7.5 DATA PACKETS

Packets which have addresses in the range 1 to 255 are routed to the SpaceWire ports and the external ports dependent on the packet address. Data packets have an address header byte a cargo field and an end of packet marker. The normal packet structure is show below.
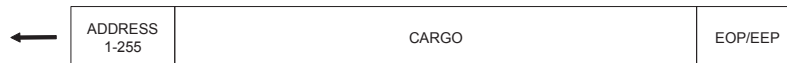
ADDRESS 1-255	CARGO	EOP/EEP

Figure 7-1 Normal router data packets

7.6 COMMAND PACKETS

Command packets are routed to the internal configuration port when the packet address is zero. Command packets perform write and read operations to registers in the SpaceWire router. Command packets accepted by the SpaceWire router are in the form shown in Figure 7-2.

Configuration read packets are in the form:

ADDRESS 0	COMMAND	EOP

Figure 7-2 Command Packet Format

The SpaceWire router supports the Remote Memory Access Protocol (RMAP) [AD2] for configuration of the internal router control registers and monitoring of the router status.

The following sections define the RMAP commands which are supported and the format of the RMAP commands used by the SpaceWire Router.

7.6.1 Supported Commands

The RMAP Command set is listed in Table 7-4 and the supported RMAP commands are defined. The commands which are not used are depicted with a grey background.

Table 7-4 Supported RMAP Command Codes		
RMAP Command Code	**Description**	**Supported in SpaceWire Router**
"0000"	*Not used*	-
"0001"	*Not used*	-
"0010"	Read single address	Yes
"0011"	Read incrementing address	Yes
"0100"	*Not used*	-
"0101"	*Not used*	-
"0110"	*Not used*	-
"0111"	Read-modify-write incrementing address	Yes
"1000"	Write single address, no verify, no acknowledge	No
"1001"	Write incrementing address, no verify, no acknowledge.	No
"1010"	Write single address, no verify, send acknowledge	No
"1011"	Write incrementing address, no verify, send acknowledge.	No
"1100"	Write single address, verify data, no acknowledge	No
"1101"	Write incrementing address, verify data, no acknowledge.	No
"1110"	Write single address, verify data, send acknowledge	Yes
"1111"	Write incrementing address, verify data, send acknowledge.	No

7.6.2 Read Command

The read single address characteristics of the SpaceWire router are defined in Table 7-5.

Table 7-5 Read Single Address Characteristics			
Action	Supported/ Not Supported	Maximum number of bytes	Non-aligned access accepted
8-bit read	NS	-	-
16-bit read	NS	-	-
32-bit read	S	4	No
64-bit read	NS	-	-
Word or byte address	32-bit aligned		
Accepted Logical Addresses	0xFE		
Accepted destination keys	0x20 at power on.		
Accepted address ranges	0x00 0000 0000 – 0x00 0000 0109		
Address Incrementation	No		

The RMAP read single address command is supported in the SpaceWire router. The single address command is used to read a single 32 bit register location from the router registers.

In Figure 7-3 the format of a read single address command is illustrated. The first byte received by the SpaceWire router configuration logic is the port address followed by the destination logical address. Fields which are depicted in bold text are expected values. Fields which are shaded are optional.
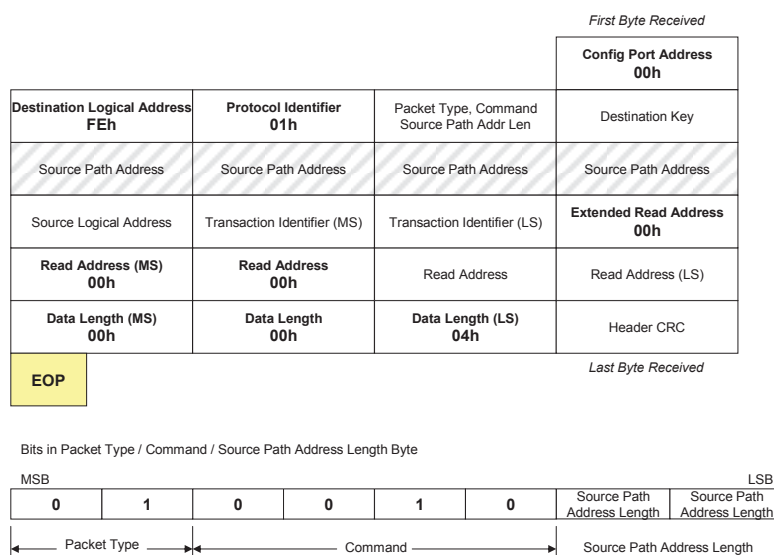
			First Byte Received
			Config Port Address **00h**
Destination Logical Address **FEh**	**Protocol Identifier** **01h**	Packet Type, Command Source Path Addr Len	Destination Key
Source Path Address	Source Path Address	Source Path Address	Source Path Address
Source Logical Address	Transaction Identifier (MS)	Transaction Identifier (LS)	**Extended Read Address** **00h**
Read Address (MS) **00h**	**Read Address** **00h**	Read Address	Read Address (LS)
Data Length (MS) **00h**	**Data Length** **00h**	**Data Length (LS)** **04h**	Header CRC
EOP			Last Byte Received

Bits in Packet Type / Command / Source Path Address Length Byte

MSB							LSB
0	1	0	0	1	0	Source Path Address Length	Source Path Address Length

Packet Type — Command — Source Path Address Length

Figure 7-3 Read Single Address Command Format

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Field	Description	Bytes
	Table 7-6 Read Single Address Command Packet Fields	
Config Port Address	The configuration port address field routes the packet to the configuration port of the router. The configuration port address (00h) is always present when configuring the SpaceWire Router.	1
Destination Logical Address	The destination logical address field is not used in the SpaceWire Router. The SpaceWire router accepts packets which have the default destination logical address of 254h (FEh).	1
Protocol Identifier	The RMAP protocol identifier is 01h.	1
Command Byte	The command byte indicates a read single address packet. The Source path address length fields are set to the number of source path addresses required as defined in section 7.6.9.	1
Destination Key	The destination key identifier must match the contents of the destination key register, see section 9.5.10. The default (power-on) destination key is 20h.	1
Source Path Address	The source path address field is used to add source path addresses to the head of the reply packet. The expected number of source path addresses is specified in the command byte. See section 7.6.9 for source path address decoding.	0,4,8,12
Source Logical Address	The source logical address should be set to the logical address of the node which sent the command.	1
Transaction Identifier	The transaction identifier identifies the command packet and reply packet with a unique number.	2
Extended Read Address	The extended read address is not used in the SpaceWire router and shall always be set to zero.	1
Read Address	The read address identifies the register address to read from. The valid read addresses are defined in section 9.	4
Data	The data length of a read single address command shall be set to 4 to read	3

Length	one 32 bit register location.	
Header CRC	The header CRC is the eight bit CRC code used to detect errors in the command packet. The CRC code is checked before the command is executed	1

In Figure 7-4 the format of the reply to a read single address command is illustrated. The first byte sent by the SpaceWire router configuration logic is the port address followed by the destination logical address. Fields which are depicted in bold text are expected values. Fields which are shaded are optional. Note that the reply is always sent out of the same port as the command was received on. The Source Path Address should not include the output port of the router being commanded as the reply will be automatically sent out of the same port that the command arrived on. See section 7.6.8.
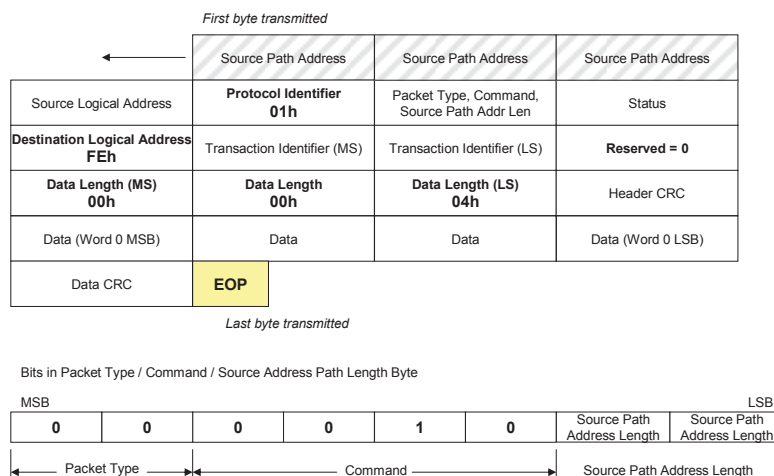

Figure 7-4 Read Single Address Reply Packet Format

Table 7-7 Read Single Address Reply Packet Fields		
Field	**Description**	**Bytes**
Source Path Address	Optional source path addresses specified in the command packet. If no source path addresses are specified then the first byte will be the source logical address.	>=0
Source Logical Address	The source logical address specified in the command packet. If source path addresses are not used then the source logical address is the address of the return packet.	1

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Protocol Identifier	The RMAP protocol identifier value 01h.	1
Command Byte	Read single address reply command byte. The packet type bits in the command byte indicate this packet is a response packet.	1
Status	The command status is returned in this field. The command status can be command successful or an RMAP error code as defined in section 7.6.6.	1
Destination logical address	The destination logical address is set to the default value FEh as the SpaceWire router does not have a logical address.	1
Transaction Identifier	The transaction identifier identifies the command packet and reply packet with a unique number. The transaction identifier in the reply packet is copied from the command packet and returned in this field, so that the command and the corresponding reply have the same transaction identifier value.	2
Data Length	The data length field is set to 4 bytes as this is a single read command.	3
Header CRC	The header CRC used to detect errors in the header part of the command packet. See section 7.6.7 for CRC generation.	1
Data	The data read from the registers in the device.	4
Data CRC	The data CRC used to detect errors in the data part of the reply packet. See section 7.6.7 for CRC generation.	1

7.6.3 Read Incrementing Command

The read incrementing address characteristics of the SpaceWire router are defined in Table 7-8.

Table 7-8 Read Incrementing Address Characteristics			
Action	Supported/ Not Supported	Maximum number of bytes	Non-aligned access accepted
8-bit read	NS	-	-
16-bit read	NS	-	-
32-bit read	S	1064	No
64-bit read	NS	-	-
Word or byte address	32-bit aligned		
Accepted Logical Addresses	0xFE		
Accepted destination keys	0x20 at power on		
Accepted address ranges	0x00 0000 0000 – 0x00 0000 0109		
Incrementing address	Incrementing address only		

The RMAP read incrementing address command is supported in the SpaceWire router. The read incrementing address is used to read a continuous block of registers from the SpaceWire router, e.g. the complete group adaptive routing table can be read in one command or all the status registers for the SpaceWire links can be read in one command.

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In Figure 7-5 the first byte received by the SpaceWire router configuration logic is the port address followed by the destination logical address. Fields which are depicted in bold text are expected values. Fields which are shaded are optional.
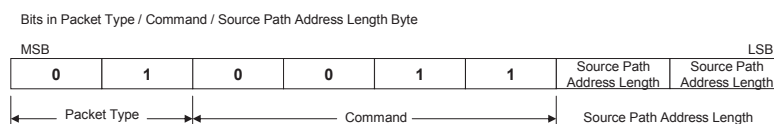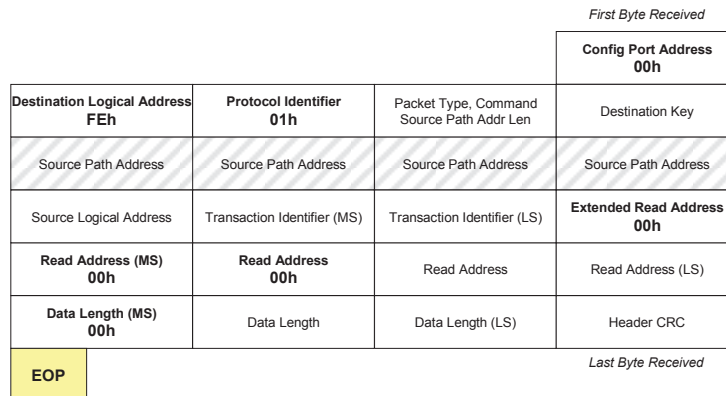

			First Byte Received
			Config Port Address 00h
Destination Logical Address FEh	**Protocol Identifier 01h**	Packet Type, Command Source Path Addr Len	Destination Key
Source Path Address	Source Path Address	Source Path Address	Source Path Address
Source Logical Address	Transaction Identifier (MS)	Transaction Identifier (LS)	**Extended Read Address 00h**
Read Address (MS) 00h	**Read Address 00h**	Read Address	Read Address (LS)
Data Length (MS) 00h	Data Length	Data Length (LS)	Header CRC
EOP			*Last Byte Received*

Bits in Packet Type / Command / Source Path Address Length Byte

MSB							LSB
0	**1**	**0**	**0**	**1**	**1**	Source Path Address Length	Source Path Address Length
Packet Type		Command				Source Path Address Length	

Figure 7-5 Read Incrementing Address Command Format

Table 7-9 Read Incrementing Address Command Packet Fields		
Field	**Description**	**Bytes**
Config Port Address	The configuration port address field routes the packet to the configuration port of the router. The configuration port address is always present when configuring the SpaceWire Router.	1
Destination Logical Address	The destination logical address is not used in the SpaceWire Router. The SpaceWire router accepts packets which have the default destination logical address of 254h (FEh).	1
Protocol Identifier	The RMAP protocol identifier is 01h.	1
Command Byte	The command byte indicates a read incrementing packet. The Source path address length fields are set to the number of source path addresses required as defined in section 7.6.9.	1

Destination Key	The destination key identifier must match the contents of the destination key register, see section 9.5.10.	1
Source Path Address	The source path address field is used to add source path addresses to the head of the reply packet. The expected number of source path addresses is specified in the command byte. See section 7.6.9 for source path address decoding.	0,4,8,12
Source Logical Address	The source logical address should be set to the logical address of the node which sent the command or it should be set to the default value of FEh.	1
Transaction Identifier	The transaction identifier identifies the command packet and reply packet with a unique number.	2
Extended Read Address	The extended read address is not used in the SpaceWire router and shall always be set to zero.	1
Read Address	The read address identifies the start address for the read incrementing command. The valid starting read addresses are defined in section 9.	4
Data Length	The data length defines the number of bytes to read from the router. Valid data lengths are in the range 4-1064. 1064 allows the all the router registers to be read in one command. If the data length field is not a multiple of four bytes then the command is rejected by the SpaceWire router.	3
Header CRC	The header CRC is the eight bit CRC code used to detect errors in the command packet. The CRC code is checked before the command is executed.	1

In Figure 7-6 the format of the reply to a read incrementing address command is illustrated. The first byte sent by the SpaceWire router configuration logic is the port address followed by the destination logical address. Fields which are depicted in bold text are expected values. Fields which are shaded are optional. Note that the reply is always sent out of the same port as the command was received on. The Source Path Address should not include the output port of the router being commanded as the reply will be automatically sent out of the same port that the command arrived on. See section 7.6.8.
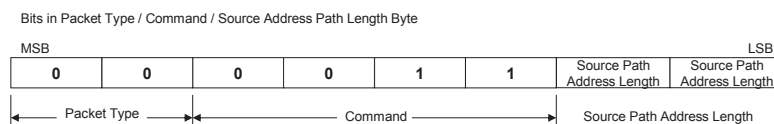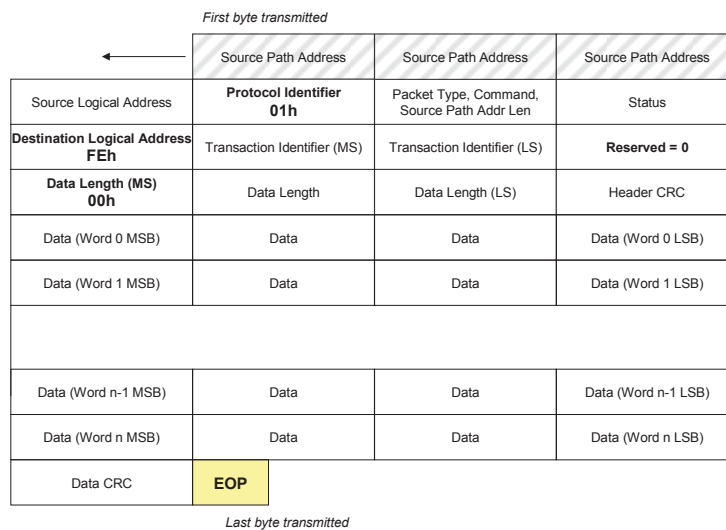
First byte transmitted

	Source Path Address	Source Path Address	Source Path Address
Source Logical Address	**Protocol Identifier 01h**	Packet Type, Command, Source Path Addr Len	Status
Destination Logical Address FEh	Transaction Identifier (MS)	Transaction Identifier (LS)	**Reserved = 0**
Data Length (MS) 00h	Data Length	Data Length (LS)	Header CRC
Data (Word 0 MSB)	Data	Data	Data (Word 0 LSB)
Data (Word 1 MSB)	Data	Data	Data (Word 1 LSB)
Data (Word n-1 MSB)	Data	Data	Data (Word n-1 LSB)
Data (Word n MSB)	Data	Data	Data (Word n LSB)
Data CRC	**EOP**		

Last byte transmitted

Bits in Packet Type / Command / Source Address Path Length Byte

MSB   LSB

0	**0**	**0**	**0**	**1**	**1**	Source Path Address Length	Source Path Address Length
Packet Type			Command			Source Path Address Length	

Figure 7-6 Read Incrementing Address Reply Packet Format

Table 7-10 Read Incrementing Address Reply Packet Fields		
Field	**Description**	**Bytes**
Source Path Address	Optional source path addresses specified in the command packet. If no source path addresses are specified then the first byte will be the source logical address.	0-12
Source Logical Address	The source logical address specified in the command packet. If source path addresses are not used then the source logical address is the address of the return packet.	1
Protocol Identifier	The RMAP protocol identifier value 01h.	1

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Command Byte	Read incrementing address reply command byte. The packet type bits in the command byte indicate this packet is a reply packet.	1
Status	The command status is returned in this field. The command status can be command successful or an RMAP error code as defined in section 7.6.6.	1
Destination logical address	The destination logical address is set to the default value FEh as the SpaceWire router does not have a logical address.	1
Transaction Identifier	The transaction identifier identifies the command packet and reply packet with a unique number. The transaction identifier in the reply packet is copied from the command packet and returned in this field, so that the command and the corresponding reply have the same transaction identifier value.	2
Data Length	The data length field is the number of bytes read from the router as specified in the data length field of the command packet.	3
Header CRC	The header CRC used to detect errors in the header part of the command packet. See section 7.6.7 for CRC generation.	1
Data	The data read from the registers in the device. The data is returned in 32 bit words starting from the address specified in read address in the command packet.	>=4
Data CRC	The data CRC used to detect errors in the data part of the reply packet. See section 7.6.7 for CRC generation.	1

7.6.4 Read Modify Write Command

The read-modify-write command characteristics are defined in Table 7-8.

Table 7-11 Read-Modify-Write Command Characteristics			
Action	Supported/ Not Supported	Maximum number of bytes	Non-aligned access accepted
8-bit read-modify-write	NS	-	-
16-bit read-modify-write	NS	-	-

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32-bit read-modify-write	S	4	No
64-bit read-modify-write	NS	-	-
Word or byte address	32-bit aligned		
Accepted Logical Addresses	0xFE		
Accepted destination keys	0x20 at power on		
Accepted address ranges	0x00 0000 0000 – 0x00 0000 0109		
Incrementing address	No		

The RMAP read-modify-write command is supported by the SpaceWire router. The read modify write command is used to set or reset a single or number of bits in a router register. The Read-Modify-Write command is useful when it is desirable to set a link register setting without upsetting the other settings in one command, i.e. set the start bit without modifying the data rate.

In Figure 7-7 the first byte received by the SpaceWire router configuration logic is the port address followed by the destination logical address. Fields which are depicted in bold text are expected values. Fields which are shaded are optional.
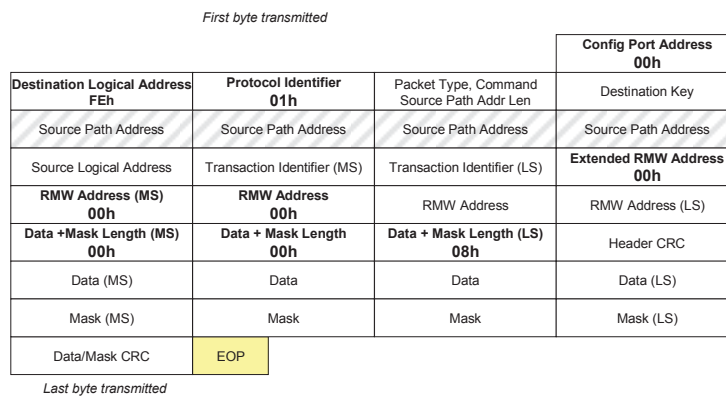
First byte transmitted

			Config Port Address 00h
Destination Logical Address FEh	Protocol Identifier 01h	Packet Type, Command Source Path Addr Len	Destination Key
Source Path Address	Source Path Address	Source Path Address	Source Path Address
Source Logical Address	Transaction Identifier (MS)	Transaction Identifier (LS)	Extended RMW Address 00h
RMW Address (MS) 00h	RMW Address 00h	RMW Address	RMW Address (LS)
Data +Mask Length (MS) 00h	Data + Mask Length 00h	Data + Mask Length (LS) 08h	Header CRC
Data (MS)	Data	Data	Data (LS)
Mask (MS)	Mask	Mask	Mask (LS)
Data/Mask CRC	EOP		

Last byte transmitted

Bits in Packet Type / Command / Source Address Path Length Byte

MSB							LSB
0	1	0	1	1	1	Source Path Address Length	Source Path Address Length

Packet Type — Command — Source Path Address Length

Figure 7-7 Read-Modify-Write Command Packet Format

Table 7-12 Read-Modify-Write Command Packet Fields		
Packet Field	**Description**	**Bytes**
Config Port Address	The configuration port address field routes the packet to the configuration port of the router. The configuration port address is always present when configuring the SpaceWire Router.	1
Destination Logical Address	The destination logical address is not used in the SpaceWire Router. The SpaceWire router accepts packets which have the default destination logical address of 254h (FEh).	1
Protocol Identifier	The RMAP protocol identifier is 01h.	1
Command Byte	The command byte indicates a read-modify-write command. The Source path address length fields are set to the number of source path addresses required as defined in section 7.6.9.	1
Destination Key	The destination key identifier must match the contents of the destination key register, see section 9.5.10.	1
Source Path Address	The source path address field is used to add source path addresses to the head of the reply packet. The expected number of source path addresses is specified in the command byte. See section 7.6.9 for source path address decoding.	0,4,8,16
Source Logical Address	The source logical address should be set to the logical address of the node which sent the command.	1
Transaction Identifier	The transaction identifier identifies the command packet and reply packet with a unique number.	2
Extended RMW Address	The extended read address is not used in the SpaceWire router and shall always be set to zero.	1
RMW Address	The read-modify-write address identifies the SpaceWire router register address to modify. Valid RMW addresses are defined in section 9.	4
Data +	The data length of the read-modify-write command is 8, 4 bytes for data and	3

Mask Length	4 bytes for the mask to modify a 32-bit register.	
Header CRC	The header CRC used to detect errors in the header part of the command packet.	1
Data and Mask	The data and mask values to write to the SpaceWire router. The data is written dependent on the mask as shown in Figure 7-8.	8
Data and Mask CRC	The data and mask CRC used to detect errors in the data part of the command packet.	1

A Read-Modify-Write command modifies the bits of a SpaceWire router register dependent on the contents of the register (Register Data), the command data (Command Data) and the command mask value (Mask) as follows:

Register Value = (Mask AND Command Data) OR (NOT Mask AND Register Data)

An example is shown below, the highlighted bits are set or reset by the command.
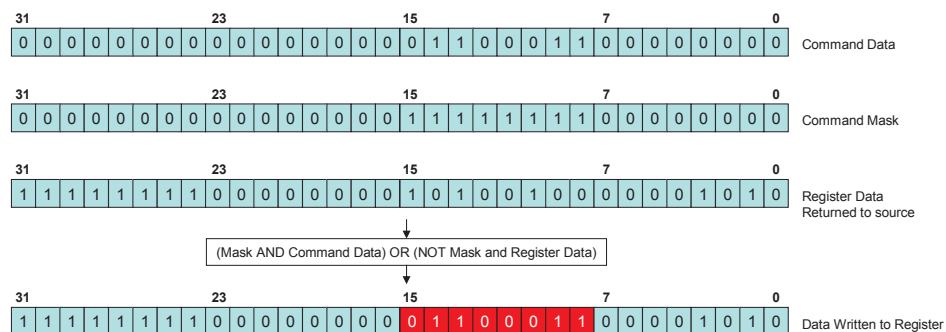
Figure 7-8 Read-Modify-Write example operation

In Figure 7-9 the format of the reply to a Read-Modify-Write command is illustrated. The first byte received by the SpaceWire router configuration logic is the port address followed by the destination logical address. Fields which are depicted in bold text are expected values. Fields which are shaded are optional. Note that the reply is always sent out of the same port as the command was received on. The Source Path Address should not include the output port of the router being commanded as the reply will be automatically sent out of the same port that the command arrived on. See section 7.6.8.

First byte transmitted

Source Path Address	Source Path Address	Source Path Address
Source Logical Address	**Protocol Identifier 01h**	Packet Type, Command, Source Path Addr Len	Status
Destination Logical Address FEh	Transaction Identifier (MS)	Transaction Identifier (LS)	**Reserved 00h**
Data Length (MS) 00h	**Data Length 00h**	**Data Length (LS) 04h**	Header CRC
Data (MSB)	Data	Data	Data (LSB)
Data CRC	EOP		

Last byte transmitted

Bits in Packet Type / Command / Source Path Address Length Byte

MSB							LSB
0	0	0	1	1	1	Source Path Address Length	Source Path Address Length

Packet Type ← → Command ← → Source Path Address Length
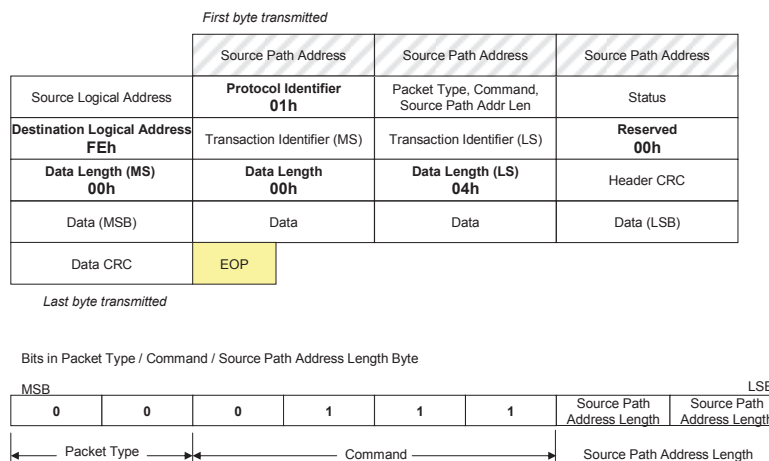
Figure 7-9 Read-Modify-Write Reply Packet Format

Table 7-13 Read-Modify-Write Reply Packet Fields		
Field	**Description**	**Bytes**
Source Path Address	Optional source path addresses specified in the command packet. If no source path addresses are specified then the first byte will be the source logical address.	0-12
Source Logical Address	The source logical address specified in the command packet. If source path addresses are not used then the source logical address is the address of the return packet.	1
Protocol Identifier	The RMAP protocol identifier value 01h.	1
Command Byte	Read-Modify-Write reply command byte. The packet type bits in the command byte indicate this packet is a response packet.	1
Status	The command status is returned in this field. The command status can be command successful or an RMAP error code as defined in section 7.6.6.	1
Destination	The destination logical address is set to the default value FEh as the	1

logical address	SpaceWire router does not have a logical address.	
Transaction Identifier	The transaction identifier identifies the command packet and reply packet with a unique number. The transaction identifier in the reply packet is copied from the command packet and returned in this field, so that the command and the corresponding reply have the same transaction identifier value.	2
Data Length	The data length field is set to 4 bytes as 4 bytes are returned in the Read-Modify-Write command.	3
Header CRC	The header CRC used to detect errors in the header part of the command packet. See section 7.6.7 for CRC generation.	1
Data	The data read from the SpaceWire router registers before the modify operation is performed.	4
Data CRC	The data CRC used to detect errors in the data part of the reply packet. See section 7.6.7 for CRC generation.	1

7.6.5 Write Command

The write command characteristics of the SpaceWire router are defined in Table 7-14.

Table 7-14 Write Command Characteristics			
Action	Supported/ Not Supported	Maximum number of bytes	Non-aligned access accepted
8-bit write	NS	-	-
16-bit write	NS	-	-
32-bit write	S	4	No
64-bit write	NS	-	-
Word or byte address	32-bit aligned		
Accepted Logical Addresses	0xFE		
Accepted destination keys	0x20 at power on		
Accepted address ranges	0x00 0000 0000 – 0x00 0000 0109		
Incrementing address	No		

The RMAP write single address, with data verify and acknowledgement command is supported in the SpaceWire router. The RMAP write command is used to write a 32 bit value into one of the SpaceWire router registers.

In Figure 7-10 the first byte received by the SpaceWire router configuration logic is the port address followed by the destination logical address. Fields which are depicted in bold text are expected values. Fields which are shaded are optional.

Figure 7-10 Write Single Address Command Packet

Table 7-15 Write Single Address Command Packet Fields		
Field	**Description**	**Bytes**
Config Port Address	The configuration port address field routes the packet to the configuration port of the router. The configuration port address is always present when configuring the SpaceWire Router.	1
Destination Logical Address	The destination logical address is not used in the SpaceWire Router. The SpaceWire router accepts packets which have the default destination logical address of 254h (FEh).	1
Protocol Identifier	The RMAP protocol identifier is 01h.	1

Command Byte	The command byte indicates a write single address, with verification and acknowledgement packet. The Source path address length fields are set to the number of source path addresses required as defined in section 7.6.9.	1
Destination Key	The destination key identifier must match the contents of the destination key register, see section 9.5.10.	1
Source Path Address	The source path address field is used to add source path addresses to the head of the reply packet. The expected number of source path addresses is specified in the command byte. See section 7.6.9 for source path address decoding.	0,4,8,12
Source Logical Address	The source logical address should be set to the logical address of the node which sent the command.	1
Transaction Identifier	The transaction identifier identifies the command packet and reply packet with a unique number.	2
Extended Write Address	The extended write address is not used in the SpaceWire router and is always expected to be zero.	1
Write Address	The write address identifies the register to write the RMAP data. The valid write addresses are defined in section 9.	4
Data Length	The data length of a write single address command is expected to be 4 bytes, to write to a 32 bit register location	3
Header CRC	The header CRC is the eight bit CRC code used to detect errors in the command packet. The CRC code is checked before the command is executed	1
Data	The 32 bit data value to write to the SpaceWire router register.	4
Data CRC	The data CRC used to detect errors in the data part of the command packet.	1

In Figure 7-11 the format of the reply to a write command is illustrated. The first byte sent by the SpaceWire router configuration logic is the port address followed by the destination logical address. Fields which are depicted in bold text are expected values. Fields which are shaded are optional. Note that the reply is always sent out of the same port as the command was received on. The Source Path Address should not include the output port of the router being commanded as the reply will be automatically sent out of the same port that the command arrived on. See section 7.6.8.
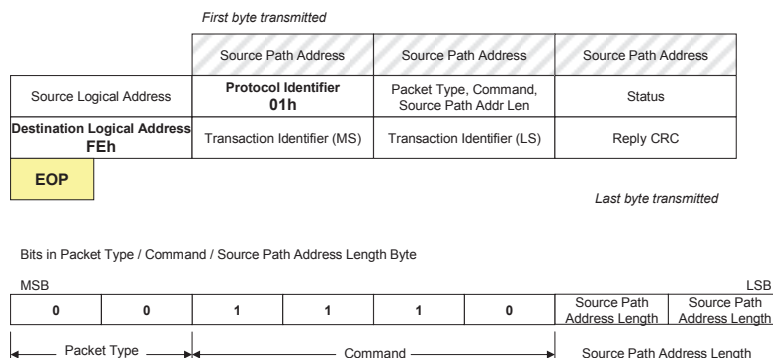
Figure 7-11 Write Single Address Reply Packet

Table 7-16 Write Single Address Reply Packet Fields		
Field	**Description**	**Bytes**
Source Path Address	Optional source path addresses specified in the command packet. If no source path addresses are specified then the first byte will be the source logical address.	0-12
Source Logical Address	The source logical address specified in the command packet. If source path addresses are not used then the source logical address is the address of the return packet.	1
Protocol Identifier	The RMAP protocol identifier value 01h.	1
Command Byte	Write single address reply command byte. The packet type bits in the command byte indicate this packet is a reply packet.	1
Status	The command status is returned in this field. The command status can be command successful or an RMAP error code as defined in section 7.6.6.	1
Destination logical	The destination logical address is set to the default value FEh as the SpaceWire router does not have a logical address.	1

address		
Transaction Identifier	The transaction identifier identifies the command packet and reply packet with a unique number. The transaction identifier in the reply packet is copied from the command packet and returned in this field, so that the command and the corresponding reply have the same transaction identifier value.	2
Header CRC	The header CRC used to detect errors in the header part of the command packet. See section 7.6.7 for CRC generation.	1

7.6.6 Command Error Response

A summary of the error conditions and the action taken is given in Table 7-17. The error conditions are recorded in the configuration port status register.

<table>
<tr><td colspan="5" align="center">Table 7-17 Configuration Port Errors Summary</td></tr>
<tr>
<th>Register Bits</th>
<th>Description</th>
<th>Reply Packet</th>
<th>Returned As</th>
<th>Returned RMAP Status Code</th>
</tr>
<tr>
<td>Invalid Header CRC</td>
<td>The header CRC was invalid therefore the header is corrupted</td>
<td>No</td>
<td><i>No Reply Packet.</i></td>
<td>-</td>
</tr>
<tr>
<td>Unsupported Protocol Error</td>
<td>The protocol byte is not the RMAP protocol identifier</td>
<td>No</td>
<td><i>No Reply Packet.</i></td>
<td>-</td>
</tr>
<tr>
<td>Source Logical Address Error</td>
<td>The source logical address is invalid (outside the range 20h-FFh)</td>
<td>No</td>
<td><i>No Reply Packet.</i></td>
<td>-</td>
</tr>
<tr>
<td>Source Path Address Sequence Error</td>
<td>The source path address sequence is invalid as specified in section 7.6.9</td>
<td>No</td>
<td><i>No Reply Packet.</i></td>
<td>-</td>
</tr>
<tr>
<td>Unused RMAP command or packet type</td>
<td>The command code is an unused command code or the packet type is invalid.</td>
<td>Yes</td>
<td>Unused RMAP command or packet type</td>
<td>2</td>
</tr>
<tr>
<td>Invalid Destination Key</td>
<td>The destination key in the command packet is invalid.</td>
<td>Yes</td>
<td>Invalid Destination Key</td>
<td>3</td>
</tr>
<tr>
<td>Invalid Data CRC</td>
<td>The Data CRC is invalid therefore the data part of the</td>
<td>Yes</td>
<td>Invalid Data CRC</td>
<td>4</td>
</tr>
</table>

	packet is corrupted			
Early EOP	The command packet was terminated early with an EOP. A reply packet is sent if the early EOP error occurs on the data part of the packet	Yes	Early EOP	5
Cargo too Large	The expected amount of SpaceWire cargo has been received without receiving an EOP marker	Yes	Cargo too large	6
Early EEP	The command packet was terminated early with an EEP. A reply packet is sent if the early EEP error occurs on the data part of the packet	Yes	Early EEP	7
Verify Buffer Overrun Error	The data length field is invalid when performing a verified write command. The valid length is 4 bytes of data.	Yes	Verify Buffer Overrun	9
Command not implemented	A command code was received which is not supported by the SpaceWire router. Supported command codes are listed in F1-18.	Yes	RMAP Command not implemented or not authorised	10
Invalid Data Length	The data length field is invalid. A data length error is recorded when: 1. The data length is not a multiple of 4. 2. The data length is zero 3. The data length is outside the range 4-1064 when performing an incrementing read 4. The data length is not 4 in a verified write	Yes	RMAP Command not implemented or not authorised (ote 1: a Verify Buffer Overrun error shall be returned when the data length is not 4 in a verified write command. Note 2: a Read Modify Write Data Length error shall be returned when the data length is not 8.	10

	command. 5. The data length is not 8 in a read modify write command.			
Invalid Register Address	The address field is addressing an unknown register for a read command or a read only register in a write command.	Yes	RMAP Command not implemented or not authorised	10
Read Modify Write Data Length Error	The read modify write data length is not 8	Yes	RMW Data Length Error	11
Invalid Destination Logical Address	The destination logical address is invalid. The destination logical address is expected to be the default 254 value	Yes	Invalid Destination Logical Address	12

7.6.7 Command Packet Cyclic Redundancy Check

The header and data part of an RMAP packet are protected from errors by the use of an 8 bit CRC code. The header and data CRC is formed using the CRC-8 code used in ATM (Asynchronous Transfer Mechanism). CRC-8 has the polynomial: $X^8 + X^2 + X^1 + 1$ with a starting value of 00h.

Command packets received by the SpaceWire router which have an invalid header CRC are discarded and the Invalid Header CRC bit is set in the configuration port register.

7.6.8 Local Source Path Address

The configuration reply packet shall be routed out of the router port the packet arrived on. For example, if SpaceWire port 1 passed a configuration command to the configuration port then the reply packet is returned to port 1.

7.6.9 Source Path Address Field

The RMAP command field "source path address length" indicates the number of source path addresses which are expected in the packet. Up to 12 source path addresses can be accepted by the router configuration port. The source path addresses shall be decoded by the SpaceWire router as follows.

- Leading zero source path address bytes are not returned in the RMAP reply packet.

- If the source path address contains only zero bytes the Source Path Address Sequence error is reported, see section 7.6.6.

- After the first non zero byte in the packet any following zeros shall be treated as an error. A source path address sequence is reported, see section 7.6.6.

The table below gives some examples of how to set the source path address length and packet address fields for the required path addresses

Table 7-18 Source Path Address Reference Table		
Source Path Address Length	**RMAP Source Path Address fields** (First→Last Transmitted)	**Reply Path Address** (First→Last Reply)
0	None	None
1	[00 00 00 20]	20
1	[00 02 08 09]	02 08 09
1	[01 02 03 04]	01 02 03 04
2	[00 00 00 00] [00 00 00 02]	02
2	[00 00 00 00] [01 02 03 02]	01 02 03 02
2	[00 00 12 01] [02 B2 03 05]	12 01 02 B2 03 05
2	[00 32 01 02] [07 02 05 08]	32 01 02 07 02 05 08
1	[00 00 00 00]	Invalid
2	[00 00 00 00] [00 00 00 00]	Invalid
1	[00 02 00 01]	Invalid
1	[00 A3 00 00]	Invalid
2	[00 02 03 00] [01 00 00 00]	Invalid
2	[00 00 00 02] [00 00 01 00]	Invalid
2	[00 00 00 00] [02 03 00 01]	Invalid

Figure 7-12 and Figure 7-13 illustrate how source path addresses are returned in relation to the RMAP packet description.

Dest Logical	Protocol ID	Command	Dest Key
00	00	04	02
Source Logical	Trans ID(1)	Trans ID(0)	Address(4)

Figure 7-12 Source Path Address field decoding

←	Local Source Path Address	04	02
Source Logical	Protocol ID	Command	Status

Figure 7-13 Source Path Addresses in Reply Packet

7.6.10 Command Packet Fill Bytes

The Configuration port accepts packets which are addressed to port 0. In the RMAP command the next byte after the destination address 0 is the destination logical address byte (which in the router is expected to be the default 254 value). The format is shown in Figure 7-14.

Path Address 0	Dest Logical Address 254	Protocol ID 1	RMAP Header

Figure 7-14 Normal Configuration Packet Header Structure

To allow source nodes which have a 16, 24 or 32 bit access port then the configuration port accepts up to three null bytes at the start of the packet. The null bytes must be zero otherwise they will be treated as the destination logical address and an invalid destination logical address shall be recorded if the byte is not 254. The header with fill bytes is shown in the Figure 7-15.

Path Address 0	Fill Byte 0	Fill Byte 0	Fill Byte 0	Dest Logical Address 254	Protocol ID 1	RMAP Header

Figure 7-15 Fill Bytes Configuration Header Structure

Note that the command packet fill bytes feature is specific to the SpW-10X router and is not part of the RMAP standard.