on the control flag, S1S60K sends the data as the PSH flagged TCP segment.

Command option: Destination IP address (UDP/SNMP 4th to 7th bytes)

It is an IP address type data. This data is used to specify an IP address of the destination of this send data. Like open command option used in specifying own IP address, a destination IP address can be directly specified.

If the value of the starting byte of the host CPU-specified destination IP address is 0 or 127 or greater than 240, S1S60K returns the error status.

When the host CPU has not set a destination IP address at UDP0 to 3 End Points (bit 6 of flag is reset), S1S60K uses the value specified with open command as the destination IP address. If the host CPU has not set a destination IP address using open command, S1S60K returns the error status.

And, if the value of the starting byte of the host CPU-specified destination IP address is 0 or 127 or greater than 240, S1S60K returns the error status.

Command option: Destination port number (UDP/SNMP 8th and 9th bytes)

It is a 16-bit numeric type data. This data is used to specify the port number of the destination of this send data.

If the destination port number specified by the host CPU is 0, S1S60K returns the error status.

Like the IP address, if the host CPU did not set the destination port number using send command (bit 5 of flag is reset), S1S60K uses the value specified with open command as the port number. And, if the host CPU did not set the destination using open command, S1S60K returns the error status.

Command option: Total data length (UDP 14th and 15th bytes)

It is a 16-bit numeric type data. When the size of send data is larger than the maximum data length of UDP0 to UDP3 (548 bytes), this data is used to set the total size of the send data.

For example, when length of the data to be sent by use of UDP is 1536 bytes, this data is divided into 544 bytes, 544 bytes and 448 bytes and then send command is issued. In this case, the host CPU sets the total data length of each send command to 1536 as shown below.

Command option	Send data length	Flag	Destination IP address	Destination port number	Total data length
1st time send	544	0x81	0.0.0.0	0	1536
2nd time send	544	0x81	0.0.0.0	0	1536
3rd time send	448	0x01	0.0.0.0	0	1536

For the send commands to be followed with send data (in this example, 1st time send and 2nd time send), set must be selected bit 7 of the flag (data to be continued) and 544 bytes must be specified for the total data length.

If the total data length specified by the host CPU is smaller than the total length of send data, S1S60K returns the error state. And, when a new set of data is to be sent after the data end (flag's bit 7 is reset), S1S60K returns the error status if the total data length is invalid even though the data continued (flag's bit 7 is set) may be selected. Namely, an error won't be warned to the following cases.

- If, in the above example, bit 1 of the flag is reset in the 2nd and 3rd time send (total data length is invalid).
- If bit 1 of the flag is reset when sending a new set of data (total data length is invalid).

Command option: PDU type (SNMP 3rd byte)

It is a 8-bit numeric type data. This data indicates the type of the protocol data unit (PDU) of SNMP message using the following values. If the host CPU specifies a value other these in send command option, S1S60K returns the error status.

PDU	PDU type
GetResponse	2
Trap	4

Command option: P1 (SNMP 10th byte)

It is an 8-bit numeric type data. When the PDU type is 2, it contains the value of Error Status field of GetResponse PDU. When the PDU type is 4, the value of Generic Trap Type field of Trap PDU is contained. For the specific values, refer to RFC1157 (A Simple Network Management Protocol).

Command option: P2 (SNMP 11th byte)

It is an 8-bit numeric type data. When the PDU type is 2, it contains the value of Error Index field of GetResponse PDU. When the PDU type is 4, it contains the value of Specific Trap field of Trap PDU. For the specific values, refer to RFC1157 (A Simple Network Management Protocol).

Command option: Request ID (SNMP 12th to 15th bytes)

It is an 32-bit numeric type data. The value is used to indicate a request from the SNMP manager that is correspondent to this response. Specify the request ID that is specified on the receive-read status option as is. Only when PDU type is 2, it is referred.

[Status]

Responding to the send command issued by the host CPU, S1S60K returns the status shown in the table below.

Table 3.19 Status Returned Responding to send Command

No.	Name	S1S60K returns status in the following situation	Processing to be implemented by host CPU
1	write	send is received. Transmit the option parameter and send data.	Writes 16-byte long option parameter to the data port.
3	ok	Data transmission is successfully ended.	None
4	working	Transmission from the End Point is disabled.	When open command is not issued, the host CPU issues the command or waits connection of TCP.
5	invalid	The End Point has not accepted send command. The terminal number is illegal.	Employs another End Point.
6	error	Option parameter of send command contains an error.	Reads the 16-byte long option parameter from the data port in order to check details of the error. Corrects the option parameter of send command and transmits it again.
7	busy	Internal resources of S1S60K are insufficient.	When any data is left not received by the host CPU, the host CPU issues "receive" command. Then transmits send command again after waiting for some time.
8	cancel	Data is sent at TCP but ACK is not returned or no answer from the device in SYSTEM.	If the cancel recurs, stop the communication with destination. As needed, it will set a longer timeout duration and try open command again.

For further information on the error status, refer to the section describing this status.

[Remarks]

When the host CPU sends, using PDU, a set of data larger than the maximum data length, S1S60K converts each send command in the series to IP fragment. In this case, the host CPU must match the total length of the data sent by a series of send commands to that of the data sent by the first send command. If there is a conflict between them, the send data sometimes does reach the application because assembly of the IP fragments becomes unavailable at the destination IP address.

At UDP0 to UDP3, the ok status is returned to the host CPU as the send data is transmitted out of S1S60K. Thus, return of the ok status does not necessarily assure that the data has arrived at the destination.

At TCP0 to TCP3, the ok status is returned to the host CPU as the send data arrived the destination. Thus, we

can be sure that the ok status-returned-data has reached the destination without fail. If arrival of the data sent out of S1S60K can't be confirmed within the predetermined timeout duration and if this trouble remains unsolved in spite of repeated data transmit attempts, the cancel status will be returned to the host CPU.

When controlling the device at SYSTEM End Point, S1S60K returns the ok status as it receives the operation specified by the host CPU. Then, as the asynchronous operation is completed, S1S60K returns the arrive status. Get the result using the receive command.

3.3 receive Command

This command is used to acquire the data arrived at a End Point into the host CPU.

[Command number] **0x0002**

[Command option] **None**

[Status]

Responding to receive command issued by the host CPU, S1S60K returns the status listed in the following table.

Table 3.20 Status Returned Responding to receive Command

No.	Name	S1S60K return status in the following situation	Processing to be implemented by host CPU
2	read	“receive” command has been accepted. Read the option parameter and receive data.	Read the 16-byte long option parameter and receive data from the data port.
3	ok	“receive” command has been accepted, but there is no corresponding receive data.	None
4	working	Receiving at the End Point is disabled.	If open command is not issued, the host CPU issues the command, or waits connection to TCP.
5	invalid	The End Point has not accepted receive command. The End Point number is illegal.	Employs another End Point.
7	busy	Internal resources of S1S60K are insufficient. There is no corresponding receive data.	If reading from the data port is not finished, the host CPU will complete the read.

The read status has the option parameters. Table 3.21 shows the configuration of the option parameters corresponding to receive command.

Table 3.21 receive-read Status Option Parameter + Receive Data

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
SYSTEM	Receive data length	Flag	0	PDU	Operation	Object	Offset		Field unique-to-object								Receive data
DATALINK					0												
TCP0 to TCP3					Destination IP address		Destinati on port number	Control flag	Data offset	Total data length							
UDP0 to UDP3								Request ID									
SNMP					0												

read status option: Receive data length (Common 0th and 1st bytes)

It is a 16-bit numeric type data. This data is used to specify byte count of the receive data that succeeds this status option parameter.

read status option: Flag (Common 2nd byte)

It is an 8-bit long bit map type data. This data is used to set or reset the functions on bit basis as well as to enable or disable the fields in the option parameter.

Table 3.22 shows detailed roles of respective bits of the flag when any one of UDP0 to 3 and TCP0 to 3 is specified. When the target is SYSTEM, DATALINK or SNMP, all flag bits are left undefined and 0 is returned.

Table 3.22 Flag of receive-read Status (TCP/UDP)

Bit	7	6	5	4	3	2	1	0
Reset (0)	Data end	Disables the destination IP address	Disables the destination port number	Reserved	Disables the control flag	Reserved	Disables the data offset	Disables the total data length
Set (1)	Data continued	Enables the destination IP address	Enables the destination port number		Enables the control flag		Enables the data offset	Enables the total data length

Note: At TCP0 to TCP3, bit 0 is normally reset (0). At UDP0 to UDP3, bit 3 is normally reset (0).

read status option: Operation (SYSTEM 4th byte)

read status option: Object (SYSTEM 5th byte)

read status option: Offset (SYSTEM 6th and 7th bytes)

The value specified by the host CPU is set as send command is executed. For the detail, refer to the send command option.

read status option: Field unique-to-object (SYSTEM 8th to 15th bytes)

It is set according to the target object of operation.

Table 3.23 Detail of Field Unique-to-Object

Object		8	9	10	11	12	13	14	15
No.	Type								
0	EEPROM	0							
1	I2C	Designates the slave device	0						
2	GPIO	0				Bit mask	Bit pattern		
3	Flash ROM	0							
4	S1S60K	0				Bit mask	Bit pattern		

read status option: Designation of slave device (SYSTEM - I2C 8th and 9th bytes)

read status option: Bit mask (SYSTEM - GPIO, S1S60K 12th and 13th bytes)

The value specified by the host CPU is setup as send command is executed. For the detail, refer to the description on send command option.

read status option: Bit pattern (SYSTEM - GPIO, S1S60K 14th and 15th bytes)

It is a 16-bit numeric type data. In Read operation, this data is used to contain the information being read.

read status option: Destination IP address (TCP/UDP/SNMP 4th to 7th bytes)

It is an IP address type data. It contains IP address of the sending source of this receive data.

As for the End Point for TCP, its sending source of the receive data is its counterpart of the connection. Thus, the same IP address is set as long as the connection is maintained.

read status option: Destination port number (TCP/UDP/SNMP 8th and 9th bytes)

It is a 16-bit numeric type data. It contains the port number of the sending source of this receive data.

As for the End Point for TCP, its sending source of the receive data is its counterpart of the connection. Thus, the same port number is set as long as the connection is maintained.

read status option: Control flag (TCP 10th and 11th bytes)

It is a 16-bit long bit map type data. It represents the control flag of TCP being set in this receive data.

Table 3.24 Detail of Control Flag for receive-read Status

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reset (0)	Reserved										URG Absent	ACK Absent	PSH Absent	RST Absent	SYN Absent	FIN Absent
Set (1)	Reserved										URG Present	ACK Present	PSH Present	PSH Present	SYN Present	FIN Present

Presence of the control flag SYN indicates that connection to TCP is established at the End Point. As the connection is made, receive data length is normally 0 meaning nonexistence of receive data. Any receive data length larger than 0 indicates that data is received as the connection is made.

Presence of the control flag FIN flag indicates that the End Point is being requested by the destination IP address to cut the connection. In this case, the host CPU must issue close command.

Absence of all control flags does not mean that an error is developing. And, the host CPU does not receive a set of data on which the control flag RST is set.

read status option: Data offset (TCP/UDP 12th and 13th bytes)

It is a 16-bit numeric type data. This data is used to indicate an offset of the starting byte of this receive data to the total data length. For example, when a data with total length of 1024 bytes is divided into 544 and 480 bytes to receive them in two different times, offset of the first receive data becomes 0 and that of the second data becomes 544.

With UDP, it indicates receiving state of a single UDP datagram but it does not have any particular meaning with TCP.

read status option: Total data length (TCP/UDP 14th and 15th bytes)

It is a 16-bit numeric type data. This data is used to indicate the total size of a data when it is larger than the length of the receive data.

With UDP, it indicates receiving state of a single UDP datagram but it does not have any particular meaning with TCP.

read status option: PDU type (SNMP 3rd byte)

It is a 8-bit numeric type data. This data indicates the type of the protocol data unit (PDU) of SNMP messages using following values.

PDU	PDU Type
GetRequest	0
GetNextRequest	1
SetRequest	3

For meaning of respective PDU types, refer to RFC1157 (A Simple Network Management Protocol).

read status option: Request ID (SNMP 12th to 15th bytes)

It is a 32-bit numeric type data. When responding to SNMP manager with send command, this request ID is set on the send command option.

[Remarks]

When the End Point for UDP is made active with the destination IP address and port number being enabled as open command is issued, it also does not receive data from other destinations than the specified IP address and port number.

When RST flag received a certain data from the End Point for TCP, state of this End Point becomes the same as that being caused after the host CPU has issued close command. In this case, therefore, S1S60K returns the working status responding to receive command issued by the host CPU even if close command is not present.

3.4 close Command

This command is used to terminate the use of an End Point.

[Command number] **0x0004**

[Command option] **None**

[Status]

Responding to close command issued by the host CPU, S1S60K returns the status shown in the table below.

Table 3.25 Status Returned responding to close Command

No.	Name	S1S60K returns a status in the following situation	Processing to be implemented by host CPU
3	ok	close processing is completed.	None
4	working	Waits until transmission of data is complete.	Waits until transmission of data is complete.
5	invalid	The End Point has not accepted close command. The End Point number is illegal.	Employs another End Point.
7	busy	Internal resources of S1S60K are insufficient.	If some data are not received by the host CPU yet, it issues receive command. Then after a while, the host CPU issues close command again.

[Remarks]

S1S60K returns the ok status as it receives close command.

As S1S60K returned the ok status, the End Point for TCP returns the control flag FIN to the destination IP address to cut the connection. The End Point continues such operations after close command has been issued. Thus, if the host CPU issues open command to the same End Point immediately after receiving the ok status, the working status can be returned.

Unlike above, the host CPU can receive the ok status when it issued open command again to the End Point for UDP immediately after receiving the ok status responding to close command.

When close command is issued to the End Point for SNMP, community name of SNMP is returned to “public”.

3.5 abort Command

This command is used to end the use of an End Point in emergency.

[Command number] **0x005**

[Command option] **None**

[Status]

Responding to abort command issued by the host CPU, S1S60K returns the status shown in the following table.

Table 3.26 Status Returned Responding to abort Command

No.	Name	S1S60K returns a status in the following situation	Processing to be implemented by host CPU
3	ok	abort processing is completed.	None
5	invalid	The End Point has not accepted abort command. The End Point number is illegal.	Employs another End Point.
7	busy	Internal resources of S1S60K are insufficient.	If the host CPU has not received some data yet, receive command should be issued. After a while, the host CPU issues abort command again.

[Remarks]

As abort command is received, S1S60K returns the **ok** status immediately. In this case, all data retained by the End Point of S1S60K are destroyed.

When **abort** command is issued to the End Point for TCP, S1S60K tries to send the control flag RST to the destination IP address.

When **abort** command is issued to the End Point for SNMP, community name of SNMP returned to "public".

3.6 stop Command

This command is used to stop function of a command or status causes the transfer of an option parameter or send/receive data at an End Point.

[**Command number**] **0x0006**

[**Command option**] **None**

[**Status**]

Responding to stop command issued by the host CPU, S1S60K returns the status shown in the following table.

Table 3.27 Status Returned Responding to stop Command

No.	Name	S1S60K returns a status in the following situation	Processing to be implemented by host CPU
3	ok	stop processing is completed.	None
5	invalid	The End Point has not accepted stop command. The End Point number is illegal.	Employs another End Point.
7	busy	Internal resources of S1S60K are insufficient. stop processing is complete.	The host CPU issues receive command when some data are not received.

[**Remarks**]

A command stopped by **stop** command is processed as not being issued by the host CPU. A status stopped by stop command is regarded as being normally received by the host CPU.

Processing of every command option, receive data, status option or send data currently being exchanged between S1S60K and the host CPU is stopped irrespective of the terminal station concerned.

3.7 status Command

This command is used to get information that can vary depending on status of the End Points.

[Command number] 0x0007

[Command option] None

[Status]

Responding to status command issued by the host CPU, S1S60K returns the status shown in the following table.

Table 3.28 Status Returned responding to status Command

No.	Name	S1S60K returns status in the following situation	Processing to be implemented by host CPU
2	read	status has been received. Read the option parameter.	Read the 16-byte long option parameter from the data port.
5	invalid	End Point has not received status command. The End Point number is illegal.	Employs another End Point.
7	busy	Internal resources of S1S60K are insufficient.	The host CPU issues receive command when some data are not received. After a while, it sends status command again.

read status has the option parameters. Table 3.29 shows configuration of the option parameter corresponding to status command.

Table 3.29 status-read Status Option Parameter

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SYSTEM	0	Flag	0	Own IP address				Subnet mask				Default gateway				
DATALINK				0												
TCP0 to TCP3				Destination IP address				Destination port number		Own port number		Timeout		Status of End Point	0	
UDP0 to UDP3																
SNMP				Community name								enterprise code				

read status option: Flag (Common 2nd byte)

It is an 8-bit long bit map type data. It is used to set or reset functions on bit basis as well as to enable or disable the field in the option parameters.

Details of respective bits of the flag are described in Tables 3.30, 3.31 and 3.32. 0 (reset) is returned to the bits whose function is reserved.

Table 3.30 Flag of status-read status (SYSTEM)

Bit	7	6	5	4	3	2	1	0
Reset (0)	Does not use DATALINK	Disables own IP address	Disables subnet mask	Disables default gateway	Reserved			Cable connected
Set (1)	Use DATALINK	Enables own IP address	Enables subnet mask	Enables default gateway				Cable not connected

Note: Bits 6, 5 and 4 are enabled only when bit 7 is reset (does not use DATALINK).

Table 3.31 Flag of status-read Status (DATALINK)

Bit	7	6	5	4	3	2	1	0
Reset (0)	S1S60K adds FCS	Receives the broadcast frames	Receives the multicast frames	Reserved				
Set (1)	S1S60K does not add FCS	Receives the frames irrespective of the destination	Does not receive the multicast frames					

Note: Bit 5 is enabled only when bit 6 is reset (receives the broadcast frames).

Table 3.32 Flag of read Status (TCP/UDP)

Bit	7	6	5	4	3	2	1	0
Reset (0)	passive open	Disables destination IP address	Disables destination port number	Disables own port number	Reserved	Disable timeout	Reserved	
Set (1)	active open	Enables destination IP address	Enables destination port number	Enables own port number		Enable timeout		

Table 3.33 Flag of read Status (SNMP)

Bit	7	6	5	4	3	2	1	0
Reset (0)	Reserved			Disables the community name for SNMP set	Disables the community name for SNMP get	Disables timeout	Private MIB unavailable	Disables enterprise code
Set (1)				Enables the community name for SNMP set	Enables the community name for SNMP get	Enables timeout	Private MIB available	Enables enterprise code

read status option: Own IP address (SYSTEM 4th to 7th bytes)

It is an IP address type data. It is used to specify IP address of the equipment including S1S60K. When the own IP address is disabled, the IP address is regarded as being not specified.

read status option: Subnet mask (SYSTEM 8th to 11th bytes)

It is an IP address type data. The subnet mask of the equipment itself including S1S60K is set on this data. For the detail, refer to the section describing **open** command.

read status option: Default gateway address (SYSTEM 12th to 15th bytes)

It is an IP address type data. The default gateway of the equipment itself including S1S60K is set on this data. For the detail, refer to the section describing **open** command.

read status option: Destination IP address (TCP/UDP 4th to 7th bytes)

It is an IP address type data. IP address of the destination of this End Point is set on this data. For the detail, refer to the section describing **open** command.

read status option: Destination port number (TCP/UDP 8th and 9th bytes)

It is a 16-bit numeric type data. Port number of the destination of this End Point is set on this data. For the detail, refer to the section describing **open** command.

read status option: Own port number (TCP/UDP 10th and 11th bytes)

It is a 16-bit numeric type data. Own port number of End Point is set on the data. For the detail, refer to the section describing **open** command.

read status option: Timeout (TCP/UDP/SNMP 12th and 13th bytes)

It is a 16-bit numeric type data. This data is used to specify the timeout period (in seconds) for various types of processing to be done at the End Point. For the detail, refer to the section describing **open** command.

read status option: Community name (SNMP 4th to 11th bytes)

It is an 8-byte long data row type data. This data is used to specify the name in order to restrict access from the network to the SNMP functions in S1S60K. For the detail, refer to the section describing **open** command.

read status option: enterprise code (SNMP14th and 15th bytes)

It is 16-bit numeric type data. This data is used to specify the node number that indicates the trees existing below iso.org.dod.internet.private.enterprise (1.3.6.1.4.1) of MIB. For the detail, refer to the section describing **open** command.

read status option: Status of End Point (TCP/UDP 14th byte)

It is an 8-bit numeric type data. Values indicating status of the End Point are set on the data as shown below.

Table 3.34 List of Status of End Point

Value	End Point for TCP	End Point for UDP
1	closed	closed
2	listen	listen
3	syn-sent	—
4	syn-received	—
5	established	established
6	fin-wait-1	—
7	fin-wait-2	—
8	close-wait	—
9	closing	—
10	last-ack	—
11	time-wait	—

The End Point for UDP takes on of **closed**, **listen** or **established** status. **Closed** indicates the End Point is not open and **listen** indicates that it is open. **Established** means that the End Point is open and send/receive data is continued.

The End Point for TCP takes every status. For the meaning of each status, refer to RFC793 (Transmission Control Protocol).

3.8 init Command

This command is used to initialize S1S60K.

[**Command number**] **0x0008**

[**Command option**] **None**

[**Status**]

This command can be issued only to the SYSTEM End Point. If the End Point does not accept **init** command, S1S60K returns the **invalid** status responding this **init** command issued by the host CPU.

[**Remarks**]

If the host CPU issues **init** command successfully, S1S60K is restarted and then it initializes itself again. S1S60K returns the **boot** status as it is restarted. However, the sequence number of the **boot** status is always 0 and this status does not correspond to **init** command issued by the host CPU.

3.9 info Command

This command is used to get information that is independent from the status of the End Point.

[Command number] **0x0009**

[Command option] **None**

[Status]

Responding to info command issued by the host CPU, S1S60K returns the following status.

Table 3.35 Status Returned responding to info Command

No.	Name	S1S60K returns status in the following situation	Processing to be implemented by host CPU
2	read	info command is accepted. Read the option parameter.	Read the 16-byte long option parameter from the data port.
5	invalid	The End Point has not accepted info command. The terminal number is illegal.	Employs another End Point.
7	busy	Internal resources of S1S60K are insufficient.	The host CPU issues receive command when some data remain not received. Then after a while, the host CPU issues info again.

Read status has the option parameters. Table 3.36 shows the configuration of the option parameter corresponding to **status** command.

Table 3.36 info-read Status Option Parameter

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SYSTEM	0		Flag	0	Intended use of End Point	Model number + Version										Maximum data length
DATALINK						MAC address								0		
TCP0 to TCP3						0										
UDP0 to UDP3						0										
SNMP						0										

read status option: Flag (Common 2nd byte)

It is an 8-bit long bit map type data. Function is reserved and reset (0) for every bit.

read status option: Intended use of End Point (Common 4th and 5th bytes)

It is a 16-bit numeric type data. It contains following numbers that indicate the intended use of the End Points.

Table 3.37 Details of read Status Option broken down by End Point Type

No.	Intended use	End Point number	End Point name
0	For system	0	SYSTEM
1	For data link layer (Ethernet)	1	DATALINK
2	For UDP layer	6 to 9	UDP0 to UDP3
3	For TCP layer	2 to 5	TCP0 to TCP3
4	For SNMP	10	SNMP

read status option: Model number + Version (SYSTEM 6th to 13th bytes)

It is an 8-byte row type data. The value depends on the internal configuration of S1S60000.

read status option: MAC address (DATALINK 6th to 11th bytes)

It is a 6-byte row type data. It is used to indicate MAC address of Ethernet.

read status option: Maximum data length (Common 14th and 15th bytes)

It is a 16-bit numeric type data. It indicates the maximum data length (in bytes) that can be sent or received at this End Point with a single time use of send or receive command. For the detail, refer to 2.1.3.

[Remarks]

The **read** status option corresponding to **info** command constantly returns the same value independent of the operational status.

3.10 error Status

It indicates that a command issued by the host CPU contains an error.

[Status number] **0x0006**

[Status option]

error status has the option parameter. Table 3.38 shows configuration of the option parameter.

Table 3.38 Common Format of error Status Option

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	0		Error type		Command		Unique-to-error-type field									

Status option: Error type (Common 2nd and 3rd bytes)

It is a 16-bit numeric type data. The option parameter error alone is defined as this data. Table 3.39 shows the error type and detailed configuration.

Table 3.39 Format of Unique-to-Error-Type Field

Error type		6	7	8	9	10	11	12	13	14	15
No.	Name										
0	Option parameter error	Offset		0							

Status option: Command (Common 4th and 5th bytes)

It is a 16-bit numeric type data. It is used to return a command containing an error as is.

Status option: Offset (Option parameter error 6th and 7th bytes)

It is a 16-bit numeric type data. This data is used to indicate the offset of the parameter that caused the error. For example, when a wrong destination IP address is coded on **open** command, the offset value 4 of the destination IP address is set on this data.

3.11 event Status

It indicates that S1S60K has an information to be sent to the host CPU.

[Status number] **0x000a**

[Status option]

event status has the option parameter. Configuration of the option parameter is shown in Tables 3.40 and 3.41.

Table 3.40 Common Format of event Status Option

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	0		Flag	0	Event type	Details of event	Unique-to-event field									

Table 3.41 Format of Unique-to-Event Field

Event type		Detail of event		6	7	8	9	10	11	12	13	14	15
No.	Name	No.	Name										
0	Cable	0	Cable disconnected	0									
		1	Cable connection recovered										
1	IP address	2	IP address duplicated	0									
		3	IP address invalid										
		4	IP address valid										
2	TCP	2	Failed in active open	End Point number	0	Destination IP address			Own port number		Destination port number		
		4	Control flag RST received										
3	ICMP	0	Destination Unreachable	IP protocol number	0	Destination IP address			Own port number		Destination port number		
		1	Time Exceeded										
		2	Parameter Problem										
		3	Source Quench										

Status option: Flag (Common 2nd byte)

It is an 8-bit long bit map type data. Function is reserved and reset (0) for every bit.

Status option: Event type (4th byte)

Status option: Details of event (5th byte)

Both are 8-bit numeric type data. Table 3.42 shows the event type being set by S1S60K in the event status, detailed meaning of the events and the action to be taken by the host CPU to the events.

Table 3.42 Meaning of Events and Actions Taken by Host CPU

Name of event type	Detailed event name	S1S60K returns event in the following situation	Action to be taken by host CPU
Cable	Cable disconnection	Ethernet cable has been disconnected.	Stops transmission/reception of data.
	Recovery of cable connection	Ethernet cable has been connected.	Resume data transmission/reception.
IP address	Duplication of IP address	Someone is already using the specified IP address.	Issues init command in order to set another IP address on S1S60K.
	IP address invalid	Lease period of the IP address has been expired and thus it is invalid now.	Waits until the IP address becomes valid again, or issues init command in order to set another IP address on S1S60K.
	IP address valid	A new IP address has been leased.	Resumes data transmission/reception.
TCP	Failure in active open	Failed to connect TCP. The End Point is now transitioned to the closed status.	Tries open again after changing the timeout period. Or, gives up the connection.
	Reception of control flag RST	Received RST from the destination. The End Point is now transitioned to the closed status.	Terminates data transmission/reception.
ICMP	Destination Unreachable	Can't find the destination.	Gives up to establish connection with the destination.
	Time Exceeded	Time is exceeded while the data is on the network.	Tries open command again after changing the timeout period.
	Parameter Problem	S1S60K failed in converting the data or the data turned into illegal on the network due to some reasons.	Sends the data again. When the same event recurs, the host CPU issues init command to reset S1S60K. If the trouble still remains, the host CPU gives up the intended connection.
	Source Quench	Data transmission is too frequent for the destination to receive all the data.	Reduces the transmission frequency.

Status option: End Point number (TCP 6th byte)

It is an 8-bit numeric data. It represents the End Point numbers described in 2.1.1.2.

Status option: IP protocol number (ICMP 6th byte)

It is an 8-bit numeric type data. S1S60K returns the event status of the event type ICMP to the End Point 0. This protocol number can be referred when the host CPU searches the End Point that caused an event.

The IP protocol numbers take the following values among those being defined by RFC1700.

Table 3.43 IP Protocol Number

IP protocol number	Protocol name	End Point number
6	TCP	2 to 5 (TCP0 to TCP3)
17	UDP	6 to 9 (UDP0 to UDP3)

Status option: Destination IP address (TCP/ICMP 8th to 11th bytes)

It is an IP address type data. An IP address of the destination is set on the data. For the detail, refer to the section describing **open** command.

Status option: Own port number (TCP/ICMP 12th and 13th bytes)

It is a 16-bit numeric type data. It represents the port number that has been set on one of the End Points. For the detail, refer to the section describing **open** command.

Status option: Destination port number (TCP/ICMP 14th and 15th bytes)

It is a 16-bit numeric data. The destination port number is set on this data. For the detail, refer to the section describing open command.

[Remarks]

S1S60K starts up on the assumption that Ethernet cable is connected. Thus, if the cable is not actually connected, the cable disconnection event is immediately notified to the host CPU.

3.12 boot Status

It notifies the host CPU that S1S60K has been started.

[Status number] **0x000b**

[Status option] **None**

[Remarks]

Sequence number and End Point number of the **boot** status are always 0.

3.13 arrive Status

It notifies the host CPU that S1S60K has received data.

[Status number] **0x000d**

[Status option] **None**

[Remarks]

Every time S1S60K receives the data to be sent to the host CPU, S1S60K returns **arrive** status to the host CPU. The host CPU can get all data from S1S60K if the host CPU issues **receive** command to the subject End Point every time it receives **arrive** status.

3.14 sleep Status

It indicates that S1S60K entered into the sleep mode.

[Status number] **0x000e**

[Status option] **None**

[Remarks]

As the sleep is turned on, S1S60K does not respond to input from the host CPU or network. Use GPIO0 to bring S1S60K out of the sleep mode to the normal operation mode. For the detail, refer to the product specification or technical manual of respective ICs.

3.15 wake Status

It indicates that S1S60K has transitioned from the sleep mode to the normal operation mode.

[Status number] **0x000f**

[Status option] **None**

[Remarks]

The wake status is not returned at the start of S1S60K. As S1S60K is started (immediately after the **boot** status has been issued), it is already in the normal operation mode. For the detail, refer to the product specification or technical manual of respective ICs.

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