

ACDC DAQ Programmers Manual

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1 Introduction

This document is intended to document the commands sent to the ACC and ACDC cards.

Table 1: List of Instructions

0x0	Do nothing
0x1	Set delay-locked loop VDD control voltage
0x2	Calibration pulse switch enable
0x3	Set pedestal
0x4	Reset DLL
0x5	Reset internal trigger
0x6	Set self trigger mask
0x7	Set self trigger instructions
0x8	Set trigger threshold
0x9	Adjust ring oscillation frequency
0xA	Enable/disable on-board LEDs
0xB	(DC) Central card FIFO toggle
0xB	(CC) Central card done
0xC	(CC) Central card read mode
0xD	(CC) Align/setup SERDES
0xE	(CC) USB trigger
0xF	(CC) Sync USB

It includes source listings of the source and destinations for each command as they were when this documentation was written. New implementations may have been written since, but that is outside the scope of this document.

The command protocol for each 32-bit instruction set is shown in Figure 1.

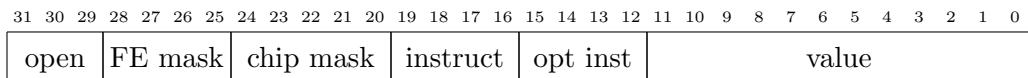


Figure 1: Command protocol

This is parsed on the front-end board like this

```
INSTRUCT_PSEC_MASK      <=  xINSTRUCT_WORD(24 downto 20);  
INSTRUCTION              <=  xINSTRUCT_WORD(19 downto 16);  
INSTRUCTION_OPT          <=  xINSTRUCT_WORD(15 downto 12);  
INSTRUCT_VALUE            <=  xINSTRUCT_WORD(11 downto 0);
```

Table 1 lists all the instruction flags passed by software.

Table 2: Optional instructions for 0x7 - set self-trigger instructions

Bits	Description
0x0	Enable
0x1	Wait for system trigger
0x2	Measure rate only
0x3	Trigger sign

The instruction for setting self-trigger instructions has many optional instructions, listed in [Table 2](#).

2 Instructions

2.1	0x1 - Set DLL VDD	5
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2.5	0x4 - Reset Self Trigger	13
2.6	0x4 - Reset Time Stamp	14
2.7	0x4 - Reset ACDC	15
2.8	0x4 - Hard Reset	16
2.9	0x6 - Set Self-trigger Mask	17
2.10	0x7 - Set Self-trigger Lo	19
2.11	0x7 - Set Self-trigger hi	21
2.12	0x8 - Set Self-trigger Threshold	23
2.13	0x9 - Set RO Target Count	25
2.14	0xA - Toggle LED	27
2.15	0xA - Read ACDC Ram	29
2.16	0xC - Set USB Read Mode	31
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2.18	0xE - Software Trigger	33
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2.1 0x1 - Set DLL VDD

This sets the dll vdd

2.1.1 Bit Fields

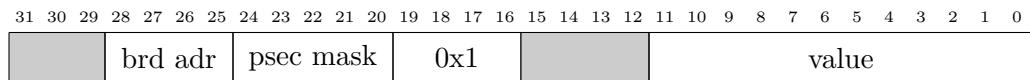


Figure 2: Command 0x1 bit fields

Bits	Name	Description
28-25	board address	The address of the board
24-20	psec mask	The psec chips to apply this to
19-16	0x1	Command marker
11-0	value	VDD Value

2.1.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::set_dll_vdd (unsigned int VALUE,
                        unsigned int boardAdr,
                        int device,
                        unsigned int psec_mask)
{
    createUSBHandles();
    const unsigned int hi_cmd = 0x00010000;
    unsigned int send_word = hi_cmd | VALUE | boardAdr <<
                           ↵ boardAdrOffset
                           | psec_mask << psecAdrOffset;

    if (device == 0)                     usb.sendData(send_word);
    if (device == 1 && mode==USB2x)    usb2.sendData(send_word);

    closeUSBHandles();
}
```

2.1.3 Destination

project:path/to/filename.vhd

2.2 0x2 -Toggle Cal

2.2.1 Bit Fields

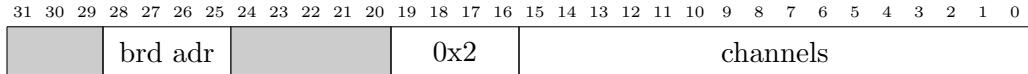


Figure 3: 0x2 - Cal enabled

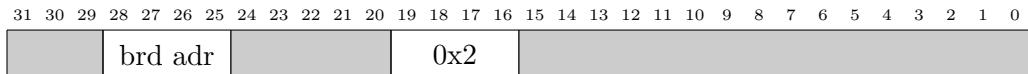


Figure 4: 0x2 - Cal disabled

Bits	Name	Description
28-25	board address	The address of the board (default = 15)
19-16	0x2	Command marker
15-0	channels	Channels (default = 0x7FFF) Not used if cal is disabled

2.2.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::toggle_CAL(bool EN, int device)
{
    createUSBHandles();

    unsigned int send_word = 0x00020000;
    unsigned int channels = 0x7FFF;
    unsigned int boardAdr = 15;

    if(EN) {
        send_word = send_word | boardAdr <<
                    ↵ boardAdrOffset | channels;
        if(device == 0)                      usb.sendData(
            ↵ send_word);
        if(device == 1 && mode==USB2x)  usb2.sendData(
            ↵ send_word);
    }
}
```

```
    } else{
        send_word = send_word | boardAdr <<
                     ↛ boardAdrOffset;
        if(device == 0)                      usb.sendData(
                     ↛ send_word);
        if(device == 1 && mode==USB2x)  usb2.sendData(
                     ↛ send_word);
    }
closeUSBHandles();
}
```

2.2.3 Destination

project:path/to/filename.vhd

2.3 0x3 -Set Pedestal Value

2.3.1 Bit Fields

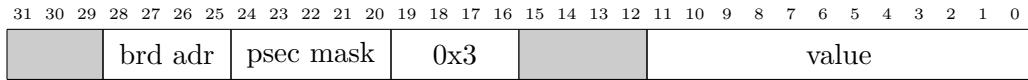


Figure 5: Command 0x3 bit fields

Bits	Name	Description
28-25	board address	The address of the board (default = 15)
24-20	psec mask	Mask for chip addresses
19-16	0x2	Command marker
12-0	value	Pedestal value (default = 0x800)

2.3.2 Source

acdc-daq:src/DAQinstruction.cpp

```

void SuMo::set_pedestal_value( unsigned int PED_VALUE,
unsigned int boardAdr ,
int device ,
unsigned int psec_mask )
{
    createUSBHandles() ;
    const unsigned int hi_cmd = 0x00030000 ;
    unsigned int send_word = hi_cmd | PED_VALUE
    | boardAdr << boardAdrOffset
    | psec_mask << psecAdrOffset ;

    if(device == 0)           usb.sendData(send_word) ;
    if(device == 1 && mode==USB2x)  usb2.sendData(send_word) ;

    closeUSBHandles() ;
}

```

2.3.3 Destination

project: path/to/filename.vhd



2.4 0x4 - Reset DLL

This command resets the DLL

2.4.1 Bit Fields

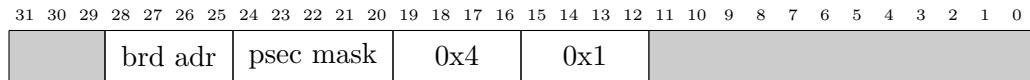


Figure 6: 0x4 Instruct Bit Fields

Bits	Name	Description
28-25	board address	The address of the board.
24-20	psec mask	Which psec chips to apply this to
19-16	0x4	Command marker
15-12	0x1	Optional command marker

2.4.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::reset_dll(bool sync)
{
    createUSBHandles();
    const unsigned int hi_cmd = 0x00041000;
    const unsigned int mask = 31; //chip mask
    unsigned int send_word = hi_cmd | mask << 20 | 15 <<
        ↳ boardAdrOffset;

    if(sync) prep_sync();
    usb.sendData(send_word); //dll reset pulse
    if(mode == USB2x) usb2.sendData(send_word);
    if(sync) make_sync();

    closeUSBHandles();
}
```

2.4.3 Destination

2.5 0x4 - Reset Self Trigger

This command resets the self trigger

2.5.1 Bit Fields

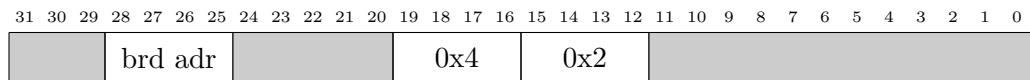


Figure 7: 0x4 Instruct Bit Fields

Bits	Name	Description
28-25	board address	The address of the board.
19-16	0x4	Command marker
15-12	0x2	Optional command marker

2.5.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::reset_self_trigger(unsigned int boardAddr, int device)
{
    createUSBHandles();
    unsigned int send_word = 0x00042000 | boardAddr <<
        ↳ boardAdrOffset;

    if(device == 0) usb.sendData(send_word);
    if(device == 1 && mode == USB2x) usb2.sendData(send_word)
        ↳ ;

    closeUSBHandles();
}
```

2.5.3 Destination

2.6 0x4 - Reset Time Stamp

This command resets the time stamp

2.6.1 Bit Fields

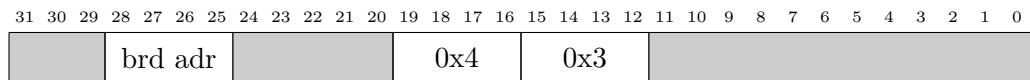


Figure 8: 0x4 Instruct Bit Fields

Bits	Name	Description
28-25	board address	The address of the board.
19-16	0x4	Command marker
15-12	0x3	Optional command marker

2.6.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::reset_time_stamp(bool sync)
{
    createUSBHandles();
    unsigned int send_word = 0x00043000 | 15 <<
        ↗ boardAdrOffset;

    if(sync) prep_sync();
    usb.sendData(send_word);
    if(mode == USB2x) usb2.sendData(send_word);
    if(sync) make_sync();

    closeUSBHandles();
}
```

2.6.3 Destination

2.7 0x4 - Reset ACDC

This command resets the acdc

2.7.1 Bit Fields

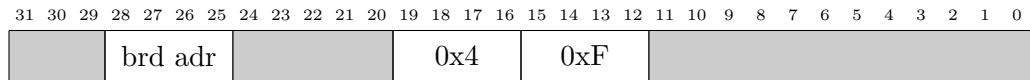


Figure 9: 0x4 Instruct Bit Fields

Bits	Name	Description
28-25	board address	The address of the board.
19-16	0x4	Command marker
15-12	0xF	Optional command marker

2.7.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::reset_acdc()
{
    usb.createHandles();
    unsigned int send_word = 0x0004F000 | 15 <<
        ↳ boardAdrOffset;

    usb.sendData(send_word);
    if(mode == USB2x) usb2.sendData(send_word);

    closeUSBHandles();
}
```

2.7.3 Destination

2.8 0x4 - Hard Reset

This command resets the acdc

2.8.1 Bit Fields

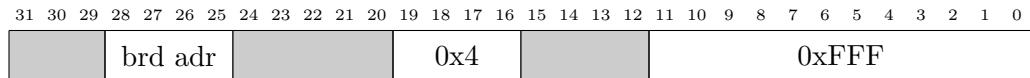


Figure 10: 0x4 Instruct Bit Fields

Bits	Name	Description
28-25	board address	The address of the board.
19-16	0x4	Command marker
11-0	0xFFFF	Hard reset value

2.8.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::hard_reset(bool DEVICE)
{
    usb.createHandles();
    unsigned int send_word = 0x00040FFF | 15 <<
        ↳ boardAdrOffset;
    usb.sendData(send_word);
    if(mode == USB2x && DEVICE==true) usb2.sendData(send_word
        ↳ );

    closeUSBHandles();
}
```

2.8.3 Destination

2.9 0x6 - Set Self-trigger Mask

This command sends certain trigger mask

2.9.1 Bit Fields

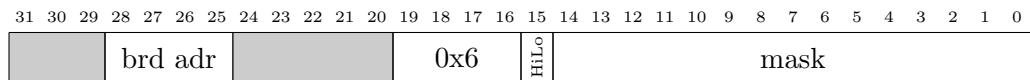


Figure 11: 0x6

Bits	Name	Description
28-25	board address	The address of the board.
19-16	0x6	Command marker
15	HiLo	Which half of the mask is being sent ¹
14-0	mask	AC/DC channel mask

2.9.2 Source

acdc-daq:src/DAQinstruction.cpp

```

void SuMo::set_self_trigger_mask(int mask, bool HiLo, unsigned
    ↵ int boardAdr, int device)
{
    unsigned int hi_cmd;
    if(HiLo) hi_cmd = 0x00068000;
    else      hi_cmd = 0x00060000;

    unsigned int send_word = hi_cmd | mask | boardAdr <<
        ↵ boardAdrOffset;

    createUSBHandles();
    if(device == 0)                      usb.sendData((unsigned
        ↵ int)send_word);
    if(device == 1 && mode == USB2x)  usb2.sendData((unsigned
        ↵ int)send_word);
}

```

¹When set to 0, the values for the 15 least significant bits are sent, which correspond to channels 1-15. When set to 1, the values for the 15 most significant bits are sent, which correspond to channels 16-30.

```
        closeUSBHandles();  
    }  
}
```

2.9.3 Destination

2.10 0x7 - Set Self-trigger Lo

This command sends certain trigger commands

2.10.1 Bit Fields

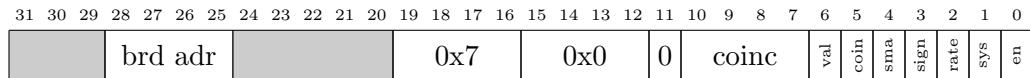


Figure 12: Command 0x7 bit fields

Bits	Name	Description
28-25	board address	The address of the board. Default is 0xF
19-16	0x7	Command marker
15-12	0x0	Optional command marker
10-7	coincidence window	The window of unknown units for the coincidence (<15)
6	use trig valid	Use trig valid as a reset on AC/DC
5	use coincidence	Use channel coincidence
4	use board sma trig	Use SMA input on AC/DC board for trigger
3	trig sign	1 for rising edge, 0 for falling edge
2	rate only	
1	sys trig option	
0	trig enable	Enables self-trigger

2.10.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::set_self_trigger_lo (
    bool ENABLE_TRIG,
    bool SYS_TRIG_OPTION,
    bool RATE_ONLY,
    bool TRIG_SIGN,
    bool USE_BOARD_SMA_TRIG,
    bool USE_COINCIDENCE,
    bool USE_TRIG_VALID_AS_RESET,
    unsigned int coinc_window,
    unsigned int boardAdr,
    int device)
{
```

```

const unsigned int hi_cmd = 0x00070000;
unsigned int send_word = hi_cmd | 0 << 11
| USE_TRIG_VALID_AS_RESET << 6
| USE_COINCIDENCE << 5
| USE_BOARD_SMA_TRIG << 4
| TRIG_SIGN << 3 | RATE_ONLY << 2
| SYS_TRIG_OPTION << 1 | ENABLE_TRIG
| coinc_window << 7
| boardAdr << boardAdrOffset;
//printf("%i\n", send_word);

createUSBHandles();

if(device == 0)                      usb.sendData((unsigned int)
    ↪ send_word);
if(device == 1 && mode == USB2x)  usb2.sendData((unsigned int)
    ↪ send_word);

closeUSBHandles();
}

```

2.10.3 Destination

2.11 0x7 - Set Self-trigger hi

This command sends certain trigger commands

2.11.1 Bit Fields

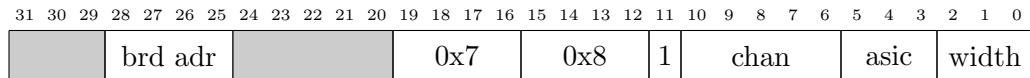


Figure 13: Command 0x7 bit fields

Bits	Name	Description
28-25	board address	The address of the board.
19-16	0x7	Command marker
15-12	0x8	Optional command marker
10-6	channel coincidence min	Number of coincident channels to enable trigger (<30)
5-3	asic coincidence min	Number of coincident asic chips to enable trigger (<5)
2-0	coincidence pulse width	Width of coincidence pulse in unknown units (<7)

2.11.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::set_self_trigger_hi(unsigned int coinc_pulse_width,
                               unsigned int asic_coincidence_min,
                               unsigned int channel_coincidence_min,
                               unsigned int boardAdr,
                               int device)
{
    const unsigned int hi_cmd = 0x00078000;
    unsigned int send_word = hi_cmd | 1 << 11
                           | channel_coincidence_min << 6
                           | asic_coincidence_min << 3
                           | coinc_pulse_width
                           | boardAdr << boardAdrOffset;
    //printf("%x\n", send_word);

    createUSBHandles();
}
```

```
    if( device == 0) usb.sendData(( unsigned int )send_word);  
    if( device == 1 && mode == USB2x) usb2.sendData(( unsigned  
        → int )send_word);  
  
    closeUSBHandles();  
}
```

2.11.3 Destination

2.12 0x8 - Set Self-trigger Threshold

This command sets trigger threshold

For some reason this seems to create a word with the psec_mask value assigned twice. It looks like he bit shifts it 20, but does the same thing again and bit shifts it by a defined value. Sorry if that doesn't make sense just look at the 4th line of the method.

2.12.1 Bit Fields

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
				brd adr	psec mask	0x8																									value

Figure 14: Command 0x8 bit fields

Bits	Name	Description
28-25	board address	The address of the board.
24-20	psec mask	Which psec chips to apply this to
19-16	0x8	Command marker
11-0	value	Trigger threshold value

2.12.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::set_trig_threshold( unsigned int TRIG_VALUE,
                               unsigned int boardAdr ,
                               int device ,
                               unsigned int psec_mask )
{
    createUSBHandles();
    const unsigned int hi_cmd = 0x00080000;
    const unsigned int mask = 31; //chip mask
    unsigned int send_word = hi_cmd | TRIG_VALUE | psec_mask
                           → << 20 | boardAdr << boardAdrOffset
```

```
| psec_mask << psecAdrOffset ;  
  
| if (device == 0)           usb.sendData(send_word);  
| if (device == 1 && mode==USB2x)  usb2.sendData(send_word);  
  
| closeUSBHandles();  
| }  
| }
```

2.12.3 Destination

2.13 0x9 - Set RO Target Count

This command sets the RO Target count. What is the RO target count?

2.13.1 Bit Fields

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	

Figure 15: 0x9 Instruct Bit Fields

Bits	Name	Description
28-25	board address	The address of the board.
24-20	psec mask	Which psec chips to apply this to
19-16	0x9	Command marker
15-0	target count	The value of the ro target count

2.13.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::set_ro_target_count (unsigned int TARGET_RO_COUNT,
                                unsigned int boardAdr ,
                                int device ,
                                unsigned int psec_mask )
{
    createUSBHandles () ;
    const unsigned int hi_cmd = 0x00090000 ;
    unsigned int send_word = hi_cmd | TARGET_RO_COUNT |
        ↳ boardAdr << boardAdrOffset
        | psec_mask << psecAdrOffset ;

    usb.sendData (send_word) ;
    if (mode==USB2x) usb2.sendData (send_word) ;

    closeUSBHandles () ;
}
```

2.13.3 Destination

2.14 0xA - Toggle LED

This command toggles the LED on all connected boards.

2.14.1 Bit Fields

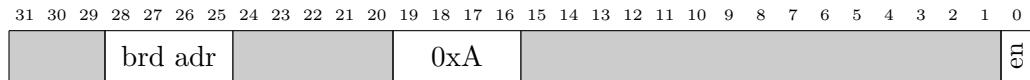


Figure 16: Command 0xA bit fields

Bits	Name	Description
28-25	board address	The address of the board. Default is 0xF
19-16	0xA	Command marker
0	enable	Enable the leds

2.14.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::toggle_LED( bool EN )
{
    unsigned int boardAdr_all = 15;

    createUSBHandles();
    unsigned int send_word = 0x000A0000;
    send_word = send_word | boardAdr_all << boardAdrOffset;

    if(EN != false){
        usb.sendData(send_word | 0x1);
        if(mode == USB2x) usb2.sendData(send_word | 0x1);
    }
    else{
        usb.sendData(send_word);
        if(mode == USB2x) usb2.sendData(send_word);
    }
    closeUSBHandles();
}
```

2.14.3 Destination

[REDACTED]

2.15 0xA - Read ACDC Ram

THIS COMMAND DOES NOT FOLLOW ERIC'S BASIC
PROTOCOL OUTLINE (section 1, Figure 1)

2.15.1 Bit Fields

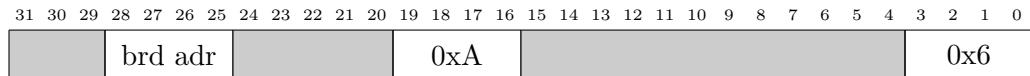


Figure 17: Command 0xA bit fields

Bits	Name	Description
28-25	board address	The address of the board (default = 15)
19-16	0xA	Command marker
3-0	0x6	Optional command marker

2.15.2 Source

acdc-daq:src/DAQinstruction.cpp

```

void SuMo::readACDC_RAM( int device , unsigned int boardAdr)
{
    unsigned int boardAdr_override = 15;

    createUSBHandles();

    unsigned int send_word = 0x000A0006;
    send_word = send_word | boardAdr << boardAdrOffset;

    if(device == 0)           usb.sendData(send_word);
    if(device == 1 && mode==USB2x)  usb2.sendData(send_word);

    closeUSBHandles();
}

```

2.15.3 Destination

project: path/to/filename.vhd



2.16 0xC - Set USB Read Mode

This command sets the USB read mode.

2.16.1 Bit Fields

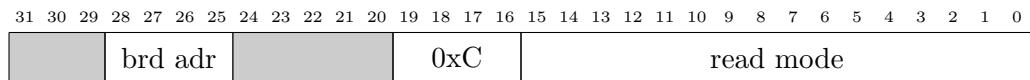


Figure 18: 0x6

Bits	Name	Description
28-25	board address	The address of the board.
19-16	0xC	Command marker
15-0	read mode	The value of the read mode

2.16.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::set_usb_read_mode( unsigned int READ_MODE )
{
    usb.createHandles();
    const unsigned int hi_cmd = 0x000C0000;
    unsigned int send_word = hi_cmd | READ_MODE | 15 <<
        ↘ boardAdrOffset;
    usb.sendData(send_word);
    usb.freeHandles();
}
```

2.16.3 Destination

2.17 0xD - Align LVDS

This command aligns the LVDS system between the central card and any acdc boards. The LVDS system is the RJ-45 connection.

2.17.1 Bit Fields

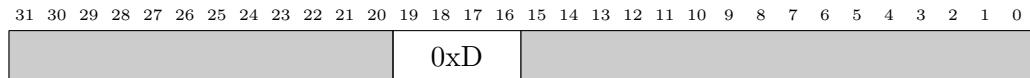


Figure 19: Command 0xD bit fields

Bits	Name	Description
19-16	0xD	Command marker

2.17.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::align_lvds()
{
    createUSBHandles();
    usb.sendData((unsigned int)0x000D0000); // toggle align
    ↪ process
    if(mode == USB2x) usb2.sendData((unsigned int)0x000D0000);
    closeUSBHandles();
}
```

2.17.3 Destination

2.18 0xE - Software Trigger

This command sends a software trigger (maybe).

2.18.1 Bit Fields

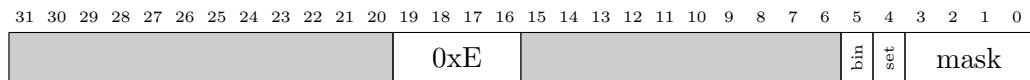


Figure 20: Command 0x7 bit fields

Bits	Name	Description
19-16	0xE	Command marker
5	bin	bin
4	set	Enable bin
3-0	mask	Soft trig mask

2.18.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::software_trigger (unsigned int SOFT_TRIG_MASK, bool
    ↪ set_bin , unsigned int bin)
{
    usb.createHandles();
    const unsigned int hi_cmd = 0x000E0000;
    unsigned int send_word = hi_cmd | SOFT_TRIG_MASK |
        ↪ set_bin << 4 | bin << 5;
    usb.sendData(send_word);
    usb.freeHandles();
}
```

2.18.3 Destination

2.19 0xF - Sync Usb

This command does something regarding to syncing the usb

2.19.1 Bit Fields

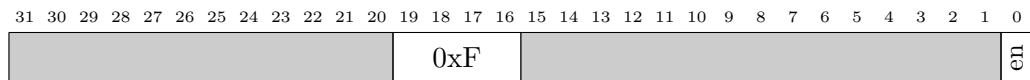


Figure 21: Command 0xF bit fields

Bits	Name	Description
19-16	0xF	Command marker
0	enable	Enable USB sync

2.19.2 Source

acdc-daq:src/DAQinstruction.cpp

```
void SuMo::sync_usb( bool SYNC) {
    createUSBHandles();
    if(SYNC != false) { //enable USB_SYNC
        usb.sendData((unsigned int)0x000F0001);
        if(mode == USB2x) usb2.sendData((unsigned int)0x000F0001
            ↪ );
    } else { //disable USB_SYNC
        usb.sendData((unsigned int)0x000F0000);
        if(mode == USB2x) usb2.sendData((unsigned int)0x000F0000
            ↪ );
    }
    closeUSBHandles();
}
```

2.19.3 Destination