

SAS3 12Gbps BP with Expander User Manual

With NVMe Support

Broadcom Cub Family SAS Expander chip

Supported Devices

Part Number	Description
2RAKVI002500	IW-RS224-07 24BAY BP-EXP
2RAKVI001501	IW-RS118-03 NVME-OCULINK BP
2RAKVI001600	IW-RS118-03 NVME-SLIMSAS BP
2RAKVI001700	IW-RS248-03 NVME-OCULINK BP
2RAKVI001800	IW-RS248-03 NVME-SLIMSAS BP
2RAKVI002600	IW-RS224-07 24BAY HYBRID BP
2RAKVI002700	IW-RS224-07 24BAY HYBRID BP

Version: 0.2

History

Version	Changes	Date
0.1	First draft	2018/8/21
0.2	Added backplane information for Jumper setting. Correct power receptacle number. Correct IW-RS118-03 Part Number	2019/01/14

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1 Overview

InWin's 12G SAS3 Backplanes equipped with LSI 35x36R Expander provide an industry leading high performance and high stability of data transfer and low power consumption for storage server solution.

The backplanes support state-of-the art SAS3 12Gbps HDD/SSD and also backward compatible with SAS 6Gbps, SATA 6Gps and SATA 3Gps HDD/SSD. Further, there are numbers of 2.5" NVMe SSD disk support on these backplane with either Oculink or SlimSAS connection.

To accommodate higher density of disks in a smaller chassis these backplanes go with board-to-board design by separating it into 2 parts. One is backplane and the other is Expander module. There are 3 miniSAS wide ports on the Expander module for connecting to RAID/HBA cards and/or cascading to another backplane or JBOD by extending it to the rear panel of the chassis through a SFF-8643 to SFF8644 cable.

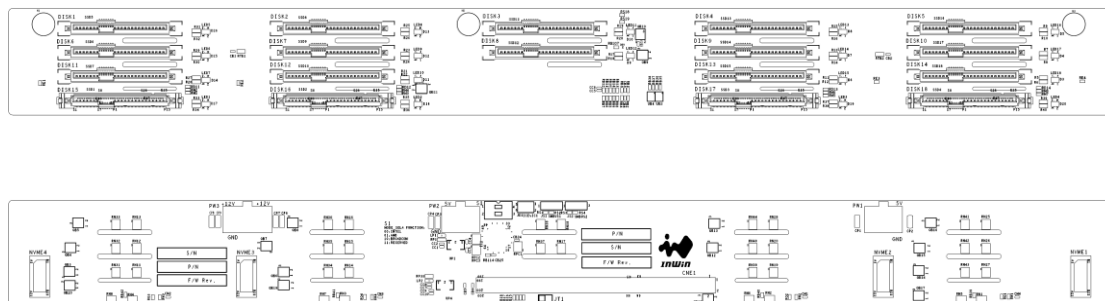
The backplanes are all implemented with smart fan control feature to support wide variety of fan modules by auto-calibrating the installed modules at system booting up. This feature provides an efficient way for heat exhaustion by sensing the temperature in the enclosure.

Along with the smart fan control feature, a system alarming feature is also implemented to alert users in case Fan module failure and/or system overheat occurs by illuminating the LED indicator and buzzing the alarm.

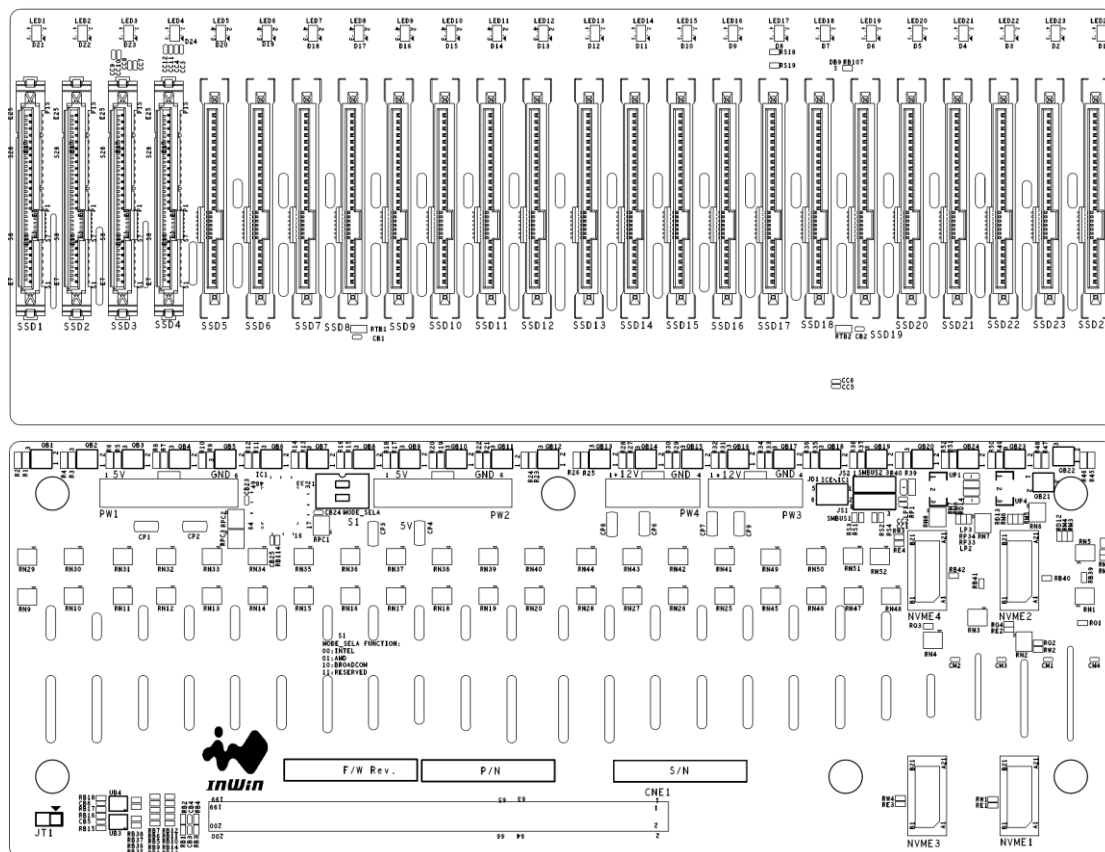
Below the views of the backplane.

Expander Module

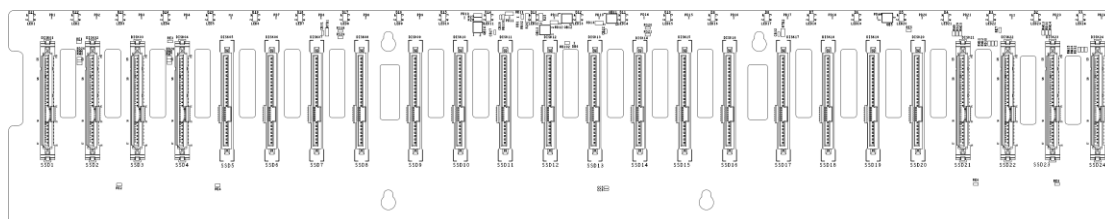
IW-RS118-03 backplane

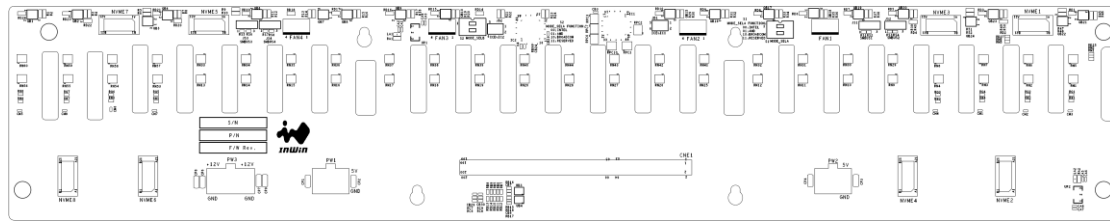


IW-RS248-03 backplane



IW-RS224-07 backplane





2 Jumper Settings

2.1 On Expander Module

System indicators and buttons designed for chassis by connecting 2-wire cable from the front panel (if existed) to the jumpers on the backplane accordingly to facilitate the alarm system.

UART header is for debugging purpose by connecting to an InWin specific serial console cable.

The definitions of the Jumpers on expander module are as below.

Jumper Name	Print	Function
JB1	M/S SEL	For future use
JB2	MUTE_BUTTON	Button for muting alarm
JB3	SYS_ERR_LED	LED indicator for Fan fails or over temperature
JB4	MB_FAN	For connecting to Motherboard Fan connector
JT1	TEST	For testing purpose
JM1	I2C_1	For future use
JM2	I2C_2	For future use
JC1	COMM	For future use
JC3	DBG/UART	Use for firmware upgrade and debugging purpose

2.2 On backplanes

There is MCU (Micro Control Unit) chip populated on backplane board for communicating with Expander module for managing LEDs and temperature detection.

The definitions of the Jumpers and switches on backplane are as below.

Jumper Name	Print	Function	Model
JD1,	ICE1	For MCU FW Programming	IW-RS118-03, IW-RS248-03, IW-RS224-07
JD2	ICE2	For MCU FW Programming	IW-RS224-07
S1	MODE_SEL	VPP over I2C Protocol Selection(for future use)	IW-RS118-03, IW-RS248-03, IW-RS224-07
S2	MODE_SEL	VPP over I2C Protocol Selection(for future use)	IW-RS224-07

3 Connectors

3.1 29-pin SAS HDD connector

There are pieces of 29-pin SAS HDD/SSD connectors to accommodate SAS/SATA HDD/SSDs on backplane. The number of the connector are as below.

Model	Number
IW-RS118-03	14
IW-RS248-03	20
IW-RS224-07	16

3.2 U.2 (SFF-8639) connector

There are pieces of U.2 connectors to accommodate SATA/SAS/NVMe HDDs/SSDs on backplane. These connectors allow to connect SAS/SATA disks or NVMe at a time. The number of the connector are as below.

Model	Number
IW-RS118-03	4
IW-RS248-03	4
IW-RS224-07	8

3.3 SFF-8643 Mini-SAS connector

There are 3 pieces of SFF-8643 female mini-SAS connectors. 2 are dedicated for connecting to host (RAID card/ HBA card) and the other one for connecting to extra backplane inside of enclosure or to an external JBOD

3.4 Power receptacle

For Expander board

1 piece of 4-pin power receptacle for providing power to the Expander board.

For backplanes

IW-RS118-03 backplane:

- 2 pieces of 3*3 power receptacle for +5V/GND

- 1 piece of 4*4 power receptacle for +12/GND

IW-RS248-03 backplane:

- 2 piece of 1*6 power receptacle for +5/GND

- 2 pieces of 1*4 power receptacle for +12V/GND

IW-RS224-07 backplane:

- 2 pieces of 3*3 power receptacle for +5V/GND

- 1 piece of 4*4 power receptacle for +12/GND

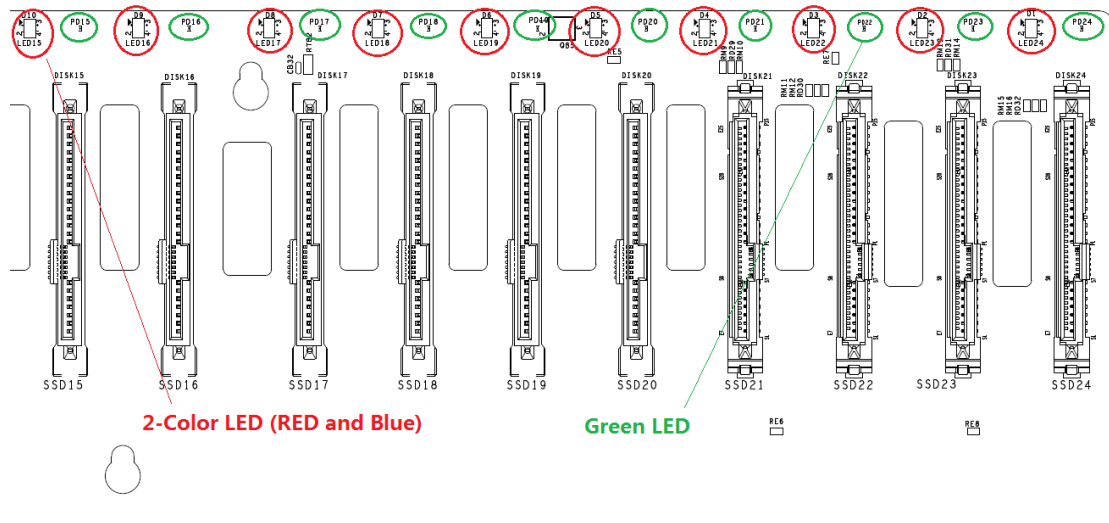
4 LED and Buzzer Behavior

4.1 Disk Bay LED

2 or 3 Disk Bay LEDs for each bay (Per SPEC, IW-RS118-03 and IW-RS248-03 are 2-LED design while IW-RS224-07 is 3-LED design) to indicate HDD status and behaviors by illuminating in different color and format.

IW-RS118-03 and IW-RS248-03 backplanes are with 2 Disk LED design while IW-RS224-07 is with 3 Disk LED design.

Some of the disk slots are designed as SATA/SAS and NVMe Hybrid which the LEDs behave according to different signals source. For SAS/SATA, the LEDs behave according to SES commands. For NVMe, the LEDs behave according to VPP over I2C respectively. SES has richer set of signals than VPP over I2C does so there are more disk array status to behave with SES.



Blue LED:

Power Indicator. Turned on whenever disk drive is properly installed.

Activity Indicator. Blinking whenever disk drive is accessing. (For 2 LED design)

Green LED:

Activity indicator. Stay off when idle and blinking whenever disk drive is accessing.

RED LED:

Fail and Locate indicator. Turned on when disk failure occurs. Blinking when locate HDD, RAID rebuild and RAID consistent check.

4.1.1 SAS/SATA Disk Array LED behavior

Basically, The LEDs behave for SAS connection following the SES control signal from RAID/HBA card. Below the table is the design SPEC of the Disk indicators.

SES Status	Status Description	Red LED (Error)	Green LED Blue LED (Activity)	Priority (Hex)	SES Control
Power-On State (before SES client intervening)					
Forced Condition					
Cleared	Empty slot or disk unplugged	Off	Off	10	N/A (SEP internal)
Condition Cleared	Disk loaded or inserting	Off	ActFlash	12	N/A (SEP internal)
Informative					
OK		Off	ActFlash	11	RQST OK
Device Off	Power down phy or bay	Off	Off	10	RQST DEVICE OFF
Reserved Device Hot Spare Do Not Remove	Usually for RAID members	Off	ActFlash	0E	RQST RSVD DEVICE RQST HOT SPARE DO NOT REMOVE
Activity					
Consistence Check (Cons Chk)	Check RAID consistence	Blink_1	ActFlash	03	RQST CONS CHECK
Rebuild/Remap (disk array)	Spare disk summoned for critical RAID rebuild	Blink_1	ActFlash	03	RQST REBUILD/REMAP
Active (Activity)		Off	ActFlash	10	RQST ACTIVITY
Warning & Error					
In Critical Array	Members in degraded RAID	Off	ActFlash	06	RQST IN CRIT ARRAY
In Failed Array	Members in broken RAID	On	ActFlash	07	RQST IN FAILED ARRAY
Rebuild/Remap Aborted (R/R Abort)	Spare disk summoned for RAID rebuild yet aborted	On	ActFlash	05	RQST R/R ABORT
Fault		On	ActFlash	04	RQST FAULT
Missing		On	ActFlash	04	RQST MISSING
Predict Failing (Fault Sensed)	Dying disk detected by enclosure	On	ActFlash	05	COMMON CONTROL PRDFAIL

Identify & Prompt					
Identify/Locate		Slow_Blink_1	ActFlash	00	RQST IDENT
Ready to Insert		Off	ActFlash	0B	RQST INSERT
Ready to Remove (RMV)	Disk spun down	Off	ActFlash	0C	RQST REMOVE
Note: ● Blink_1 : 50% On and then Off in a one second circle ● Slow_Blink_1 : 50% On and then Off in a 2 seconds circle ● ActFlash : Stay off while idle and fast flash upon I/O load					

4.1.2 NVMe Disk LED behavior

The LEDs behave for NVMe connection following the VPP over I2C signal from RAID/HBA card. Below the table is the design SPEC of the Disk indicators.

VPP over I2C Status	Status Description	Red LED (Error)	Green LED Blue LED (Activity)	Priority (Hex)	SES Control
Locate	To locate the disk	Slow_Blink_1	Off	01	
Rebuild	Rebuild member in RAID	Slow_Blink_2	ActFlash	02	
Fail	Member in broken RAID	ON	Off	03	
Activity	Disk is being accessed		ActFlash		
Note: ● Slow_Blink_1 : 50% On and then Off in a 2 seconds circle ● Slow_Blink_2 : 2s On and then 1s Off in a 3 seconds circle ● ActFlash : Stay off while idle and fast flash upon I/O load					

4.2 System Alarm LED

There is a system error LEDs designed on Expander module with a header for connecting an LED indicator to front panel (if there is) to indicate system Error such as system Fan Fail and Over-Temperature in enclosure.

System Fail Indicator:

JB3 is the jumper header for system Fail Indicator. The System Fail indicator on the front panel connect to this header to indicate system fan fails or system overheat when it occurs.

Fan Fail:

When the Fan RPM is lower than 50% of the expected speed the indicator goes ON. And it goes off when the issue is resolved or not existed.

Overheat:

When the system temperature at the backplane area is going beyond 45°C the System Fail LED is turned ON. And would be turned off when temperature is going under 44°C

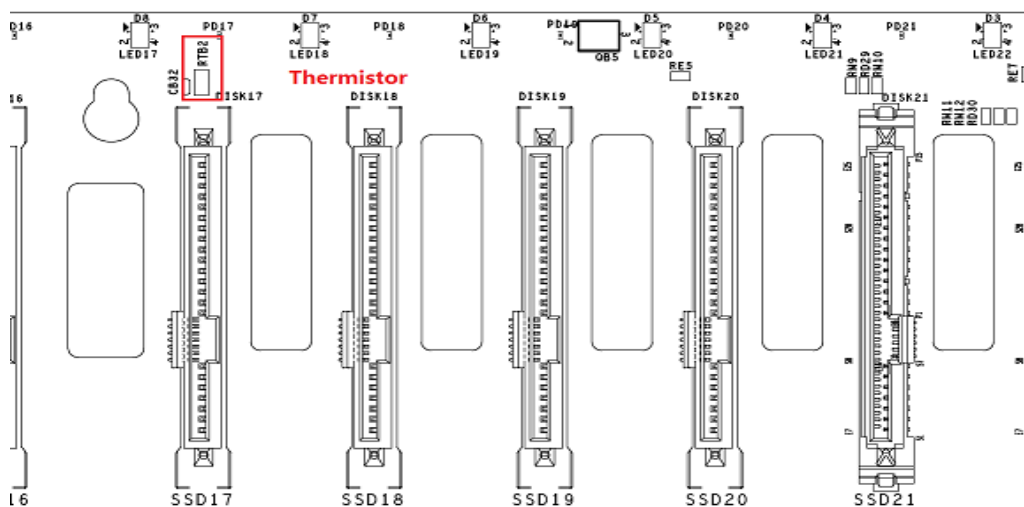
Note:

- ◆ When the system alarm is triggered, the Buzzer beeps along with it and stops beeping when alarm is disappear.
- ◆ 1 short beep stands for Fan Fails
- ◆ 2 short beeps stand for Over-Temperature
- ◆ Press Mute Button to disable buzzer beeps and will be retriggered when either system error occurs again.

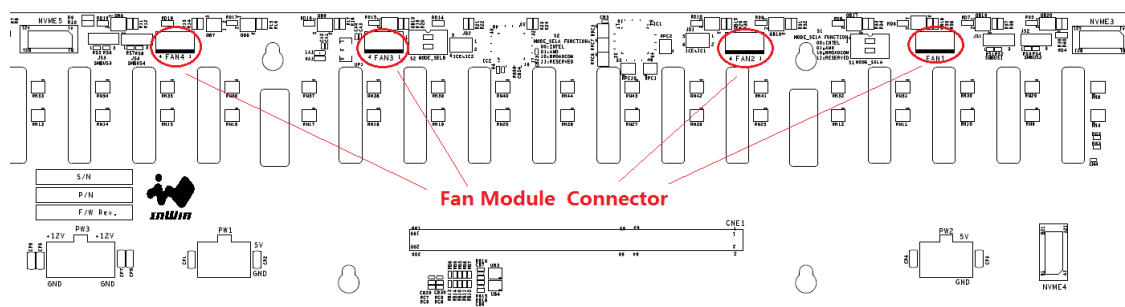
5. Smart Fan Control

InWin's Backplane is implemented Smart Fan Control feature by automatically detecting the existences of the Fan Modules and intelligently control the Fan RPM per the system temperature being sensed by 2 thermal sensors on residing backplane.

Please note that this feature only supported on the backplane with Fan connector design.



Thanks to Smart Fan Control feature the Fan connectors on backplane support wide variety of PWM driven Fan modules being used in the enclosure.

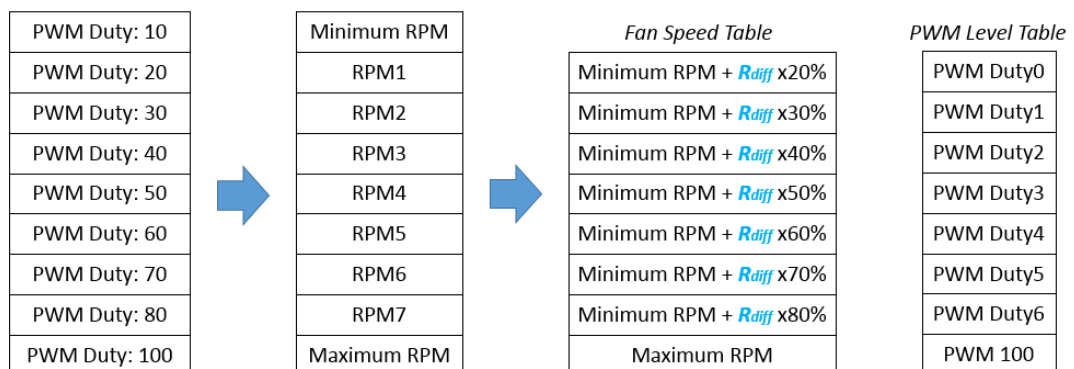


How it works?

1. Fan module auto-calibration would launch in every system boot. The profile would then be recorded and used until next reboot.
2. Backplane starts fan calibration and calculates the corresponding PWM duty cycle for each level. There are totally 8 speed levels to be calculated and recorded.
3. The 8 levels of fan speed are mapped to the temperature readings sensing by thermistor spreading from 25 to 45 °C in 3.75 degree C step.
4. In normal operation, when the system Temperature changed, the fan module would change speed accordingly. And, the Fan failure alarm would be triggered when the RPM of the Fan module is dropped lower than 75% of its expected speed.
5. The fan module calibration and control profile are as below.

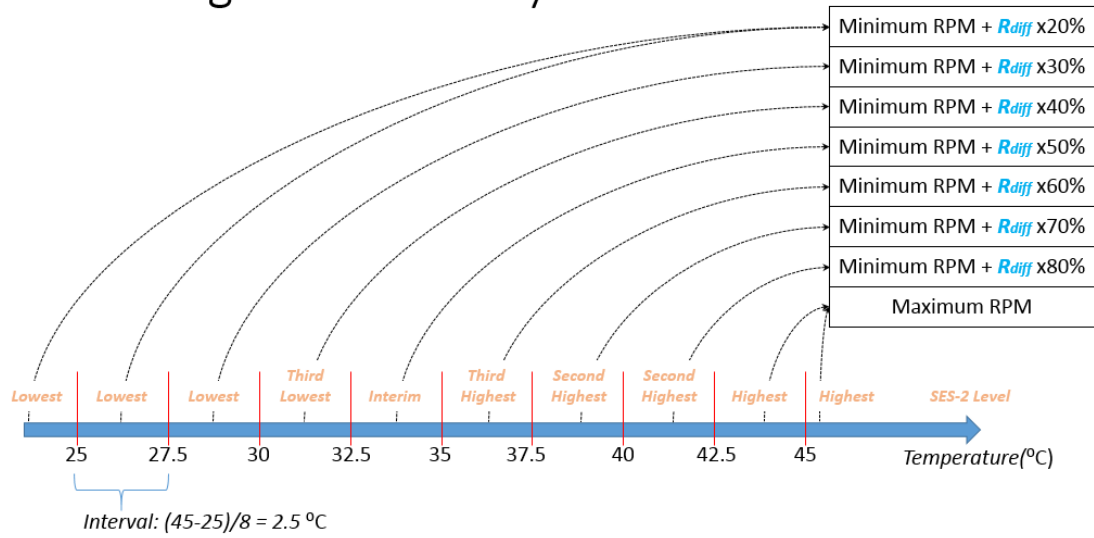
Fan Speed Measurement

$$R_{diff} = \text{Maximum RPM} - \text{Minimum RPM}$$



Cooling Control Policy – 45 Celsius

Fan Speed Table



6. Firmware Upgrade

The SAS3 backplane is implemented with a firmware upgrade feature through a serial console in case it is required. There are 2 firmwares to be upgraded. One is Expander system firmware and another is MFG configuration data. They are not necessarily to be upgraded at the same time. Either one can be upgraded independently when required.

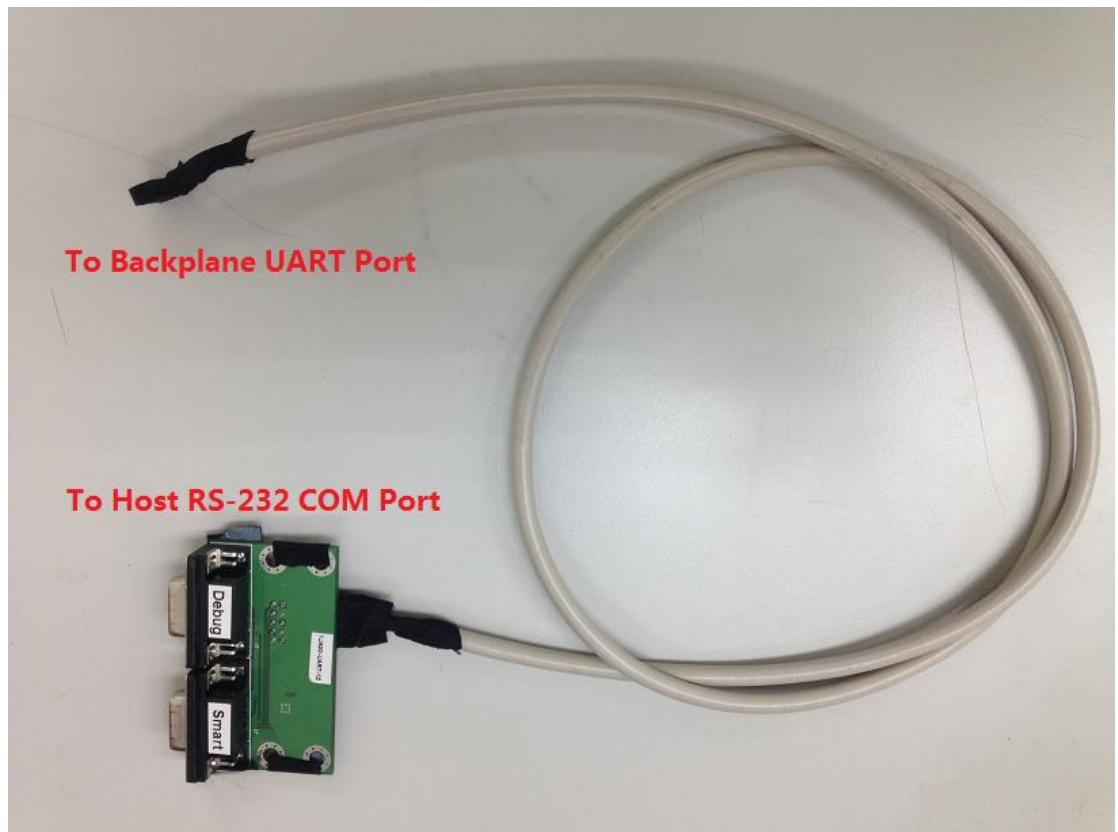
How to upgrade firmware?

1. Out-Of-Band through serial console
2. In Band through SES Command

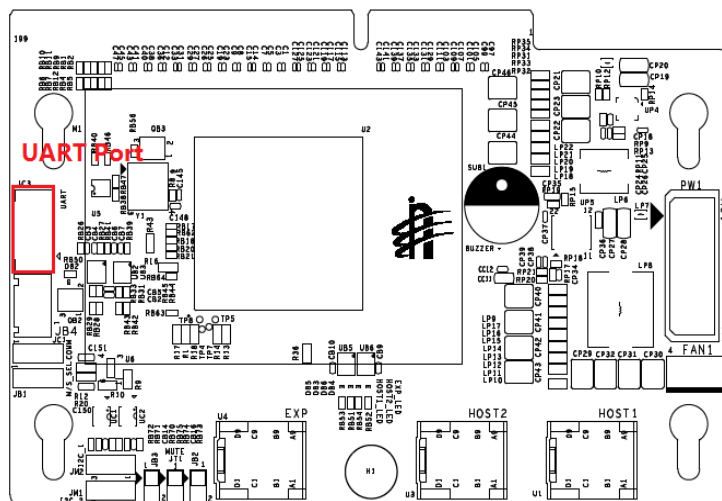
6.1 Out-Of-Band through serial console

InWin's SAS-3 12Gps Backplane implements a serial UART port allowing users to conduct firmware upgrade through it.

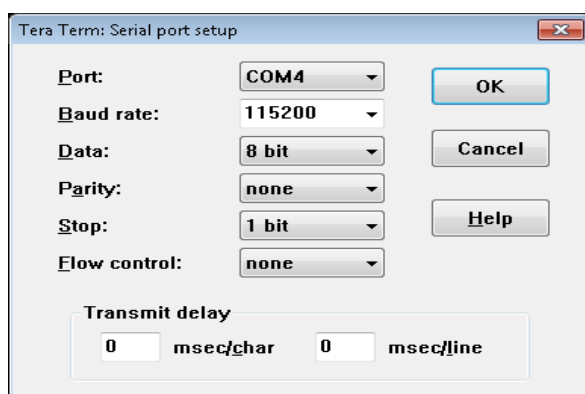
1. Require a proprietary serial cable InWin made.



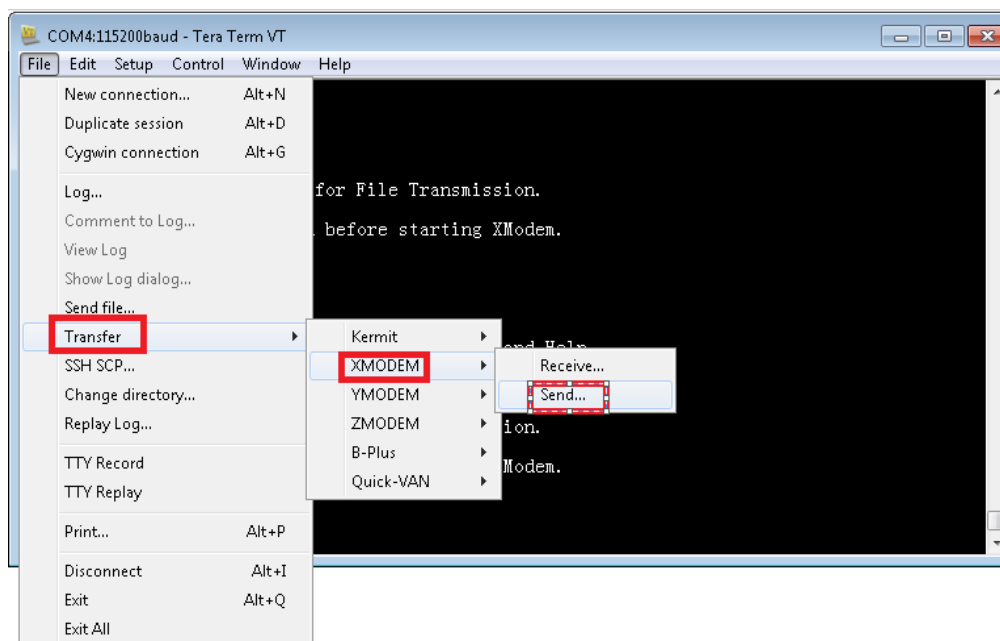
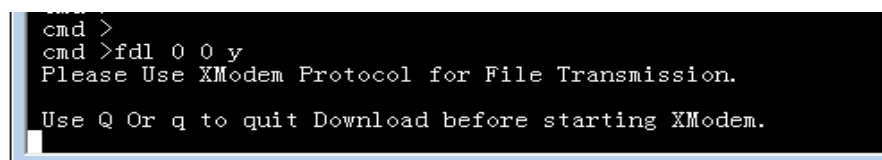
2. Require a host with a serial COM port.
3. Connect serial cable between Backplane and host.

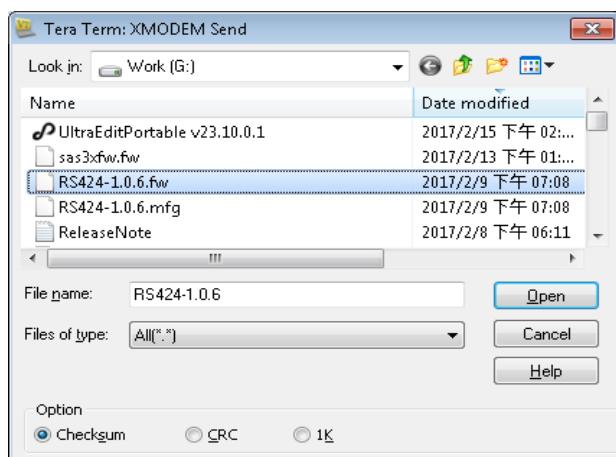


4. Configure serial port setting as 115200, N, 8, 1.

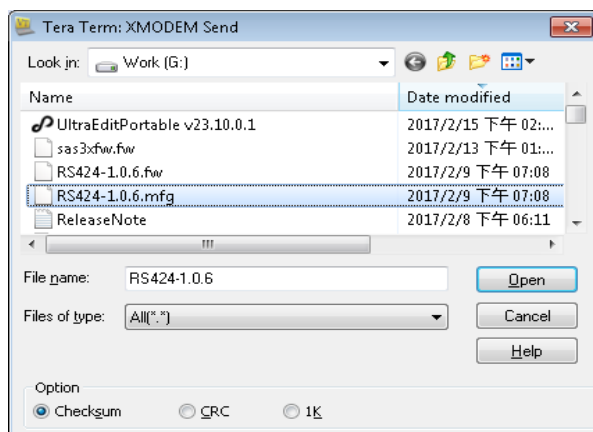
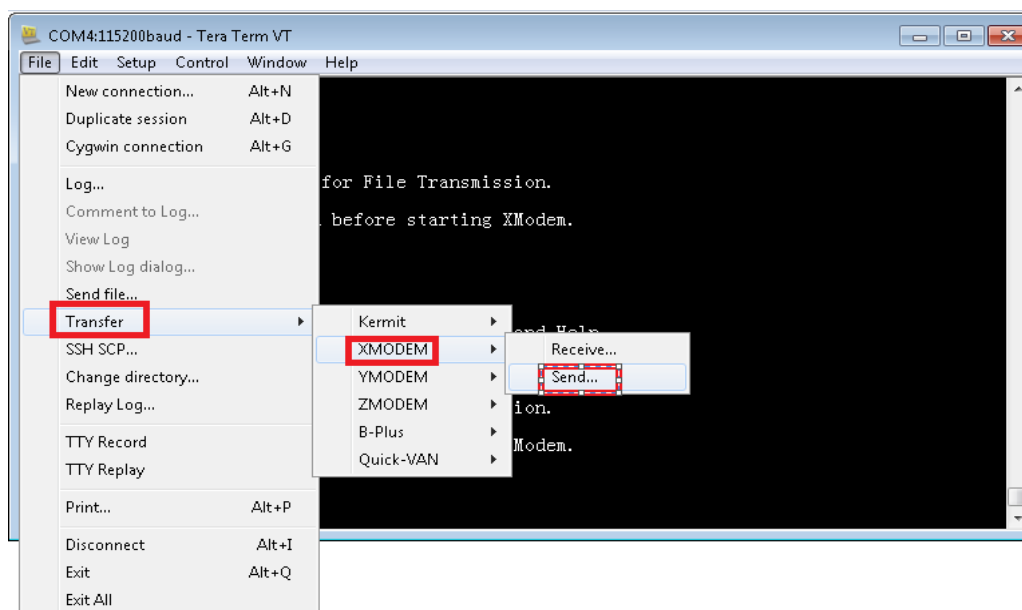
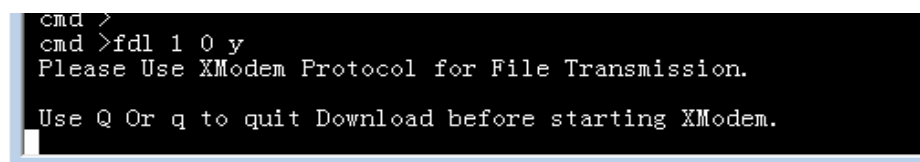


5. Command “fdl 0 0 y” for system firmware upgrade in serial console. Sending system firmware through Xmodem.





6. Command “fdl 1 0 y” in serial console for system configuration data upgrade.
Sending system firmware through Xmodem.



7. Reset system by typing “reset” command in serial console or power cycle to make new firmware take effect.

6.2 In Band through SCSI Command

An option way to program firmware out of UART console is to leverage sg utilities going through In Band connection. No extra serial cable required.

1. Download sg utility. (For either Windows or Linux)
 - i. http://sg.danny.cz/sg/p/sg3_utils-1.42_mw64exe.zip
 - ii. http://sg.danny.cz/sg/p/sg3_utils-1.42.tgz
2. Install sg utility onto server which is with HBA/RAID card installed.
3. Connect backplane to the installed HBA/RAID card.
4. Issue command to check connected backplane.
 - i. “sg_scan -s” to list SCSI devices in the system.

```
C:\Users\Administrator\Downloads\sg3_utils-1.42>sg_scan -s
PD0      [C]      WDC WD50  00AAKX-001CA      15.0      W -DCWYAFU307288

SCSI0:0,0,0   claimed=1 pdt=0h      WDC WD50  00AAKX-001CA      15.0
SCSI1:1,112,0 claimed=0 pdt=dh      IN-WIN   RS-316      0009
SCSI1:2,36,0  claimed=0 pdt=dh      IN-WIN   RS-212      0009
```

5. Issue command to conduct firmware upgrade.

- i. sg_ses_microcode usage

```
C:\Users\Administrator\Downloads\sg3_utils-1.42>sg_ses_microcode -h
Usage: sg_ses_microcode [--bpw=CS] [--help] [--id=ID] [--in=FILE]
                        [--length=LEN] [--mode=MO] [--non]
                        [--offset=OFF] [--skip=SKIP] [--subenc=SEID]
                        [--tlength=TLEN] [--verbose] [--version]
                        DEVICE

where:
  --bpw=CS|-b CS      CS is chunk size: bytes per send diagnostic
                        command (def: 0 -> as many as possible)
  --help|-h           print out usage message then exit
  --id=ID|-i ID       buffer identifier (0 (default) to 255)
  --in=FILE|-I FILE   read from FILE ('-I -' read from stdin)
  --length=LEN|-l LEN length in bytes to send; may be deduced from
                        FILE
  --mode=MO|-m MO     download microcode mode, MO is number or
                        acronym (def: 0 -> 'dmc_status')
  --non|-N            non-standard: bypass all receive diagnostic
                        results commands except after check condition
  --offset=OFF|-o OFF buffer offset (unit: bytes, def: 0);
                        ignored if --bpw=CS given
  --skip=SKIP|-s SKIP bytes in file FILE to skip before reading
  --subenc=SEID|-S SEID subenclosure identifier (def: 0 (primary))
  --tlength=TLEN|-t TLEN total length of firmware in bytes
                        (def: 0). Only needed if TLEN>LEN
  --verbose|-v        increase verbosity
  --version|-V        print version string and exit

Does one or more SCSI SEND DIAGNOSTIC followed by RECEIVE DIAGNOSTIC
RESULTS command sequences in order to download microcode. Use '-m xxx'
to list available modes. With only DEVICE given, the Download Microcode
Status dpage is output.
```

- ii. For MFG file upgrade use below the command
 sg_ses_microcode.exe -b 4k -m 7 -i 1 -I Cub-1.0.7.mfg SCSI1:1,112,0

- iii. For Firmware upgrade use below the command
`sg_ses_microcode.exe -b 4k -m 7 -i 0 -l Cub-1.0.11.fw SCSI1:1,112,0`
6. Power cycle backplane to make new firmware take effect.

7. Management

To manage backplane, users can connect a serial console cable to backplane or expander UART through RS232 COM port on system host. Refer to Section 6.1 for the details of the serial console cable and the console terminal setting.

There are some useful commands for users to check expander status, conduct firmware update and debug issue when required.

Useful Console Commands

Function	Command
help	To list the usage of the CLI commands
Show/Set the current	date [set <newdate(*)>]
Reset the expander	reset [watchdog]
Display phy info.	phyinfox [-i [(1 .. NumBpc)] -s -i : show phy info of BPC expander -s : show SES Array Device info of CSE BRC (bridge console only)
Configuration update	fdl 1 0 y Download and Update MFG configuration. (feed it with 'MFG image file')
Firmware Update	Fdl 0 0 y Download and update firmware
Display info for all phys	phyinfo [help edfb power cable] [up <PhyNum(D)>] - no arguments displays default output - 'help' displays detailed help information - 'edfb' subcommand displays EDFB info - 'power' subcommand displays power mgmt info - 'up' filters to display connected phys only - 'cable' subcommand displays cable mgmt info - <PhyNum> is a valid phy index and filters the output to display info about that phy
Display or reset all phy counters	counters [config event reset] - no arguments displays phy error counters and generic broadcast counters

	- 'config' subcommand displays phy event configuration - 'event' subcommand displays phy event counters - 'reset' subcommand resets all phy counters
Display expander SAS address	sasaddr [-d] ('-d': also show virtual ports address)
Show POST info	showpost
Show MFG revision	showmfg
Show firmware revision	rev