I2C FRU FAN SPECIFICATION

FOR FANS USED ON SELECT FACEBOOK SYSTEMS

REV 1.5.0
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REVISION HISTORY

REVISION	AUTHOR(S)	DESCRIPTION	DATE
1.0.0	Daniel Xu	INITIAL RELEASE	07/14/2020
1.1.0	Daniel Xu	Removed requirement for GND pins to mate first. Changed to use one EEPROM per Dual Rotor Fan.	07/16/2020
1.1.1	Daniel Xu	Edited Multirecord header and Internal Use Area to conform with IPMI FRU Information Storage v1.2	08/21/2020
1.2.0	Daniel Xu	Corrected OEM Multirecord offsets. Made specification generic to all FB servers.	11/18/2020
1.3.0	Daniel Xu	Corrected Product Info Area size byte.	01/20/2021
1.4.0	Dan Zhang	Move FRU format spec to github	02/05/2021
1.5.0	Daniel Xu	Change I2C Series Resistor Value from 100 ohms to 22 ohms.	02/26/2021

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SCOPE

This document provides the technical specification for FRU Fans for use on Facebook rack-mounted and standalone data center equipment. As such, the information in this document should provide the information needed to create a fan conforming to the FRU Fan Specification. Additionally, this document provides examples of expected FRU Fan behaviors to help inform both fan manufacturers and system designers understand the fan's capabilities.

Currently, FRU Fans are being introduced for certain products at Facebook.

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INTRODUCTION

This specification describes both the electrical and command interfaces for I2C FRU Fans. I2C FRU Fans are designed for use in select Facebook servers. The decision to use FRU Fans is undertaken by the core team for a specific server product.

Traditional DC fans come in two, three and four-wire varieties. A two-wire fan consists of a wire for applying a voltage and a wire for ground. Control of the fan is done via pulse-width modulation (PWM) or via a variable power supply on the voltage wire. The three-wire fan adds a tachometer output which allows for the ability for a system to monitor the RPM of a fan. The four-wire fan adds a PWM input which removes the need for directly controlling the voltage line on the fans. Instead, a PWM duty cycle is given to the PWM input and the fan will automatically adjust the RPM.

The benefits of a FRU Fan are to provide traceability beyond what even a four-wire fan can provide.

- Serial number, model and date code.
- Voltage and Current Character
- SW and HW Revisions

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ELECTRICAL SPECIFICATION

Electrical specification for the FRU Fan interface.

SYSTEM INTERFACE

The interface between the system and the FRU Fan will have the following signals. Note that the connector may include more pins due to power requirements.

DUAL ROTOR FAN

Signal Name	Description
V+	The supply voltage for the fan. Provides power for both the fan and associated circuity. (Shared)
GND	Ground (Shared)
PWM_1	PWM Control (Server-side rotor)
PWM_2	PWM Control (Exhaust-side rotor)
TACH_1	Tachometer Reading (Server-side rotor)
TACH_2	Tachometer Reading (Exhaust-side rotor)
SDA	I²C Data Line (Shared)
SCL	I²C Clock Line (Shared)
PRES	Fan Presence Detect

CONNECTOR

The exact connector between the system and the FRU Fan is left unspecified to allow for flexibility for system designers. However, for a dual rotor fan, there most likely needs to be a 12-pin connector due to needing two pins for the power and ground signals.

VOLTAGE LEVELS

The V+ line's voltage is defined by the fan. The GND signal is the ground reference for the fan. All other signals are to operate at 3V3.

I²C INTERFACE

Electrical specification follows the "Standard-mode" I²C device characteristics in the I²C specification. For FRU Fans, additional specifications for the interface are defined to allow for system compatibility. The I2C interface should operate at 3V3 (+/- 5%). In addition, the speed for communication should be 400KHz-capable.

No pull-ups resistors should be placed on the I²C signals (SDA, SCL) on the fan. It is the job of the system designer to appropriately select those resistors. To assist, the fan vendor should report the added capacitance of the FRU Fan on the I²C signals. To protect the system from high-voltage spikes, a series resistor (~22 ohms) should be placed on the FRU Fan circuity for both the SCL and SCK lines as close as possible to the pins. The fan vendor should also report the total series resistance to the EEPROM.

System side considerations include proper selection of pull-up resistor. In addition, hot swap protection is not built into the FRU fan. For safe hot swapping of the fans, a I2C hot swap buffer like the Texas Instruments TCA4311A or the NXP PCA9511 along with protection diode is recommended on the system.

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FUNCTIONAL SPECIFICATION

This is expected to be compatible with future generations of Smart Fans.

PRESENCE DETECT ($\overline{PRES}$)

On the system, the presence detect should be pulled-up with a high-valued resistor (ex. 1M). When no fan is present, the system will see the presence detect signal high. When the fan is fully mated, the FRU Fan pull the signal down to ground.

I²C ADDRESSING

The system should operate using 7-bit I²C addresses. The address should be 1010000.

I²C PROTOCOL (SDA, SCL)

The FRU Fan will communicate to the system via an I²C EEPROM interface.

GENERAL PROTOCOL SPECIFICATIONS

The system is the master and the FRU Fan is the endpoint device.

EEPROM INTERFACE

The interface used will need to be compatible with the standard 24LCXX EEPROMs with **2-byte addressing** not 1-byte. A list of 12LCXX series EEPROMs can be seen below (From Ref 3). Note that this shows both 1 and 2 byte addressed EEPROMs. In addition, the EEPROM must be 400KHz capable.

SERIAL EEPROM CROSS REFERENCE GUIDE

Size (bits)	MCHP Part #	Atmel Part #	Catalyst Part #	Fairchild Part #	Philips / Signetics Part #	Rohm Part #	ST Part #	Xicor Part #
128 to 512K I²C™ compatible Devices (Microchip's B revision devices do not use address pins A0, A1 and A2. These pins have no internal connection.)								
128	24AA00 **T- t / p**		CAT24C00 **pt-v T**					
128	24C00 **T- t / p**							X24C00 **pt-v**
128	24LC00 **T- t / p**							
1K	24AA01 **T- t / p**	AT24C01-10 **pt-v T**	CAT24C01B **pt-v T**			BR24C01A **p-W T**	M24C01-**vptT**	
1K	24LC01B **T- t / p**				PCA8581C **p**			X24C01 **pt-v**
1K	24C01C **T- t / p**	AT24C01A-10 **pt-v T**	CAT24WC01 **pt-v T**		PCA8581 **p**		M24C01-**vptT**	X24C01 **pt-v**
1K	24LC014 **T- t / p**	AT24C01A-10 **pt-v T**	CAT24WC01 **pt-v T**		PCA8581C **p**		M24C01-**vptT**	X24012 **pt-v**
1K	24LC21A **T- t / p**	AT24C21-10 **pt-v T**	CAT24C21 **pt-v T**		PCB2421C **p**	BR24C21 **p-T**	ST24FC21-**ptT**	
1K	24LCS21A **T- t / p**						ST24FW21-**ptT**	
2K	24AA02 **T- t / p**	AT24C02ad-10 **pt-v T**	CAT24WC02 **pt-v T**			BR24C02 **p-WT**	M24C02-**vptT**	
2K	24LC02B **T- t / p**			FM24C02U **fvtp**	PCF8582C-2 **p**			X24C02 **pt-v**
2K	24C02C **T- t / p**	AT24C02ad-10 **pt-v T**	CAT24WC03 **pt-v T**	FM24C03U **fvtp**	PCF8582C-2 **p**		M24C02-**vptT**	X24C02 **pt-v**
2K	24LC024 **T- t / p**	AT24C02ad-10 **pt-v T**	CAT24WC03 **pt-v T**		PCF8582C-2 **p**		M24C02-**vptT**	X24C02 **pt-v**
2K	24LC025 **T- t / p**							
2K	24LCS52 **T- t / p**						M34C02, M34C02-W	
4K	24AA04 **T- t / p**	AT24C04ad-10 **pt-v T**	CAT24WC04 **pt-v T**			BR24C04 **p-T**	M24C04-**vptT**	
4K	24LC04B **T- t / p**			FM24C04U **fvtp**	PCF8594C-2 **p**			X24C04 **pt-v**
8K	24AA08 **T- t / p**	AT24C08ad-10 **pt-v T**	CAT24WC08 **pt-v T**			BR24C08 **p-WT**	M24C08-**vptT**	
8K	24LC08B **T- t / p**			FM24C08U **fvtp**	PCF8598C-2 **p**			X24C08 **pt-v**
16K	24AA16 **T- t / p**	AT24C16ad-10 **pt-v T**	CAT24WC16 **pt-v T**			BR24C16 **p-WT**	M24C16-**vptT**	
16K	24LC16B **T- t / p**			FM24C16U **fxvtp**	PCF85116-3 **p**			X24C16a **pt-v**
32K	24AA32A **T- t / p**	AT24C32ad-10 **pt-v T**	CAT24WC32 **pt-v T**			BR24C32 **p-WT**	M24C32-**vptT**	
32K	24LC32A **T- t / p**							X24320 **pt-v**
64K	24AA64 **T- t / p**	AT24C64ad-10 **pt-v T**	CAT24WC64 **pt-v T**			BR24C64 **p-WT**	M24C64-**vptT**	
64K	24LC64 **T- t / p**			FM24C64 **fvtp T**				X24645 **pt-v**
64K	24AA65 **T- t / p**							
64K	24LC65 **T- t / p**							
128K	24AA128 **T- t / p**	AT24C128d-10 **pt-v T**	CAT24aC128 **pt-v T**				M24C128-**avptT**	
128K	24LC128 **T- t / p**			FM24C128 **fvtp T**				X24128 **pt-v**
128K	24FC128 **T- t / p**	AT24C128d-10 **pt-v T**	CAT24aC128 **pt-v T**				M24C128-**avptT**	X24128 **pt-v**
256K	24AA256 **T- t / p**	AT24C256d-10 **pt-v T**	CAT24WC256 **pt-v T**				M24C256-**avptT**	
256K	24LC256 **T- t / p**			FM24C256 **fvtpT**				X24C256 **pt-v**
512K	24AA512 **T- t / p**	AT24C512d-10 **pt-v T**					M24512-**vptT**	
512K	24LC512 **T- t / p**							
512K	24FC512 **T- t / p**	AT24C512d-10 **pt-v T**						
512K	24AA515 **T- t / p**							
512K	24LC515 **T- t / p**							
512K	24FC515 **T- t / p**							

The fan vendor should report what EEPROM model(s) are being used on the fan.

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EEPROM Data Structure

The FRU data on the EEPROM will be organized per the IPMI FRU Information Storage Definition v1.2.

FRU Information Format

The latest FAN FRU format please refer to: Smartfan-fru.md at Facebook OpenBMC github

REFERENCES

1. UM10204 I²C-bus specification and user manual https://www.nxp.com/docs/en/user-guide/UM10204.pdf
2. IPMI Platform Management FRU Information Storage Definition https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/platform-management-fru-document-rev-1-2-feb-2013.pdf
3. Microchip Serial EEPROM Cross Reference Guide http://ww1.microchip.com/downloads/en/devicedoc/21621d.pdf