SKB SERIES
FIBEROPTIC SWITCH MODULE

User's Manual

JDS Uniphase

Contents

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Safety Information, Instructions, and Symbols

Safety Information

Power Requirements

The unit can operate from any DC power source that supplies 5 V. The maximum power consumption is 1 to 2.5 A, depending on the configuration.

Safety Instructions

The following safety instructions must be observed whenever the unit is operated, serviced, or repaired. Failure to comply with any of these instructions or with any precaution or warning contained in the user's manual is in direct violation of the standards of design, manufacture, and intended use of the unit. JDS Uniphase assumes no liability for the customer's failure to comply with any of these safety requirements.

Before Initializing and Operating the Unit

☑ Inspect the unit for any signs of damage, and read the user's manual thoroughly.

☑ Install the unit as specified in the **Getting Started** section.

☑ Ensure that the unit and any devices or cords connected to it are properly grounded.

Operating the Unit

Warning

To avoid the risk of injury or death, always observe the following precautions before initializing the unit:

- If using a voltage-reducing autotransformer to power the unit, ensure that the common terminal connects to the earthed pole of the power source.
- Willfully interrupting the protective earth connection is prohibited.
- Never look into the end of an optical cable connected to an optical output device that is operating. Laser radiation is invisible, and direct exposure can severely injure the human eye. For more information, see the user's manual of the laser source in use.
- Turning off the power to the device does not always block the externally supplied radiation to the connector at the output of the unit.
- Do not use the unit outdoors.
- To prevent potential fire or shock hazard, do not expose the unit to any source of excessive moisture.
- Do not operate the unit when its covers or panels have been removed.
- Do not interrupt the protective earth grounding. Any such action can lead to a potential shock hazard that can result in serious personal injury.

	• Do not operate the unit if an interruption to the protective grounding is suspected. In this case, ensure that the unit remains inoperative. • Unless absolutely necessary, do not attempt to adjust or perform any maintenance or repair procedure when the unit is opened and connected to a power source. • Repairs are to be carried out only by a qualified professional. • Do not attempt any adjustment, maintenance, or repair procedure to the unit's internal mechanism if immediate first aid is not accessible. • Disconnect the power from the unit before adding or removing any components. • Operating the unit in the presence of flammable gases or fumes is extremely hazardous. • Do not perform any operating or maintenance procedure that is not described in the user's manual. • Some of the unit's capacitors can be charged even when the unit is not connected to the power source.

Safety Symbols

The following symbols and messages can be marked on the unit (Table 1). Observe all safety instructions that are associated with a symbol.

Table 1: Safety Symbols

Symbol	Description
	Laser safety. See the user's manual for instructions on handling and operating the unit safely.
	See the user's manual for instructions on handling and operating the unit safely.
	Electrostatic discharge (ESD). See the user's manual for instructions on handling and operating the unit safely.
	Frame or chassis terminal for electrical grounding within the unit.
	Protective conductor terminal for electrical grounding to the earth.
WARNING	**The procedure can result in serious injury or loss of life if not carried out in proper compliance with all safety instructions. Ensure that all conditions necessary for safe handling and operation are met before proceeding.**
CAUTION	The procedure can result in serious damage to or destruction of the unit if not carried out in compliance with all instructions for proper use. Ensure that all conditions necessary for safe handling and operation are met before proceeding.

General Information and Specifications

General Information

This user's manual for the SKB Series Fiberoptic Switch Module contains complete operating instructions.

The SKB modular 1xN controllable switch controls up to four 1xN optical switches, with configurations up to 100 channels (Figure 1). Small and rugged, the switch is designed to be used in embedded applications. It is available in single-mode (SM) and multimode (MM) versions. It has several features that reduce installation and support efforts. The switch offers low insertion loss and is independent of data format and direction (bidirectional).

Figure 1: SKB Switch

The standard single-pole configuration consists of a single-common port that can be aligned to any one of 26 ports. In electrical terms, the SKB switch is a single-pole, 26-throw switch. The switching mechanism implements collimating lenses that eliminate the problems associated with modal noise and provide low insertion loss and high repeatability.

With use of an adapter cable assembly (user supplied), the switch is backward compatible with the SK Series Fiberoptic Switch Module and the SP Series Fiberoptic Switch Module.

The switch can operate in an enhanced command mode that provides the capability of readable switch parameters.

The optics can be internally connected to provide custom solutions at the customer's request.

Configurations

The SKB switch is offered in a standard chassis with standard software that controls numerous configurations. Examples, shown in Figure 2, include

- A single switch with 1xN configuration for N up to 100
- Up to four 1xN switches with a total channel count of up to 100 (for example, four 1x25 switches, two 1x50 switches, and so on)
- Up to two MxN blocking switches for a total M+N channel count of 100 (for example, two 25x25 switches, one 50x50 switch, and so on)
- 1xN switches plus relay switches and passive devices, such as couplers (for example, two 1x25 stepper motor switches with two relay switches and couplers)

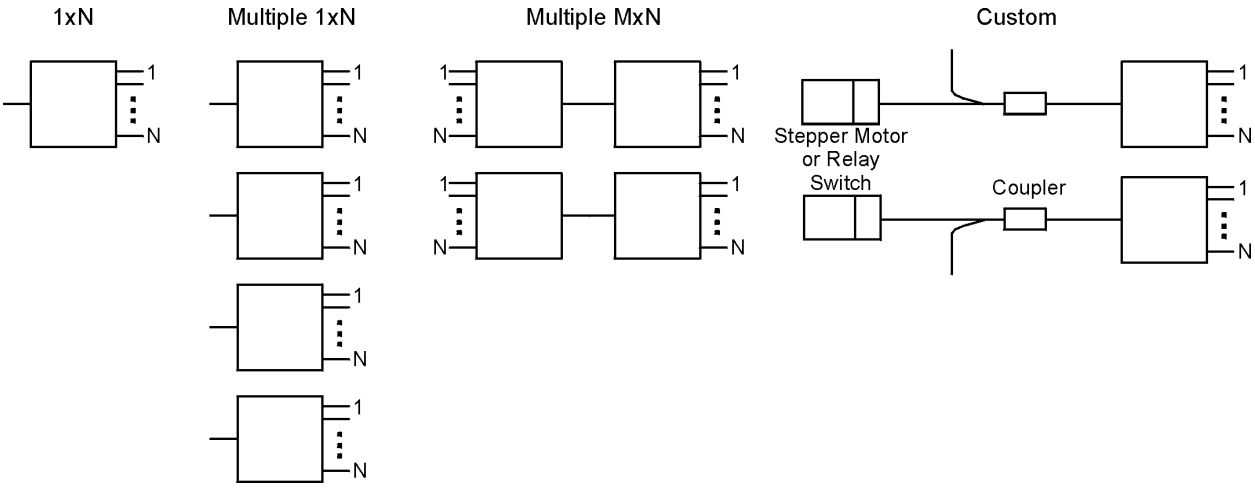

Figure 2: Configuration Examples

A 1xN configuration is shown more closely in Figure 3.

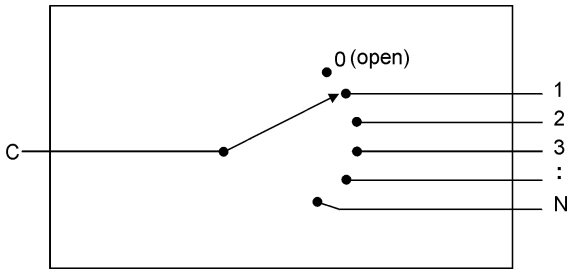

Figure 3: 1xN Configuration

Packages

The SKB switch is available in two package configurations:

- Package 1 can accommodate up to two 1xN switches with a single control interface
- Package 2 can accommodate up to four 1xN switches with a single control interface

Components

For large channel count switches, a high-precision stepper motor is used to align optical channels. The use of collimating lenses minimizes insertion loss.

For some applications, optional relay-based switches can be used.

Passive devices can be incorporated on a custom basis.

Latching and Non-Latching

Latching and non-latching SKB switches have the same functionality, command set, and specifications, with the following differences:

- On power off, the non-latching version does not guarantee an optical connect
- When reapplying power to the SKB switch, a latching version stays on the latched channel and a non-latching version resets to a configured known position

Channel Switching Times

The time to a sequential channel (for example, going from channel two to three) can appear to be greater than the specification for the adjacent channel. This discrepancy can be due to a few reasons:

- If the user has used the REPLACE command to replace a damaged channel, that channel is not sequential. Management of the switching order can be done using the SWAP_CHANNEL command.
- The factory configuration can be such that a channel was deliberately skipped.

Confirming Time Between Channels

The SKB switch allows the user to confirm the specified time to switch between channels. The CONNECTION_TIME? query physically checks the time by switching between the start and destination channel and outputs the results from the internal clock.

Key Features

- Up to 100 channels
- Typical insertions loss 0.4 dB (MM) for up to 26 channels
- Parallel and RS485 serial interface control
- Compact modular package suitable for original equipment manufacturing (OEM)

Applications

- Remote fiber test systems in telecommunications networks
- Fiber network restoration
- Fiberoptic component test and measurement

Standard Accessories

- 3 mm fiber cables or 900 µm fiber pigtails (customer specified)
- User’s manual

Specifications

The following optical specifications describe the warranted characteristics of the unit (Table 2). Supplementary specifications describe the typical non-warranted performance of the unit (Table 3).

Table 2: Optical Specifications[1,2,3]

Parameter	Typical (Maximum) N<26 Non-Latching N<25 Latching	Typical (Maximum) 26≤N≤100 Non-Latching 25≤N≤92 Latching
Insertion loss SM MM	 0.5 (0.7) dB 0.4 (0.6) dB	 0.8 (1.2) dB 0.7 (1.0) dB
Wavelength SM MM	1290 to 1670 nm 850 to 950 nm or 950 to 1350 nm	
Return loss SM MM	 62 (57) dB 25 (20) dB	 55 (45) dB 20 (20) dB
Polarization dependent loss (SM)	0.02 (0.04) dB	0.04 (0.08) dB
Insertion loss stability[4]	±0.02 (0.025) dB	±0.03 (0.04) dB
Change in insertion loss during power on-off cycle; latching version SM MM	 ±1.0 (2.0) dB ±1.0 (2.0) dB	 ±2.0 (4.0) dB ±2.0 (4.0) dB
Repeatability[5] sequential switching random switching	 ±0.005 (0.01) dB ±0.01 (0.05) dB	 ±0.01 (0.03) dB ±0.03 (0.08) dB
Crosstalk	-90 dB	-80 dB
Switching time (one channel/each additional channel) low speed, high accuracy medium speed	 25/15 ms 20/15 ms	
Optical input power	300 mW continuous	
Lifetime	at least 10 million cycles	
Interface	parallel and RS485 serial	

[1] All specifications referenced without connectors.
[2] All optical measurements taken after temperature has stabilized for one hour.
[3] All specifications are at low speed setting. Repeatability can be affected by increasing speed.
[4] Return loss specifications based on 1 m pigtail length.
[5] Repeatability measured after one-hour warm-up.

Table 3: Other Specifications

Electrical	
Input voltage	5 ±0.25 V DC
Power consumption	1 to 2.5 A maximum, configuration dependent
Physical	
Dimensions (W x H x D) package 1 fiber version package 1 cable version package 2 fiber version package 2 cable version	 7.82 x 2.78 x 14.00 cm (3.08 x 1.095 x 5.51 in) 7.82 x 2.78 x 17.17 cm (3.08 x 1.095 x 6.76 in) 13.84 x 2.78 x 14.00 cm (5.45 x 1.095 x 5.51 in) 13.84 x 2.78 x 17.17 cm (5.45 x 1.095 x 6.76 in)
Weight	depends on configuration 0.6 kg maximum for package 1 configuration 1 kg maximum for package 2 configuration
Environmental	
Operating temperature	-35 to 75 °C
Storage temperature	-40 to 85 °C
Humidity	maximum 95% RH from -35 to 75 °C

Getting Started

The SKB Series Fiberoptic Switch Module package consists of the switching unit with fiber pigtails.

Before Initializing and Operating the Unit

☑ Inspect the unit for any signs of damage.

☑ Read the user's manual thoroughly, and become familiar with all safety symbols and instructions to ensure that the unit is operated and maintained safely.

Initial Inspection

Warning

To avoid electrical shock, do not initialize or operate the unit if it bears any sign of damage to any portion of its exterior surface, such as the outer cover or panels.

Check that the unit and contents are complete:

1. Wear an anti-static wrist strap and work in an electrostatic discharge (ESD) controlled area.

2. Inspect the shipping container for any indication of excessive shock to the contents, and inspect the contents to ensure that the shipment is complete.

3. Inspect the unit for structural damage that can have occurred during shipping.

4. Keep the packaging.

Immediately inform JDS Uniphase and, if necessary, the carrier if the contents of the shipment are incomplete, if the unit or any of its components are damaged or defective, or if the unit does not pass the initial inspection.

Operating Environment

In order for the unit to meet the warranted specifications, the operating environment must meet the following conditions for temperature and humidity.

Temperature

The unit can be operated in the temperature range of -35 to 75 °C.

Humidity

The unit can be operated in environments with up to 95% humidity (-35 to 75 °C). Do not expose it to any environmental conditions or changes to environmental conditions that can cause condensation to form inside the unit.

Warning

- Do not use the unit outdoors.
- To prevent potential fire or shock hazard, do not expose the unit to any source of excessive moisture.

Storing and Shipping

To maintain optimum operating reliability, do not store the unit in locations where the temperature falls below -40 °C or rises above 85 °C. Avoid any environmental condition that can result in internal condensation. Ensure that these temperature and humidity requirements can also be met whenever the unit is shipped.

Claims and Repackaging

Immediately inform JDS Uniphase and, if necessary, the carrier, if

- The contents of the shipment are incomplete
- The unit or any of its components are damaged or defective
- The unit does not pass the initial inspection

In the event of carrier responsibility, JDS Uniphase will allow for the repair or replacement of the unit while a claim against the carrier is being processed.

Returning Shipments to JDS Uniphase

JDS Uniphase only accepts returns for which an approved Return Material Authorization (RMA) has been issued by JDS Uniphase sales personnel. This number must be obtained prior to shipping any material to JDS Uniphase. The owner's name and address, the model number and full serial number of the unit, the RMA number, and an itemized statement of claimed defects must be included with the return material.

Ship return material in the original shipping container and packing material. If these are not available, typical packaging guidelines are as follows:

1. Wear an anti-static wrist strap and work in an ESD controlled area.

2. Wrap the unit in anti-static packaging. Use anti-static connector covers, as applicable.

3. Pack the unit in a reliable shipping container.

4. Use enough shock-absorbing material (10 to 15 cm or 4 to 6 in on all sides) to cushion the unit and prevent it from moving inside the container. Pink poly anti-static foam is the best material.

5. Seal the shipping container securely.

6. Clearly mark FRAGILE on its surface.

7. Always provide the model and serial number of the unit and, if necessary, the RMA number on any accompanying documentation.

8. Ship the unit only to the address given at the beginning of this document.

Cleaning Connectors

	**Caution** • Connecting damaged or dirty fibers to the unit can damage the connectors on the unit. • Never force an optical connector. Some connectors have a ceramic ferrule that can easily be broken.

Optical cable ends need to be cleaned before using them with the unit.

The following items are required for cleaning:

- Filtered compressed air or dusting gas (for example, Tech Spray Envi-Ro-Tech Duster 1671 gas, available from http://www.techspray.com/1671.htm)
- Lint-free pipe cleaners (for example, from 3M[1]) or lint-free swab
- Lint-free towels (for example, 10 x10 cm or 4 x 4 in HydroSorb III wipers, available from http://www.focenter.com/acctech/hydrosobr_wipers.htm)
- Optical grade isopropyl alcohol or optical grade 200° ethanol (do not use rubbing alcohol, which contains 30% water)

To clean the connectors:

1. Blow the sleeve with filtered compressed air (Figure 4).

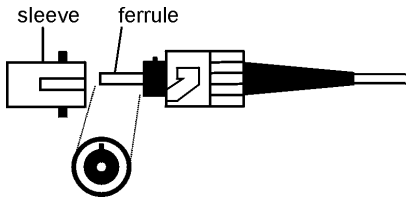

Figure 4: Connector Cleaning (connector type can vary)

2. Apply optical grade isopropyl alcohol or optical grade ethanol (do not use rubbing alcohol) to a small area of a lint-free towel and rub the end of the ferrule over the wet area.

3. Wipe the ferrule on a dry area of the lint-free towel.

4. Using the dusting gas or compressed air, blow the end of the ferrule.

5. Apply the alcohol or ethanol to a lint-free pipe cleaner or swab and wipe off the remaining parts of the connector.

6. With the other end of the pipe cleaner or swab, dry the areas cleaned.

[1] 3M is a trademark of 3M.

7. Using the dusting gas or compressed air, blow the areas cleaned.

Storing Fiberoptic Connectors

All fiberoptic connectors are shipped with dust caps installed on the connectors. Keep the dust caps on the connectors whenever the fiberoptic connectors are not mated.

Handling Fiberoptic Cables

The SKB switch can be shipped with fiber pigtail outputs. These pigtails must be handled with care to avoid damage.

	**Caution** Do not bend the pigtails with a radius under 4 cm (1.5 in). A small bend radius adversely affects the optical performance of the pigtail and leads to early failure of the pigtail.

Installing the Switch

	**Caution** • Protection against reverse connection of the power input is not incorporated in the SKB switch. Reverse connection of the power input results in damage to the switch. • The SKB switch requires that the power input be within the tolerance given at the unit. Care needs to be exercised in the design of the system power to compensate for any wiring losses in cabling. Failure to maintain the correct supply voltage can result in unpredictable operation of the switch.

Figure 5 shows the connector locations for the SKB switch. There are two connectors on the switch. The first connector is a 25-pin D-subminiature connector used by the parallel interface. The second connector is a nine-pin D-subminiature connector, which provides for the power connection. A separate chassis ground connection point also is provided.

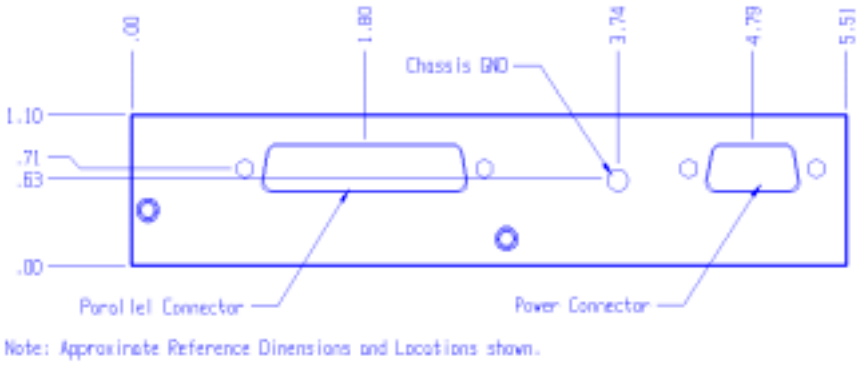

Figure 5: Connector and Chassis GND Locations

Cabling

The pin assignment of the parallel interface DB25 female connector is arranged such that shield and data lines are ordered sequentially on a ribbon cable. If discrete wires are used, the shield and data lines need to be twisted together to eliminate potential crosstalk.

The pin assignment of the power/serial (DB9) interface is arranged to accommodate discrete wires. The two data lines are run as a twisted pair, and the power and ground lines are run as a twisted pair. The shield is used to encase both of the twisted pairs within the cable.

When using the parallel interface, a common ground is required for the master/slave power supply.

Installing the Switch

To install the switch:

1. Mount the chassis using the four holes provided (Figure 6). An M3 lug with maximum thread depth in the unit of 5 mm is recommended.

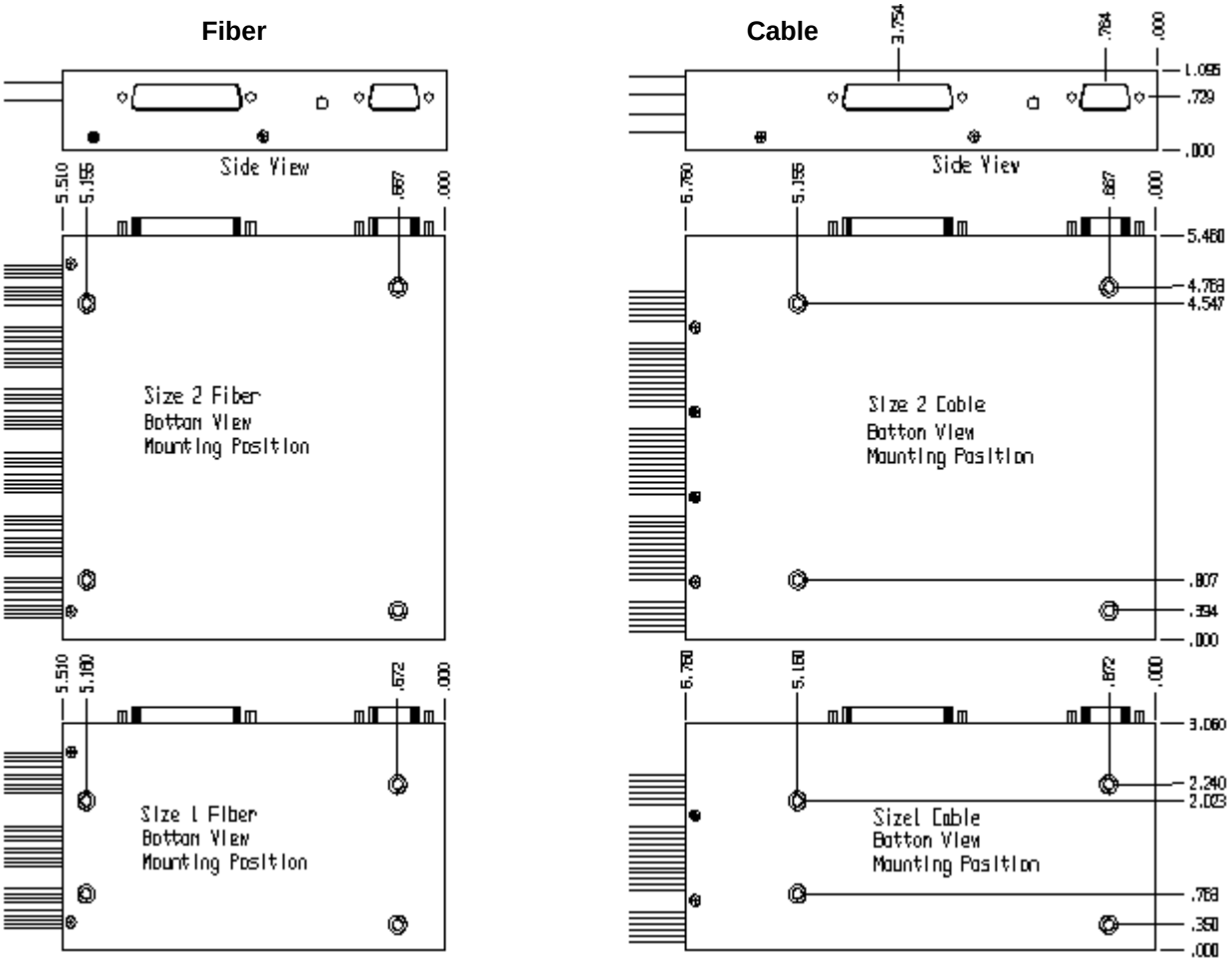

Figure 6: Mounting Hole Locations for Fiber and Cable Versions

2. Connect the ground lug to chassis ground. An 8 mm depth M3 lug with flat and lock washers is recommended (5 mm maximum thread depth in unit).

3. Install the connectors.

4. Connect the power supply to the unit via the nine-pin port. A supply of 5 V ±5%, 1 to 2.5 A maximum (configuration dependent), is required.

5. Connect a 25-pin parallel cable to the unit. The switch is now ready for use.

For information on installing multiple SKB switches in a network, see the **Connecting Multiple Switches** section.

Power / Serial Interface

The nine-pin D-subminiature connector is used for power and serial RS485 interface. The interface provides power, differential serial (RS485), and trigger signals. The SKB switch has the receiver and driver installed for the RS485 serial interface but not the software for using this interface.

The RS485 interface is a high-speed differential bus used to communicate serially with the master device. The SKB RS485 interface operates over a range of 2400 to 4800 baud and defaults to read mode. The default baud rate for the switch is 2400 baud asynchronous, self-clocking. The RS485 interface only requires three lines to connect to the differential bus: shield, RXTX-, and RXTX+. The interface must be connected to provide power to the SKB device.

The RS485 communication settings are:

- Eight data bits
- One stop bit
- No parity bits
- 2400 (default) and 4800 baud rate

Simultaneous operation of serial and parallel interface is not supported.

Connecting Multiple Switches

Up to 32 RS485 unit loads can be connected to the differential bus, so up to 30 SKB switches and one master controller can be used to construct an RS485 network. Exceeding the limit of 32 devices excessively loads the RS485 drivers and attenuates the differential signal. The consequence is reduced noise immunity of the bus and an increased error rate.

The most appropriate method of connecting RS485 nodes is by multidropping the connection from master to node 1, to node 2, and onward to node n. The bus must form a single continuous path. Do no put individual nodes at the end of long branches or spokes from the middle of the bus. If branches are used, make them short. The preferred bus architecture is shown in Figure 7.

Figure 7: Preferred RS485 Bus Architecture

RS485 buses usually require line termination when fast transmissions, high data rates, or long cables lengths are employed. Although no termination is required if the bus cable length is short and transmission speed is low, it is always recommended.

Terminate bus lines at both ends of the main cable to prevent signal reflection, for example. In Figure 7, termination is applied at the Master node and SKB n node.

The common method of termination is parallel line termination, whereby a resistor is placed across the differential lines at the most extreme end of the bus (SKB n+1). The resistor value must be equal to the characteristic impedance of the cable. In practice, the resistor value needs to be slightly higher than characteristic impedance. A common mistake is to connect a terminating resistor at each node in the RS485 bus. This action causes line problems when more than four nodes are connected because the active bus driver is loaded excessively.

The maximum cable length specified for RS485 buses is 1219 meters (4000 feet). Generally, the longer the cable length, the slower the data transmission rate. All applicable data baud rates used by the SKB switch operate over the maximum cable length when proper termination is used and the number of nodes does not exceed 31.

Pin Assignment

The signals for power and communication are connected via the nine-pin D-subminiature serial connector (Figure 8 and Table 4).

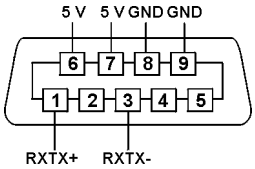

Figure 8: Pin Assignment

Table 4: Pin Assignment

Pin	Signal	Description	Functionality
Pin 1	RXTX+	transmit/receive data positive side (B)	TXA. Differential input/output signal from the RS485 host.
Pin 2	shield	signal shield	This line is connected to chassis ground at the host end and is isolated at the slave.
Pin 3	RXTX-	transmit/receive data negative side (A)	TXB. Complement of the differential input/output from the RS485 interface.
Pin 4	trigger	active low trigger signal, transistor-to-transistor logic (TTL), multi-dropped, pulled UP at slave with 100 K	This line is driven by the host processor (master) to indicate to the slaves that a trigger-based action is to be executed on the falling edge of this signal. This action is usually preconditioned by a request to the applicable slaves.
Pin 5	Attention	active low attention signal, open collector, pulled UP at master with 470 ohm	This line is driven by the SKB module (slave) to indicate to the master that it requires the host attention. This signal is an open collector signal that is terminated at the host end by a 470 ohm resistor connected to V+.

(table continued)

Pin	Signal	Description	Functionality
Pin 6	V+	5 V supplies in	These lines are supplied by a 5V ±5% regulated power supply provided from the host. Each of these wires provides power for different elements of the module.
Pin 7	V+	5 V supplies in	
Pin 8	GND	power ground	These lines are power supply grounds and are isolated from the chassis ground.
Pin 9	GND	power ground	

RS485 Addresses

The addresses are outlined in Table 5.

Table 5: RS485 Addresses

Address	Description
0	Reserved for master. Cannot be an SKB switch.
2 to 31	Valid address range for SKB devices.
255	Broadcast address. Packets sent with a broadcast address are received and parsed by all active SKB devices on the RS485 bus.

Each SKB switch is pre-assigned an address of 1. If an SKB device is reset (either hard or soft), and the network address is 1, the ATTN line is asserted. The ATTN line is de-asserted when the device address is changed to something other than 1. This feature acts as a mechanism for informing the bus master that a device with the default address is connected to the bus.

RS485 Protocol

A proprietary link-layer RS485 protocol has been developed that enables network-based communication utilizing a single master and multiple slaves on a common bus. The protocol provides a high-level flow control mechanism (using acknowledge packets) and link-layer error detection (using CRC packet validation). The RS485 protocol consists of two elements: the RS-485 link-layer communication packet and the master-slave acknowledge cycle.

The RS485 packet is composed of a number of bytes surrounding a data payload (Figure 9). The data payload section of the RS485 packet holds exactly one standard command packet, as illustrated. The packet bytes are designated as shown in Table 6.

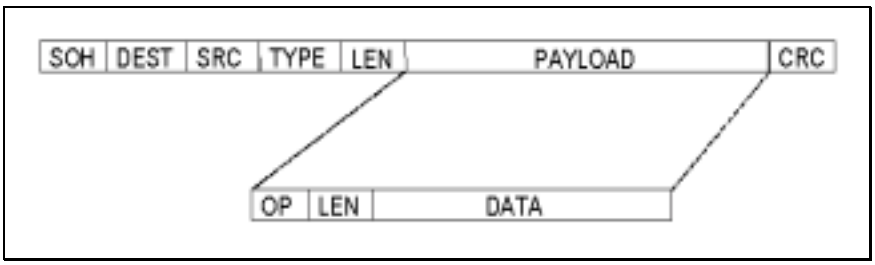

Figure 9: RS485 Link-Layer Packet and Command Packet

Table 6: RS485 Link-Layer Packet Fields

Packet Byte	Size (bits)	Description
SOH	8	Start of header byte (0x81)
DEST	8	Destination address of the packet (0x00 reserved for master, 0xFF reserved for broadcast)
SRC	8	Source address (for sending ACK's and responses)
TYPE	8	Packet type (DATA = 0, ACK = 1)
LEN	16	Length of payload section of the RS485 packet
CRC	16	16-bit CRC value with 0x1021 as polynomial

The master-slave acknowledge cycle refers the process of indicating to the sender that an RS485 packet has been received intact and that more packets can be sent. This action is accomplished by sending an RS485 ACK packet back to the sender. Once a valid RS485 packet is received, and the CRC has been verified, another packet can be sent by the master. Therefore, successful reception of the link-layer packet must be followed by an ACK response from the slave. If no ACK packet is received following transmission of a data packet with a specified timeout period, the sender needs to re-transmit the data packet. An ACK packet consists of a standard RS485 packet without a length byte, any data payload bytes, or CRC bytes. The type byte is defined as an ACK (1). The ACK packet is shown in Figure 10.

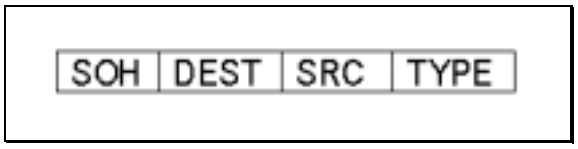

Figure 10: RS485 ACK Packet

This ACK cycle is reversed when response data packets are sent from the SKB slave to the master. In this case, the master is expected to acknowledge receipt of the link-layer packet by sending an ACK packet back to the slave.

A timeout period of 500 ms is used by the SKB switch for all serial data transfers. Therefore the time between subsequent bytes of a packet, or the time between data and ACK packets (being both sent and received, is 500 ms.

A holdoff period of 1 ms is observed by the SKB switch when transmitting data or ACK packets back to the master. The holdoff is a short delay to allow the master to prepare to receive data from the slave.

If a communication error occurs (for example, CRC mismatch), no ACK packet is transmitted to the sender.

If no ACK packet is received within a particular period following transmission of the last RS485 packet byte, retransmit the original RS485 packet.

Typical protocol is shown in Figure 11.

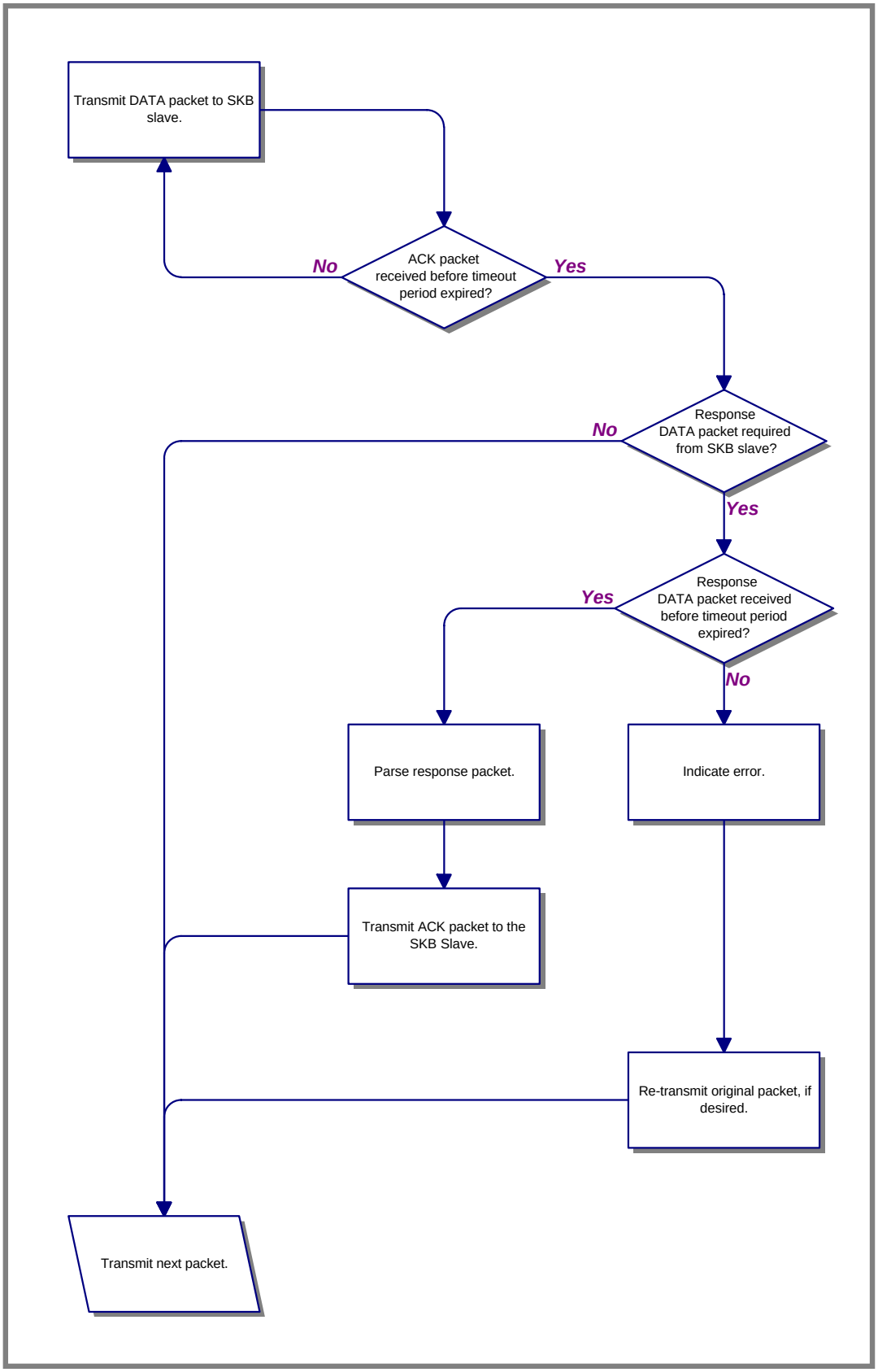

Figure 11: RS485 Network Implementation

Parallel Interface

A 25-pin D-subminiature connector is used for the parallel interface.

Pin Assignment

The pin assignment for the parallel interface is outlined in Figure 12 and Table 7.

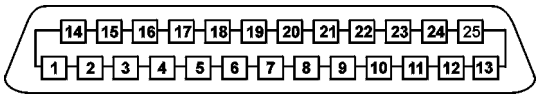

Figure 12: Pin Assignment

Table 7: Pin Assignment

Pin	Signal	Description
1	GND[1]	shield
2	D1	data line 1
3	D2	data line 2
4	GND[1]	shield
5	D5	data line 5
6	D6	data line 6
7	GND[1]	shield
8	BUSY	busy output: low = idle high = operation in progress (switching)
9	ERROR	error output: low = normal high = error in error queue
10	GND[1]	shield
11	/SOP	start of packet--provides a start-and-stop mechanism
12	R/W	read/write--driven by master read and write cycles
13	GND[1]	shield
14	D0	data line 0 input; least significant bit (LSB)
15	GND[1]	shield
16	D3	data line 3
17	D4	data line 4
18	GND[1]	shield

(table continued)

Pin	Signal	Description
19	D7	data line 7; most significant bit (MSB)
20	STROBE	STROBE input, active low: high-to-low pulse = read data lines and home line high = ignore state of data lines and home line This line is internally pulled high via 10 k ohm resistor to 5 V DC
21	GND[1]	shield
22	RESERVED	reserved; internal use only; do not use
23	RESERVED	reserved; internal use only; do not use
24	GND[1]	shield
25	RESET	resets the hardware (MCU reset)

[1] Connect GND signal lines to common ground of the master.

Caution

If the reserved pins are used for any purpose, compatibility with future versions of the SKB module can be compromised.

Using SK / SP Emulation Mode

The SKB switch can be run in a mode that emulates operation of the SK and SP product line. A hybrid, parallel connector cable must be constructed. Contact JDS Uniphase for instructions on cable pinouts.

Simultaneous operation of serial and parallel interface is not supported.

Using the Switch

Voltage Levels

All parallel interface signals are TTL compatible. The active state of each signal is outlined in Table 8.

Table 8: Parallel Interface States

Signal Name	Active State	Inactive State
D0 - D7	high	low
/STROBE	low	high
BUSY	high	low
ERROR	high	low
/SOP	low	high
R/W	high = read low = write	N/A
/RESET	low	high

Line Descriptions

Data Lines (D0...D7)
Byte data is composed of a binary eight-bit pattern presented on the /D0 to /D7 data lines. Input and output byte data are presented the same way.

Data line formats are outlined in Table 9.

Table 9: Data Line Formats

/SOP	D7	D6	D5	D4	D3	D2	D1	D0	Channel Number
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	1	0	2
0	'	'	'	'	'	'	'	'	'
0	1	1	1	1	1	1	1	1	255

The value 0 indicates that the input needs to be set low (for example, <0.8 V DC).
The value 1 indicates that the input needs to be set high (for example, ≥2 V DC).

/SOP Input Line
The /SOP line provides a data packet start/stop mechanism. Transition of the /SOP line from a high-to-low state indicates the beginning of a data packet, and all subsequent bytes placed on the data lines are considered packet data bytes. Transition of the /SOP line back from a low-to-high state indicates the end of a data packet. The master is responsible for controlling the /SOP line.

/STROBE Input Line
The /STROBE line is used to signal the SKB switch to read data from or write data to the data lines. A change on the data lines has no effect until there is a high-to-low transition on the

/STROBE line. The /STROBE line is driven by the master for both transmit and receive operations.

R/W Input Line
The R/W line is driven by the master as a bus control mechanism. When the R/W line is driven low, /D0-/D7, /SOP, and /STROBE line transitions are interpreted as input operations from the master to the slave. When R/W is driven high, operations are interpreted as output from the slave to the master.

BUSY Output Line
The BUSY line provides a flow control mechanism. The BUSY line is pulled high by the slave after each byte is transferred. The master does not toggle any lines until a high-to-low transition of the BUSY line is detected.

ERROR Output Line
The ERROR line is used to flag the master when the slave detects an error. When the error line is high, there is an error in the error queue. The ERROR line is driven low when the errors are read out of the error queue or the error queue is cleared.

/RESET
Reset resets the micro-controller unit (MCU) in the switch. All communication interfaces are reset.

Parallel Protocol

The read and write cycles follow a mechanism that tightly coupled the control signals (SOP and STROBE lines on the master side and BUSY line on the slave side) to provide flow control. These cycles are defined as follows.

Read Cycle

The read cycle refers to the bus master reading bytes from the SKB slave (Figure 13). In this mode, the master ensures that the R/W line is pulled high. The master then toggles the /SOP line from the high to the low state, which signals the SKB switch to place the first data byte on the data lines. The BUSY line is held high to indicate to the master that a valid byte has been placed on the data lines. To indicate that the master has completed the read, the /STROBE line transitioned to low. The SKB switch subsequently pulls the BUSY line low to signal that the data acknowledgment has been received. The master then sets the STROBE to high. The BUSY transitions to high to indicate to the master when the next byte has been placed on the data lines. Upon completion of the last data byte transmission, the master resets the /SOP line from the low to the high state to indicate the end of the data packet.

Write Cycle

The write cycle refers to the bus master writing bytes to the SKB slave (Figure 14). In this mode, the master ensures that the R/W line is pulled low. The master then toggles the /SOP line from high to low, which indicates the beginning of a new packet. Binary byte data is subsequently placed on the data lines /D0 to /D7 and entered by use of the /STROBE line. After each STROBE, the BUSY line is held high until the SKB switch is ready to receive the next data byte. Upon completion of the last data byte transmission, the /SOP line is toggled from low to high, indicating the end of the data packet.

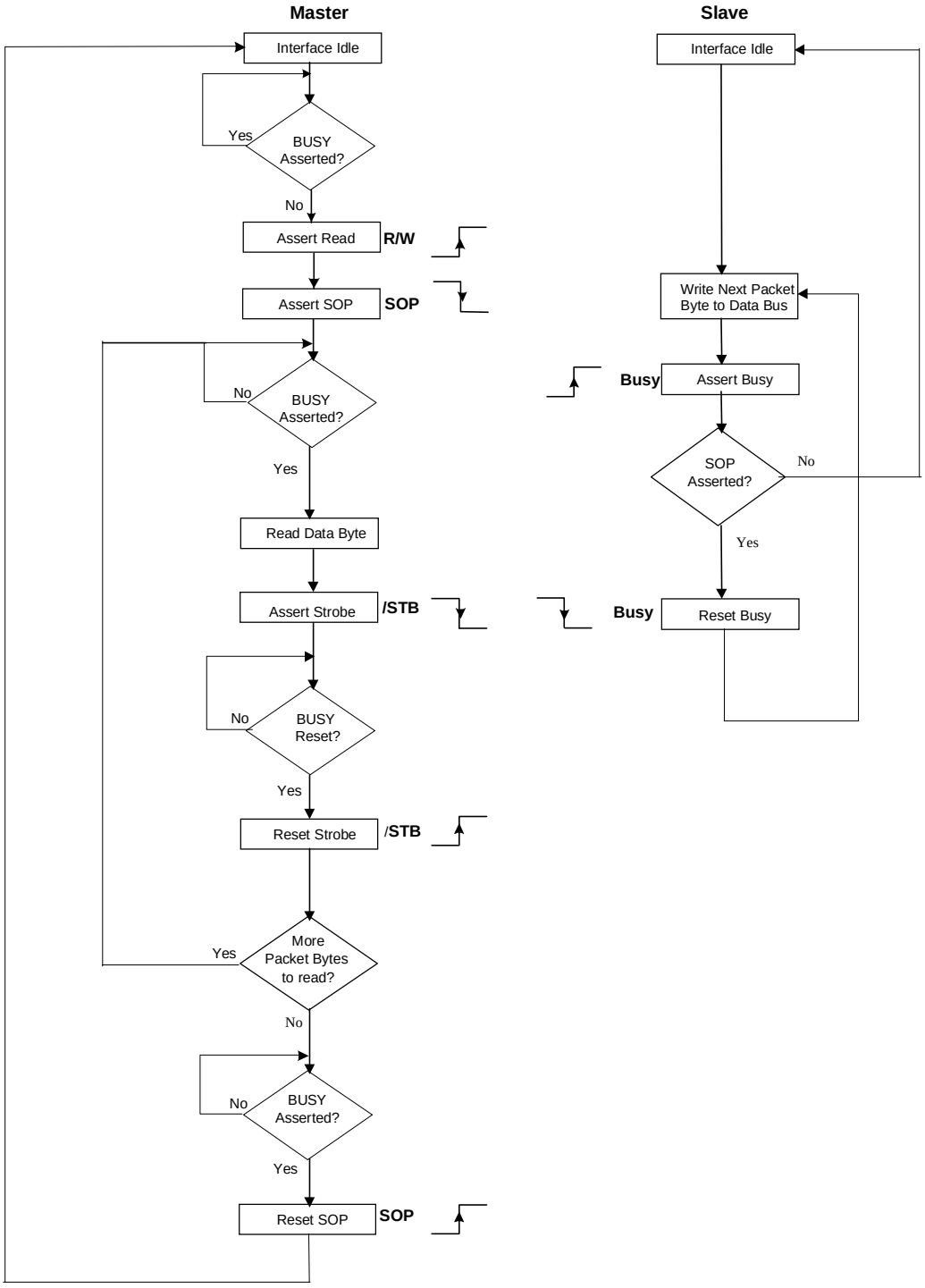

Figure 13: Flowchart of Read Cycle

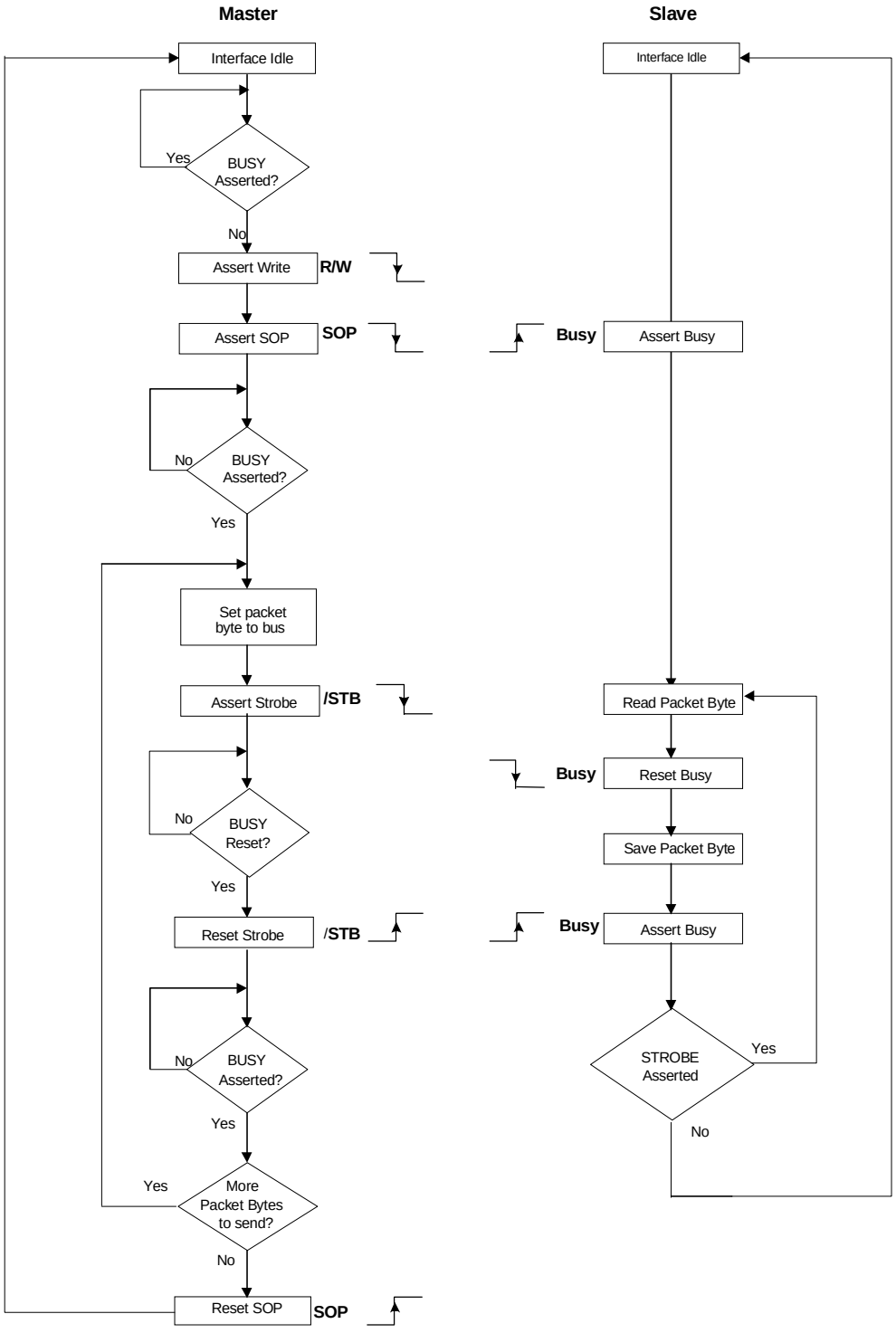

Figure 14: Flowchart of Write Cycle

Timing

The SKB switch uses bidirectional parallel lines for the data bus (D0 to D7) and dedicated input/output lines for flow control. Data flow control is implemented on a byte-by-byte basis, using the BUSY output line of the SKB switch as the primary mechanism of controlling the data transfer rate. By using control signals, the actual signal timing can vary (within defined tolerances) according to the availability of the SKB switch, which is indicated with a low-level BUSY signal.

The primary control signals of the master are the /SOP and /STROBE lines. Transitions of the /SOP line are used to delimit the beginning and end of packets. The /STROBE line is used to signal the SKB switch to either read bytes from the data lines or write bytes to the data lines.

Timing dependencies have been minimized, allowing use of control signals to regulate communication. However, the following timing requirements must be observed:

- A hold time of 5 µs must be applied when toggling SKB input lines (for example, R/W, D0-D7, /SOP, /STROBE, /RESET).
- The maximum period between sequential bytes (indicated by transitions of the /STROBE line) is 500 ms.

The following general rules apply:

- The master needs to ensure that the BUSY line is de-asserted (low) before toggling any parallel communication lines (for example, /SOP, /STROBE, and so on).
- Communication lines must be toggled according to the steps indicated in the protocol flow charts for read and write operations. Poll the error line following each operation.

The read cycle protocol is illustrated in Figure 15. Typical line toggling for a master read cycle is shown. The figure shows the relationship of the R/W, /SOP, and /STROBE input lines and the BUSY output line during a three-byte response packet read from the SKB switch.

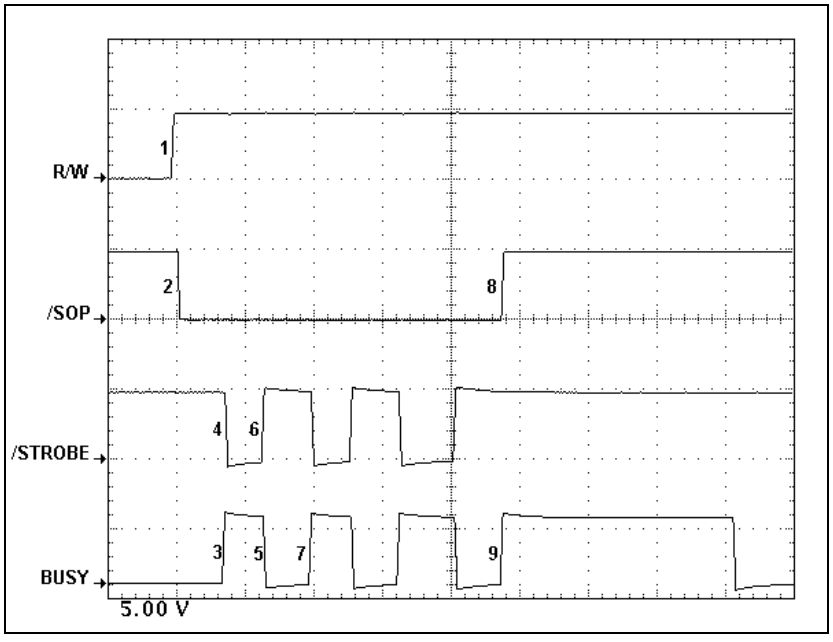

Figure 15: Three-Byte Response Packet Read from the SKB Switch

The following actions correspond to numbered events in the figure:

1. The R/W line is driven high to indicate read-from-SKB operation.
2. The /SOP line is then asserted (low) to indicate the start of a command packet.
3. The BUSY line of the SKB switch is asserted (high) to indicate the first byte of the packet has been written to the data bus.
4. Binary data is read from the data lines (D0 to D7) and the /STROBE line is asserted (low) to indicate to the SKB switch that the byte was read.
5. The BUSY line is de-asserted (low) to indicate to the master that the SKB switch is ready to send another byte.
6. The /STROBE is de-asserted (high) to indicate to the SKB switch that the master is ready to accept another byte.
7. The BUSY is asserted (high) to indicate to the master that another byte has been written to the data bus. All subsequent bytes are processed in the same fashion to indicate the master has read the data bus.
8. The /SOP line is de-asserted (high) to indicate end of packet.
9. The BUSY line is asserted (high) to indicate packet parsing and driven low when end-of-packet processing is complete.

This write cycle protocol is illustrated in Figure 16. Partial parallel interface line toggling is shown. The figure shows the relationship of the R/W, /SOP, /STROBE input lines, and the BUSY output line during a two-byte command packet write to the SKB switch.

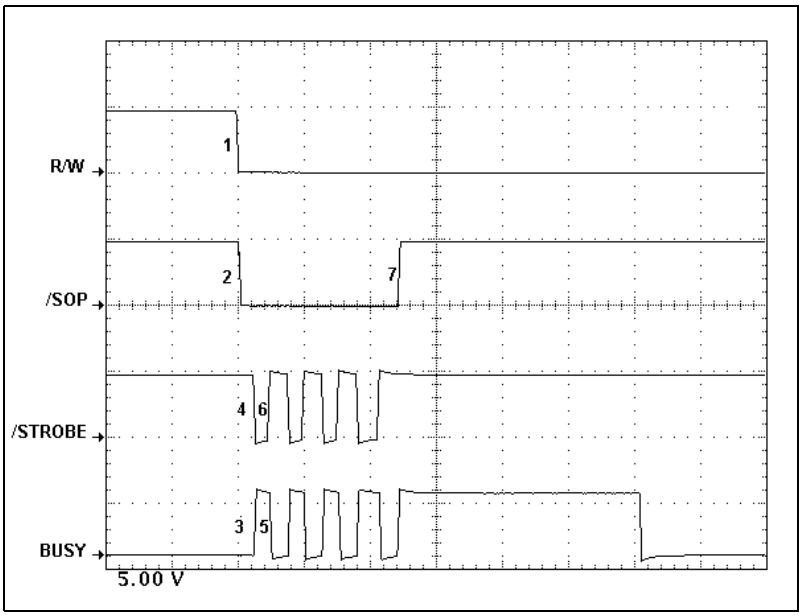

Figure 16: Four-Byte Command Packet Write to the SKB Switch

The following actions correspond to numbered events in the figure:

1. The R/W line is pulled low to indicate write-to-SKB operation.
2. The /SOP line is then asserted (low) to indicate the start of a command packet.
3. The BUSY line of the SKB switch is asserted (high) to indicate /SOP processing.

4. Binary data is written to the data lines (D0 to D7), and the /STROBE line is asserted (low) to indicate to the SKB switch that the byte can be read.
5. The BUSY line transitions to the idle (low) state to indicate that the SKB switch has read the byte.
6. The STROBE line is de-asserted (high), the SKB switch then asserts (high) BUSY to complete the byte transfer. All subsequent bytes are strobed-in to the SKB switch in the same way.
7. After BUSY transitions high following the final byte, the /SOP line is de-asserted (high) to indicate end-of-packet.

Error Cycle

The timing error cycle refers to the operation of the ERROR line (Figure 17). When any error occurs on the SKB switch, a corresponding error code is written to an eight-deep error queue. Error codes can be written to the error queue as a result of operational or communication errors. When an error code is pending in the error queue, the LINE of the parallel interface is driven high. The ERROR line remains in the high state while there are error codes present in the error queue. Error queue management commands are included in the SKB standard command set. Figure 17 shows the relationship of the /SOP and /STROBE input lines and the BUSY and ERROR output lines during a three-byte packet transfer.

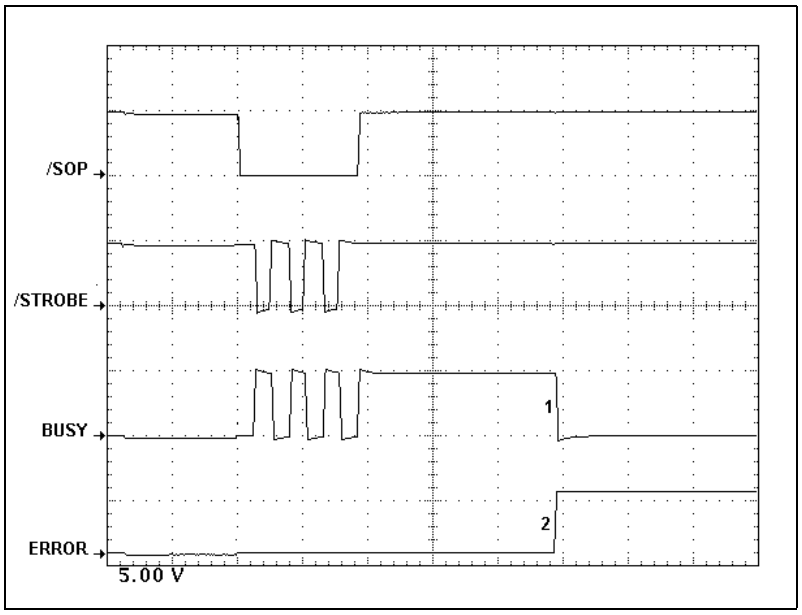

Figure 17: Three-Byte Packet Write Produces an Error

In the figure, the communication process was successful, indicating that the error was due to an operational aspect of the SKB switch.

The following actions correspond to events numbered in the figure:

1. The command packet is transferred normally. In this case, the packet transfer was successful due to the fact that the final BUSY cycle indicates completion of packet processing. When a communication error is indicated, the ERROR line is asserted (high) before this point.
2. The error line is asserted (high) and remains asserted until the error queue is cleared.

ERROR asserted does not preclude more operations from occuring; more data packets can be received or transmitted. The error line needs to be polled after each operation to determine the condition of the SKB switch.

Commands

Architecture Overview

Instructions and queries are received by the SKB module as command packets. Command packets describe a method of encapsulating a command opcode, a length code, and applicable parameter data in a format that can be interpreted by the command processor of the instrument module firmware.

Command packets are the only available means of moving data into and out of the SKB module.

External communication drivers and protocols are utilized to transmit and receive command packets. For example, the parallel communication driver can directly transmit command packets, while the serial communication driver can implement a protocol that embeds command packets within larger protocol packets.

Command Packet Format

Essentially all communication with the SKB module, regardless of interface or protocol used, is accomplished via command packets.

A standard command packet can be up to 256 bytes in length.

The first byte is always an opcode, which can be any number between 0 and 127. The most significant bit (MSB) is never set in a command packet opcode.

The second byte is always the length, in bytes, of the following parameter data. The value of the length byte corresponds to the number of bytes in the parameter data section of the command packet, regardless of the actual data type represented by the binary parameter data.

The minimum length of a command packet is two bytes. The opcode and length (even if zero) must be transmitted to the SKB module.

Command packets appear as follows:

OP	LEN	DATA

where OP = opcode and LEN = length.

The communication architecture of the SKB switch does not implement a command-response scheme. Each command packet sent is not necessarily answered with a response packet. Only those opcodes that represent a query generate a response packet.

Response Packet Format

Response packets refer to packets transmitted by the SKB switch for the purposes of returning query data. Response packets have an identical format as a standard command packet, with the MSB of the opcode byte set.

If, for example, an opcode of 0x01h was sent to the SKB switch and this opcode represented a query, the response packet has an opcode of 0x81h.

The length byte of a response packet represents the total length of the parameter response data, regardless of the actual data types embedded in the parameter area.

Parameter Data Types

Parameter data of the command packet is limited to 254 bytes, which can be allocated at the discretion of the application according to standard data types shown in Table 10.

Table 10: Parameter Data Types

Data Type	Size in Bytes (Bits)
signed char	1 (8)
unsigned char	1 (8)
signed int	2 (16)
unsigned int	2 (16)
signed long	4 (32)
unsigned long	4 (32)
float	4 (32)

Byte Order

When utilizing data types larger than one byte, the byte order follows “little-endian” convention: the low-order byte (which holds the least significant bit, or LSB) is referenced as byte 0. Subsequent bytes progress toward the high-order byte (which holds the MSB). This sequence is illustrated as follows.

Single-byte bit order:

Bit	7	6	5	4	3	2	1	0

Double-byte bit order:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	Byte 0 (low)								Byte 1 (high)							

Quadruple-byte bit order:

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	Byte 0 (low)								Byte 1							

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	Byte 2								Byte 3 (high)							

Example:

The 16-bit number represented by 0x1234h is split into two bytes as follows: 0x34h (Byte 0) and 0x12h (Byte 1). In the command or response packet, however, these bytes are contiguous and therefore appear as 0x3412h.

Common Commands

SKB common commands refer to those operations and queries common to most switch modules and instruments. These commands represent the core functionality of the instrument module.

RESET

Description	Reset all switches to the default state. This command is functionally the same as a hardware Reset. The following major events occur: • Current settings (channel positions are saved) • A hardware reset is generated by the microcontroller • On wakeup, non-latching switches move to the Reset position (factory default is a null-connect channel, but this can have been changed by the user), and latching switches stay on the same channel Also see the SWITCH command, which can be used to send individual switches to the reset position.
Parameters	NA
Parameter Description	NA

OPCODE	Length	Parameters
0x00	0x00	

IDN?

Description	Query identification information
Parameters	NA
Parameter Description	NA

Command packet

OPCODE	Length	Parameters
0x01	0x00	

Response packet

OPCODE	Length	Parameters
0x81	0x22	U8 Serial_Num[15], U8 Model_Num[15], Core_Ver[2], App_Ver[2] Serial_Num (unsigned eight-bit array of 15 elements)--An array of 15 eight-bit integers (0 to 255) representing the serial number of the device. Unused bytes are zero-padded. Model_Num (unsigned eight-bit array of 15 elements)--An array of 15 eight-bit integers (0 to 255) representing the model number of the device. Unused bytes are zero-padded. Core_Ver (unsigned eight-bit array of two elements)--A pair of two eight-bit integers (0 to 255) representing the core firmware version. The first element corresponds to the major version and the second to the minor version (for example, 1.10). Unused bytes are zero-padded. App_Ver (unsigned eight-bit array of two elements)--A pair of two eight-bit integers (0 to 255) representing the application firmware version. The first element corresponds to the major version and the second to the minor version (for example, 1.10). Unused bytes are zero-padded. The numeric values of the bytes representing the serial, model, and version numbers are ASCII codes of equivalent character bytes. Therefore, U8 data can be directly translated into ASCII character data for display to the user.

STATUS?

Description	Query the status register value
Parameters	NA
Parameter Description	NA

Command packet

OPCODE	Length	Parameters
0x02	0x00	

Response packet

OPCODE	Length	Parameters
0x82	0x01	U8 Status_reg Status_reg (unsigned eight-bit)--Current binary value of the Module Status Register (MSR), as indicated in the following table.

Bit	7	6	5	4	3	2	1	0
Function	ERR	EQO	ALRM	OPP				
R/W	R	R	R	R	R	R	R	R
Initial value	0	0	0	0	0	0	0	0

ERR (ERROR, bit 7)--This bit indicates that an error code has been written to the error queue. It is cleared when the error queue is cleared.

EQO (ERROR QUEUE OVERFLOW, bit 6)--This bit indicates that more than eight errors have occurred and the error queue has overflowed. It is cleared when the error queue is read at least once and can hold another error code.

ALRM (ALARM, bit 5)--This bit indicates that a bit in the alarm register is set. It is cleared when the alarm register is cleared.

OPP (OPERATION IN PROGRESS, bit 4)--This bit indicates that a critical operation is in process. It is cleared when the operation is complete.

ALARM?

Description	Query the alarm register value
Parameters	NA
Parameter Description	NA

Command packet

OPCODE	Length	Parameters
0x03	0x00	

Response packet

OPCODE	Length	Parameters
0x83	0x02	U16 Alarm_reg Alarm_reg (unsigned 16-bit)--Current binary value of the Alarm Register (AR), as indicated in the following table

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Function	EPV	OT	UT	CFO												
R/W	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Initial value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EPV (EEPROM VERIFY FAIL, bit 15)--This bit indicates that the verify operation of an EEPROM write failed. It is cleared when the AR is read.

OT (OVER TEMPERATURE, bit 14)--This bit indicates that ambient temperature of the module has exceeded the high temperature threshold for a period of at least 10 seconds. It is cleared when the temperature falls below the high temperature threshold.

UT (UNDER TEMPERATURE, bit 13)--This bit indicates that ambient temperature of the module has dropped below the low temperature threshold for a period of at least 10 seconds. It is cleared when the temperature falls below the high temperature threshold.

CFO (CONFIGURATION OVERFLOW, bit 12)--This bit indicates that user configuration commands have been executed more than 50,000 times. This bit is not cleared when the configuration command counter exceeds 50,000. This bit can only be cleared at the JDS Uniphase factory.

LERROR?

Description	Read and clear last error message in the error queue
Parameters	NA
Parameter Description	NA

Command packet

OPCODE	Length	Parameters
0x04	0x00	

Response packet

OPCODE	Length	Parameters
0x84	0x01	U8 Error_code Error_Code (unsigned eight-bit)--Error code represents the last error that occurred, as indicated in the following table

Error Code	Description
0 (0x00)	No error--OK
1 (0x01)	Invalid command opcode
2 (0x02)	Command packet length mismatch
3 (0x03)	Invalid packet length
4 (0x04)	Invalid command packet parameter
5 (0x05)	EEPROM write failure
6 (0x06)	Switch 1 failure
7 (0x07)	Switch 2 failure
8 (0x08)	Switch 3 failure
9 (0x09)	Switch 4 failure
10 (0x0A)	Invalid spare channel
11 (0x0B)	Communication interface receive time-out
12 (0x0C)	Communication interface transmit time-out
13 (0x0D)	Communication packet invalid
14 (0x0E)	Communication receive run-on condition
15 (0x0F)	Communication transmit run-on condition
16 (0x10)	Communication invalid transmit operation initiated by master

(table continued)

Error Code	Description
17 (0x11)	Communication transmit attempts exceed limit--transmit operation aborted
18 (0x12)	Communication invalid STROBE received
19 (0x13)	RS485 link-layer packet CRC mismatch
20 (0x14)	RS485 invalid link-layer packet length
21 (0x15)	RS485 invalid link-layer packet type
22 (0x16)	RS485 invalid source address
23 (0x17)	RS485 link-layer packet ACK transmit timeout
24 (0x18)	RS485 link-layer packet ACK receive timeout
25 (0x19)	RS485 link-layer ACK expected but DATA packet received
26 (0x1A)	RS485 unexpected ACK packet received
27 (0x1B)	UART overrun (bytes missed in serial receive)
28 (0x1C)	Undefined error

EQCLEAR

Description	Erase all entries in the error queue
Parameters	NA
Parameter Description	NA

Command packet

OPCODE	Length	Parameters
0x05	0x00	

TEMP?

Description	Query temperature information
Parameters	NA
Parameter Description	NA

Command packet

OPCODE	Length	Parameters
0x06	0x00	

Response packet

OPCODE	Length	Parameters
0x86	0x06	U16 Hi_temp, U16 Low_temp, U16 Temp Hi_temp (unsigned 16-bit)--Configured high temperature threshold (234 – 353 °K) Low_temp (unsigned 16-bit)--Configured low temperature threshold (233 – 352 °K) Temp (unsigned 16-bit)--Actual ambient temperature (233 – 353 °K) Temperature (°C) = Temperature (°K) - 273 All temperature information is referenced in degrees Kelvin. Conversions are as follows: 1 °C = 1 °K and 0 °C = 273 °K approximately 1 °F = 0.55 °K and 0 °F = 255.37 °K

STIMER?

Description	Query the system timer. System time is defined from the last reset (includes power cycle and hard or soft reset).
Parameters	NA
Parameter Description	NA

Command packet

OPCODE	Length	Parameters
0x0B	0x00	

Response packet

OPCODE	Length	Parameters

0x0B	0x07	U16 Msec, U8 Sec, U8 Min, U16 Hour, U8 Year
		
		Msec (unsigned 16-bit)--The current millisecond timer index (0 to 999).
		
		Sec (unsigned eight-bit)--The current second timer index (0 to 59).
		
		Min (unsigned eight-bit)--The current minute timer index (0 to 59).
		
		Hour (unsigned 16-bit)--The current hour timer index (0 to 8759).
		
		Year (unsigned eight-bit)--The current year timer index (0 to 255).
		
		The system timer is returned as seven bytes as described previously. These bytes can be extracted into a “C” structure, for example, as follows:
		
		`struct TIMER  /* define system timer struct */`
		`{`
		`  U16_t Msec;  /* milliseconds */`
		`  U8_t Sec ;  /* seconds */`
		`  U8_t Min ;  /* minutes */`
		`  U16_t Hour;  /* hours */`
		`  U8_t Year;  /* years (approx. 8760 hours) */`
		`};`

RESET_STIMER

Description	Reset the system timer to 0
Parameters	NA
Parameter Description	NA

Command packet

OPCODE	Length	Parameters
0x0C	0x00	

SWITCH

Description	Modify logical switch state
Parameters	Switch, Input, Output
Parameter Description	Switch (unsigned eight-bit)--switch number Input (unsigned eight bit)--input channel Output (unsigned eight bit)--output channel

Command packet

OPCODE	Length	Parameters
0x20	0x03	U8 Switch, U8 Input, U8 Output Switch (unsigned eight-bit)--Logical switch number upon which to perform action (for example, 1 to 4) Input (unsigned eight-bit)--Input channel to connect (for example, 1 on a 1xN switch) Output (unsigned eight-bit)--Output channel to connect specified input channel, where 0 = reset position (factory configured to be a null connect, but this can have been changed by user) 1 to 200 = output channel number 254 = previous channel; ignored if the switch is on the first channel 255 = next channel; ignored if the switch is on the last channel

SWITCH?

Description	Query logical switch state
Parameters	Switch, Input
Parameter Description	Switch (unsigned eight-bit)--switch number Input (unsigned eight-bit)--input channel number

Command packet

OPCODE	Length	Parameters
0x21	0x02	U8 Switch, U8 Input Switch (unsigned eight-bit)--Logical switch number upon which to read information (for example, 1 to 4) Input (unsigned eight-bit)--Input channel to find connection of

Response packet

OPCODE	Length	Parameters
0xA1	0x01	U8 Output Output (unsigned eight-bit)--The output channel connected to the input channel specified

NUM_SWITCH?

Description	Query number of logical switches
Parameters	NA
Parameter Description	NA

Command packet

OPCODE	Length	Parameters
0x22	0x00	

Response packet

OPCODE	Length	Parameters
0xA2	0x01	U8 Switches Switches (unsigned eight-bit)--The number of logical switches in the module (for example, 1 to 4)

LEARN?

Description	Query command(s) required to return the switch to current state following reset. This query returns the information required to send the switch back to the state it was in prior to reset.
Parameters	NA
Parameter Description	NA

Command packet

OPCODE	Length	Parameters
0x24	0x00	

Response packet

OPCODE	Length	Parameters
0xA4	0x04 to 0x0F[1]	(1-4) * (U8 Opcode, U8 Sw_Id, U8 Cur_In, U8 Cur_Out) Opcode (unsigned eight-bit)--“SWITCH” command opcode (0x20) Sw_Id (unsigned eight-bit)--Switch number (1 to 4) Cur_In (unsigned eight-bit)--Current input channel of the switch (1 to 2) Cur_Out (unsigned eight-bit)--Current output channel of the switch (0 to 200)

[1] The length is variable, depending on the number of switches in the module.

TST?

Description	Perform a self-test operation and return results
Parameters	NA
Parameter Description	NA

Command packet

OPCODE	Length	Parameters
0x25	0x00	

Response packet

OPCODE	Length	Parameters
0xA5	0x01 to 0x04[1]	U8 Sw1_Result, U8 Sw2_Result, U8 Sw3_Result, U8 Sw4_Result, Sw1_Result (unsigned eight-bit)--Self-test result (0/1, where 0 = pass and 1 = fail) Sw2_Result (unsigned eight-bit)--Self-test result (0/1, where 0 = pass and 1 = fail) (if necessary) Sw3_Result (unsigned eight-bit)--Self-test result (0/1, where 0 = pass and 1 = fail) (if necessary) Sw4_Result (unsigned eight-bit)--Self-test result (0/1, where 0 = pass and 1 = fail) (if necessary)

[1] The length is variable, depending on the number of switches in the module.

SAVE

Description	Save the current state of all switches at one of 10 locations
Parameters	Location
Parameter Description	Location (unsigned eight-bit)--Memory location to save state

Command packet

OPCODE	Length	Parameters
0x26	0x01	U8 Location Location (unsigned eight-bit)--Memory location of state data (0 to 9)

RECALL

Description	Recall a module state previously saved
Parameters	Location
Parameter Description	Location (unsigned eight bit)--memory location

Command packet

OPCODE	Length	Parameters
0x27	0x01	U8 Location Location (unsigned eight-bit)--Memory location of state data (0 to 9)

Configuration Commands

SKB configuration commands are operations and queries that allow users to modify basic instrument settings.

CONFIG?

Description	Query the configuration of all logical switches
Parameters	NA
Parameter Description	NA

Command packet

OPCODE	Length	Parameters
0x23	0x00	

Response packet

OPCODE	Length	Parameters
0xA3	0x04 to 0x0F[1]	(1-4) * (U8 Sw_Id, U8 Sw_Type, U8 Max_In, U8 Max_Out) Sw_Id (unsigned eight-bit)--Logical switch identification number (1 to 4) Sw_Type (unsigned eight-bit)--Physical switch type (0:motor or 1:relay) Max_In (unsigned eight-bit)--Maximum number of inputs of the switch (1 to 2) Max_Out (unsigned eight-bit)--Maximum number of outputs of the switch (1 to 200)

[1] The length is variable, depending on the number of switches in the module.

HITEMP

Description	Set the upper temperature threshold
Parameters	Temp
Parameter Description	Temp (unsigned 16-bit)--The °K high temperature threshold that, if exceeded, causes the OT alarm register bit to be set

Command packet

OPCODE	Length	Parameters
0x07	0x02	U16 Hi_temp Hi_temp (unsigned 16-bit)--High temperature threshold (234 to 353 °K) All temperature information is referenced in degrees Kelvin. Conversions are as follows: 1 °C = 1 °K and 0 °C = 273 °K approximately 1 °F = 0.55 °K and 0 °F = 255.37 °K

LOWTEMP

Description	Set the lower temperature threshold
Parameters	Temp
Parameter Description	Temp (unsigned eight-bit)--The °K low temperature threshold that, if exceeded, causes the UT alarm register bit to be set

Command packet

OPCODE	Length	Parameters
0x08	0x02	U16 Low_temp Low_temp (unsigned 16-bit)--Low temperature threshold (233 to 352 °K)

SPARES?

Description	Query the current number of spare fibers available on the logical switch specified
Parameters	Switch
Parameter Description	Switch (unsigned eight-bit)--logical switch

Command packet

OPCODE	Length	Parameters
0x30	0x01	U8 Switch Switch (unsigned eight-bit)--Logical switch number (1 to 4)

Response packet

OPCODE	Length	Parameters
0xB0	0x01	U8 Spares Spares (unsigned eight-bit)--The number of spare channels currently configured for the switch

REPLACE

Description	Replace output channel with factory spare
Parameters	Switch, Output, Spare
Parameter Description	Switch (unsigned eight-bit)--switch number Output (unsigned eight-bit)--channel number to be replaced Spare (unsigned eight-bit)--factory spare number

Command packet

OPCODE	Length	Parameters
0x33	0x3	U8 Switch, U8 Output, U8 Spare Switch (unsigned eight-bit)--Logical switch number (1 to 4) Output (unsigned eight-bit)--The replaced output channel (1 to 200) Spare (unsigned eight-bit)--The factory spare number used for the replacement (1 to 200) This command resets the switch.

SWAP_CHANNEL

Description	Swap channel designations between two optical fibers. This command can be used to reorder channels when the channels have been spliced into the system incorrectly. The factory-configured order also can be recalled.
Parameters	Switch, Output1, Output2
Parameter Description	Switch (unsigned eight-bit)--switch number Output1 (unsigned eight-bit)--first output channel Output2 (unsigned eight-bit)--second output channel

Command packet

OPCODE	Length	Parameters
0x34	0x03	U8 Switch, U8 Output1, U8 Output2 Switch (unsigned eight-bit)--Logical switch number (1 to 4) Output1 (unsigned eight-bit)--The first output channel (1 to 200) Output2 (unsigned eight-bit)--The second output channel (1 to 200) This command resets the switch.

LATCHING?

Description	Query latching status of the switch
Parameters	Switch
Parameter Description	Switch (unsigned eight-bit)--switch number

Command packet

OPCODE	Length	Parameters
0x35	0x01	U8 Switch Switch (unsigned eight-bit)--Logical switch number (1 to 4)

Response packet

OPCODE	Length	Parameters
0xB3	0x01	U8 Latching_Status Latching_Status (unsigned eight-bit)--The status of the switch (latching or not: 1/0 respectively)

RESET_CHANNEL?

Description	Query output channel associated with the reset position for the selected switch
Parameters	Switch
Parameter Description	Switch (unsigned eight-bit)--switch number

Command packet

OPCODE	Length	Parameters
0x36	0x01	U8 Switch Switch (unsigned eight-bit)--Logical switch number (1 to 4)

Response packet

OPCODE	Length	Parameters
0xB6	0x01	U8 Output_Channel Output_Channel (unsigned eight-bit)--The output channel associated with the reset position (0 to 200)

RESET_CHANNEL

Description	Define the reset output channel
Parameters	Reset_Channel
Parameter Description	Reset_Channel (unsigned eight-bit)--Output channel number to be associated with the reset channel

Command packet

OPCODE	Length	Parameters
0x37	0x02	U8 Switch, U8 Reset_Channel Reset_Channel (unsigned eight-bit)--The output channel to be associated with the reset position (0 to 200) The reset channel is defined in reference to input port 1. This command resets the switch.

RECALL_FAC_SETTING

Description	Recall the original factory setting of the switch
Parameters	Switch
Parameter Description	Switch (unsigned eight-bit)--switch number

Command packet

OPCODE	Length	Parameters
0x38	0x01	U8 Switch Switch (unsigned eight-bit)--Logical switch number (1 to 4) This command resets the switch. The setting is modified with the MODIFY_SPEED, RESET_CHANNEL, REPLACE, and SWAP_CHANNEL commands. Commands are reset to factory defaults.

SPEED?

Description	Query the speed of the switch
Parameters	Switch
Parameter Description	Switch (unsigned eight-bit)--switch number

Command packet

OPCODE	Length	Parameters
0x39	0x01	U8 Switch Switch (unsigned eight-bit)--Logical switch number (1 to 4)

Response packet

OPCODE	Length	Parameters
0xB9	0x01	U8 Speed Speed (unsigned eight-bit)--The speed setting of the switch (1 to 5) 1 is the slowest speed with the highest repeatability. Only speeds 1 and 2 are implemented at this time.

MODIFY_SPEED

Description	Modify the speed setting of the specified switch
Parameters	Switch, Speed
Parameter Description	Switch (unsigned eight-bit)--switch number Speed (unsigned eight-bit)--speed setting for specified switch

Command packet

OPCODE	Length	Parameters
0x3A	0x02	U8 Switch, U8 Speed Switch (unsigned eight-bit)--Logical switch number (1 to 4) Speed (unsigned eight-bit)--The speed setting of the switch (1 to 5) 1 is the slowest speed with the highest repeatability. Only speeds 1 and 2 are implemented at this time.

CONNECTION_TIME?

Description	Query the time to connect two channels, in ms. This test breaks the current connection. The SKB switch allows the user to confirm the specified time to switch between channels. The CONNECTION_TIME? query physically checks the time by switching between the start and destination channel and outputs the results from the internal clock.
Parameters	U8 Switch, U8 Start, U8 Destination
Parameter Description	Switch (unsigned eight-bit)--switch number Start (unsigned eight-bit)--output channel to begin measurement Destination (unsigned eight-bit)--destination output channel

Command packet

OPCODE	Length	Parameters
0x3B	0x03	U8 Switch, U8 Start, U8 Destination Switch (unsigned eight-bit)--Logical switch number (1 to 4) Start (unsigned eight bit)--The output channel of the specified switch where measurement begins Destination (unsigned eight-bit)--The destination output channel on the specified switch

Response packet

OPCODE	Length	Parameters
0xBB	0x02	U16 Interval Interval (unsigned 16-bit)--In ms

SET_DEVICE_ADDRESS

Description	Modify the RS485 network address of the switch
Parameters	Address
Parameter Description	Address (unsigned eight-bit)--device address

Command packet

OPCODE	Length	Parameters
0x3D	0x01	U8 Address Address (unsigned eight-bit)--Network address (2 to 31)

DEVICE_ADDRESS?

Description	Query the RS485 network address of the device
Parameters	NA
Parameter Description	NA

Command packet

OPCODE	Length	Parameters
0x3E	0x00	

Response packet

OPCODE	Length	Parameters
0xBE	0x01	U8 Address Address (unsigned eight-bit)--Network address (2 to 31)

SET_TRIGGER_CMD

Description	Set the trigger command
Parameters	Opcode, Param1, Param2, Param3
Parameter Description	Opcode (unsigned eight-bit)--opcode of command to be executed Param1, Param2, Param3 (unsigned eight-bits)--first, second, and third parameter of the selected command (number of parameters ranges from 0 to 3 depending of the selected command)

Command packet

OPCODE	Length	Parameters
0x3F	0x01 to 0x04[1]	U8 Opcode, U8 Param1, U8 Param2, U8 Param3 Opcode (unsigned eight-bit)--Opcode of the command selected to be executed as part of the trigger command (0x20 to 0x27) Param1 (unsigned eight-bit)--Parameter 1 (if necessary) (0 to 9) Param2 (unsigned eight-bit)--Parameter 2 (if necessary) (1 to 2) Param3 (unsigned eight-bit)--Parameter 3 (if necessary) (1 to 200)

[1] The length is variable, depending on the selected command.

TRIGGER_CMD?

Description	Query the trigger command
Parameters	NA
Parameter Description	NA

Command packet

OPCODE	Length	Parameters
0x40	0x00	

Response packet

OPCODE	Length	Parameters
0xC0	0x01 to 0x04[1]	U8 Opcode, U8 Param1, U8 Param2, U8 Param3 Opcode (unsigned eight-bit)-- Opcode of the command selected to be executed as part of the trigger command (0x20 to 0x27) Param1 (unsigned eight-bit)--Parameter 1 (if necessary) (0 to 9) Param2 (unsigned eight-bit)--Parameter 2 (if necessary) (1 to 2) Param3 (unsigned eight-bit)--Parameter 3 (if necessary) (1 to 200)

[1] The length is variable, depending on the selected command.

Controlling the Switch using a Printer Port

The switch can be controlled with an enhanced parallel port (EPP) of a personal computer.

Setting the Computer to EPP Mode

In order to interface with the SKB switch via the computer parallel port, it is necessary to make the data lines bidirectional. This action is accomplished by using a parallel port that is configured to be operating in EPP mode.

To set the PC to EPP mode:

1. Use the PC operating manual and configure the parallel port for EPP, entering into the computers BIOS mode/setup and changing (or confirming) the port.

Using the Printer Port

To use the printer port with the switch:

1. Construct a cable wired as outlined in Table 11.

Table 11: Cable Wiring for Printer Port Use

Printer Signal Name	Register Bit (Hex Address) Bit Number	PC Connector Pin	SKB Pin	SKB Signal Name
Line Feed	(37A) 1[1]	14	20	/STROBE
Data 0	(378) 0	2	14	D0
Data 1	(378) 1	3	2	D1
Data 2	(378) 2	4	3	D2
Data 3	(378) 3	5	16	D3
Data 4	(378) 4	6	17	D4
Data 5	(378) 5	7	5	D5
Data 6	(378) 6	8	6	D6
Data 7	(378) 7	9	19	D7
PE	(37B) 5	12	8	BUSY
STROBE	(37A) 0[1]	1	12	R/W
SLCT	(37B) 4	13	9	ERROR
SLIN	(37A) 3[1]	17	22	/HOME
INIT	(37A) 2[1]	16	11	/SOP

(table continued)

Printer Signal Name	Register Bit (Hex Address) Bit Number	PC Connector Pin	SKB Pin	SKB Signal Name
Printer Port Ground[2]		18, 19, 20, 21, 22, 23, 24, 25	1, 4, 7, 10, 13, 15, 18, 21, 24	Shield[2]
			Power Source Ground	Power Ground

[1] Invert the signals on these lines.
[2] Connect these lines with the shield lines wrapped around the signal lines.

2. Connect the cable between the printer port and the parallel interface connector of the SKB switch.

3. Connect a 5 V power source to the serial power connector of the SKB switch.