

SCUBA-2 Bus Backplane ISA

1. Summary

The purpose of this document is to describe the protocol for the communication between SCUBA2 the Clock Card (CC) and all other cards in the Multi-Channel Electronics (MCE). For a complete list of commands, refer to bb_isa_revXX.xls.

2. References

- [1] SCUBA 2 data acquisition software overview
- [2] Bus Backplane Instruction Set Architecture
- [3] MCE Firmware Block Diagrams: SC2/ELE/S563/100, SC2/ELE/S563/200, SC2/ELE/S563/201, SC2/ELE/S563/300, SC2/ELE/S563/400, SC2/ELE/S563/500.

3. Introduction

In the MCE, the CC will act as the master card, and all other cards will be slaves. In other words, all communication sequences over LVDS will be initiated by the CC. The CC will send commands on a multi-tapped LVDS line over the Bus Backplane (BB) to the other cards, and will wait for their replies on dedicated point-to-point lines. For the purpose of BB communication, a simple well-defined Instruction-Set Architecture (ISA) will be implemented. This ISA will exist internally to the MCE. However, it will be advantageous if this protocol and the one that has been tabled by Gao are similar. The focus this BB ISA is to provide a simple, short, byte-aligned, error-free instruction set that is easily implemented. This ISA will contain the commands that have a direct correspondence with commands that are issued by the Real-Time Linux PC's (RTLPC), and commands that will be used for internal operations which the RTLPC's need not know about.

4. The SCUBA-2 BB ISA

4.1 Clock Card Commands

CC will initiate all communication with other cards, and wait for replies to each command issued. The generalized command format is shown below [2].

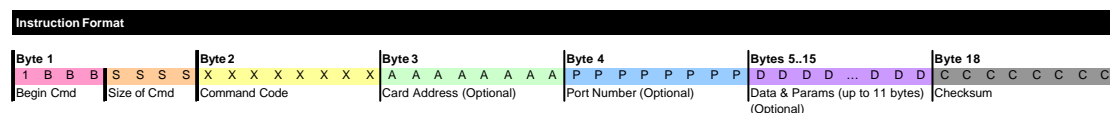


Figure 1. BB Instruction Format

All commands will be generated by the CC, and will be byte-aligned. Commands will be transmitted MSB-first. Each coloured background in the figure above designates a field that may appear in a command. Each character in the coloured backgrounds corresponds to a bit. The fields are:

Command Code	Requirement	Bits	Range
Begin Cmd	Required	4	8..15
Size of Cmd	Required	4	0..15
Command Code	Required	8	0..255
Card Address	Optional	8	0..255
Port Number	Optional	8	0..255
Data (up to 11 bytes)	Optional	n/a	n/a
Checksum (if necessary)	Required	8	0..255

Figure 2. BB Instruction Fields

As noted in the figure 2, some fields are labelled as ‘Optional’. This feature is included in the ISA so that when timing is critical, short commands can be issued and parsed quickly. If optional fields are included in a command, it will be important to adhere to following rules for a receiving-card to correctly parse the optional fields:

- The ‘Size of Cmd’ field will indicate the number of bytes of optional fields included with a command.
- If an optional field is included, then all other optional fields before it must also be included with the command. This requirement removes the necessity to identify each optional field with some pre-amble. To implement this requirement efficiently, the optional fields have been inserted in the BB Instruction Format in a hierarchal manner (see Figure 1). The instruction format is structured such that if the ‘Port Number’ field is required to properly specify a command, then all preceding fields (i.e. ‘Card Address’) would also be necessary in general.

All instruction fields are discussed below (refer to Figure 1 to identify each field):

‘Begin Cmd’: This field is required, and is 4 bits long. Its MSB is always ‘1’, to indicate the beginning of a command string (it is assumed that when the LVDS command line is inactive, it is held low ‘0’). The remaining 3 bits of this field are used for command-sequence bookkeeping. Before being issued, a command will be assigned an ordered sequence number (from 0..7), which the receiving cards will use to determine if they have dropped any commands. For example, if a card sequentially parses two commands that with ‘Begin Cmd’ fields ‘1000’ and ‘1010’ respectively, then it will conclude that it has missed the command that began with ‘1001’, and may request that the CC resend that command. Note that the next ‘Begin Cmd’ field in sequence with ‘1111’ will be ‘1000’.

Usage example: **‘1110’: beginning of command, with sequence number 6**

‘Size of Cmd’: This field is required, and is 4 bits long. It is a measure (in bytes) of the length of all the optional fields that are included with a particular command. 4 ‘Size of Cmd’ bits are enough to allow a command to include 11 bytes of optional fields (Card Address, Port Number, Data and/or Checksum). If no optional fields are included, ‘Size of Cmd’ will be ‘0000’. Note also that the maximum total length of a command will be 16 bytes.

Usage example: **‘0110’: optional fields of the command are 6 bytes long**

‘Command Code’: This field is required, and is 8 bits long. This will allow firmware developers to create up to 256 different commands. A list of all known commands is included in this document.

Usage example: **‘0x10’: command code means ‘Get 1st Stage Feedback’[2]**

‘Card Address’: This field is optional, and is 8 bits long. If it is not included, the command will be understood to target all the cards in the MCE. If it is included, the command will only affect the cards that it is addressed to. Each bit position in this byte will designate a particular card. By using a byte, every card that is multi-dropped from the LVDS ‘cmd’ line can be individually addressed:

- Bit 0: (LSB): BC0 (leftmost)
- Bit 1: BC1
- Bit 2: BC2
- Bit 3: RC0
- Bit 4: RC1
- Bit 5: RC2
- Bit 6: RC3
- Bit 7 (MSB): AC (rightmost)

A '1' at any bit position in this field will indicate that a command is directed to a corresponding card, and a '0' will indicate that a card may disregard the command after its sequence number (contained in the 'Begin Cmd' field) has been verified.

Usage example: **'10000111': this command is addressed to the AC and all three BCs.**

'Port Number': This field is optional and is 8 bits long. 'Port Number' refers to a channel on a card. For example, if the 'Card Address' field was '10000000', it would mean that the AC was the target of a particular command. Thus the 'Port Number' field would designate which channel of the AC was targeted. Note that if this field is not used for legitimate information, an invalid value of '0xFF' will be inserted in the field.

Usage example: **Port Number '00001100': if the address card was designated by the 'Card Address' field, the command would refer to AC row-select line #12.**

'Data': This field is optional, and is up to 11 bytes long. The data field will be used to send data (parameters, bias values, etc..) to cards.

'Checksum': This field is required, and is 8 bits long. Each bit in the 'Checksum' byte will be calculated to be the single-bit sequential 'XOR' of the bits of that index in all other command bytes. If transmission error rates are below an agreed-upon level, then this field may not be included in the final version of the BB ISA. However, it is required for fibre optic communication between the CC and the RTL computers. If this field is not included in the BB ISA, then the 'Data' field will be extended by 1 byte, to a maximum of 12 bytes. The maximum command length will remain at 16 bytes.

4.2 Card Replies

For every command that the CC issues, it will expect to receive a reply from the cards that it addressed. Each reply will contain identical 'Begin Cmd' and 'Cmd Code' fields that were used by the CC when it issued the command. Each reply will also contain an appropriate 'Size of Cmd' field. If the 'Card Address' or 'Port Number' fields were included in the command, then the reply will also duplicate these fields. If the CC requested information to be returned, replies may also include the 'Data' field. By following this reply-protocol, it will be easy to match the replies that are received by the CC to the commands that it issued, so that it can retire commands that have been correctly replied to.