Mini FieldHub User Manual

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Approved by	*Laboratory*

Used abbreviations:

AC	Alternating Current
DC	Direct Current
DNL	Do Not Load
FPGA	Field Programmable Gate Array
GP	General Purpose
ICM	IceCube Communication Module
IRIGB	Inter Range Instrumentation Group Timecode
mFH	mini FieldHub
PCB	Printed Circuit Board
SoC	System on Chip
UART	Universal Asynchronous Receiver Transmitter
USB	Universal Serial Bus

History		
Version	Date	Observation
1.0	2024-04-22	Draft
1.1	2024-04-23	See datasheet, wire pair connector type corrected to DSUB-9 female
1.2	2024-07-11	Wire pair current / voltage measurements resolution added
1.3	2024-07-22	Clock source select jumper, typo corrected, JP5 -> JP2

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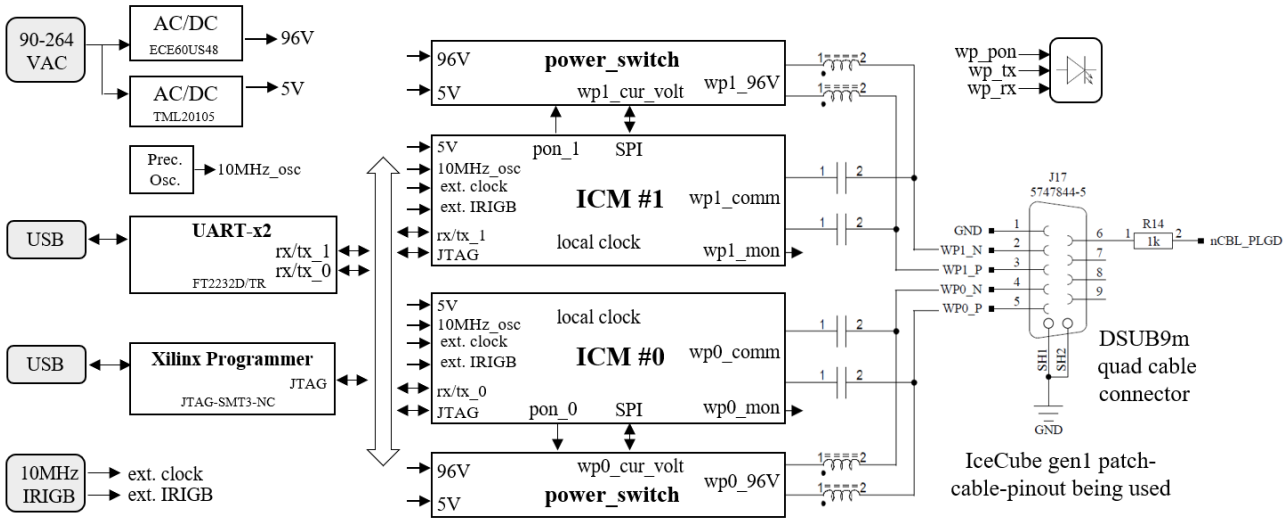
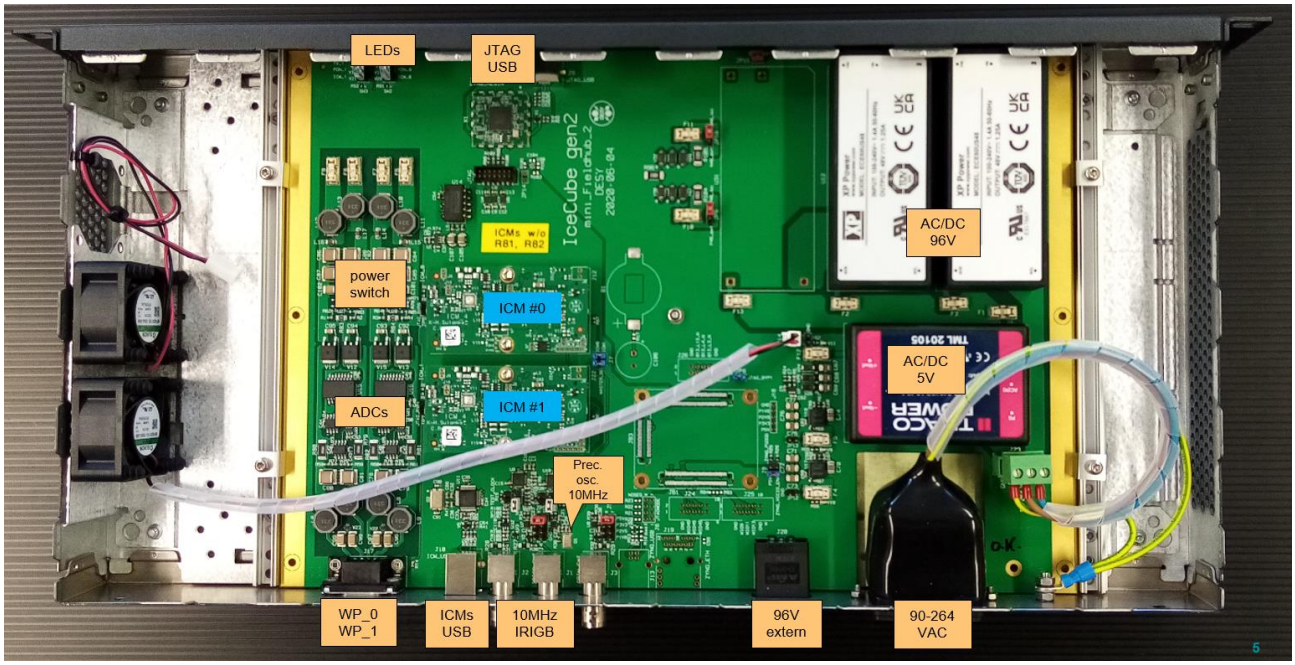
1 Introduction

The mFH, equipped with two ICMs, allows to communicate with IceCube Upgrade in-ice modules, by controlling two wire pairs. The wire pair voltages and currents can be monitored.

2 Block Diagram



3 mini-Fieldhub Rev.2



4 Datasheet

Mechanics	483x230x45 mm, (19x9x1.75 inch), zinc-plated steel / aluminum (front+back plate)
Weight	4kg
Operating Temperature	-25°C to +85°C
AC input connector	rubber connector (cold device plug)
AC Input voltage range	96 to 264VAC
Max. power consumption	150W @ 96V output, 218W @ 144V ouput
Wire pair voltage by internal AC/DC	96V nominal, 144V optional
Wire pair voltage by external psupply	70V to 150V
Wire pair maximum current	0.6A
External power supply connector type	TE 1-178293-2
Wire pair current monitoring, resolution	4.12 mA/bit
Wire pair voltage monitoring, resolution	0.3377 V/bit
Wire pair connector (in-ice-module)	DSUB-9 female, 4/40” fixing nuts
Clock input	50ohm-terminated BNC
Clock input, signal level	100mV to 5V pk-pk, sine or rectangular, check J4 setting!
IRIGB input	50ohm-terminated BNC
IRIGB input, signal level	2.5V to 5V, check J4 setting!
GP_in input	50ohm-terminated BNC
GP_in input, signal level	1.8V to 5V, check J5 setting!
Communication module type	ICM_1 to ICM_4
JTAG-USB connector type	USB-B (ICM, FPGA-flash programming)
JTAG-module type	DIGILENT JTAG-SMT3-NC
ICM-flash type	IS25WP128-JLLE (ICM_1) or IS25WP128-JKLE (ICM_2..4)
ICM-USB connector type	USB-B, (ICM to in-ice-device, power switch and communication)
ICM-USB to UART bridge type	FT2232D

5 How to open the mini-FieldHub

At the back side, remove the two countersunk M3 screws using a Torx-10 screw driver. In some cases it could be necessary to increase the unscrew-force by additionally using a spanner or plier. Reason is the accidentally used wrong Loctite-type 2701 instead of 243. Lift the modules lid by leveraging the outer edges (there are notches) with a flat headed screw driver (e.g 8mm wide). Before putting the lid back, be sure the 4-fold LED light pipes at the front panel are positioned correctly!

6 ICMs, Clock and IRIGB Sources

There are 3 ICM clock sources, the own precision local oscillator, an external 10MHz clock and the mFH-local precision 10Mhz oscillator. The IRIGB signal is usually provided by a GPS module in parallel to the external 10MHz. An artificial IRIGB could also be generated by one of the two ICMs. So far this feature is not yet implemented in firmware. Clock sources and clock voltage levels have to be set by jumpers.

7 Jumper Settings

7.1 96V wire pair Power Supply by two internal AC/DC modules ECE60US48

The figure below shows the default jumper settings for 96V wire pair voltage, delivered by the two internal 48V/60W AC/DC power modules. For other use cases see the tables below.

7.2 144V wire pair Power Supply by three internal AC/DC modules ECE60US48

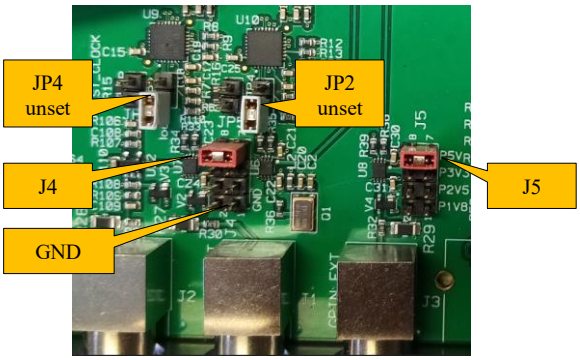
jumper	**setting**	**remark**
JP16, GND48_sel	unset	Mid voltage GND_48 by 100k resistor divider
JP15, 96V_sel	unset	
JP9	P48_loc	
JP10	N48_loc	

7.3 Variable external wire pair Power Supply, 75V to 150V

jumper	**setting**	**remark**
JP16, GND48_sel	unset	Mid voltage GND_48 by cable connection
JP15, 96V_sel	unset	
JP9	P48_ext	
JP10	N48_ext	

7.4 Selecting the external clock / IRIGB source

The figure below shows the default jumper settings for enabling the external clock and the external IRIGB signal, assuming 3V to 5V logic level at a 50ohm load. JP4, JP5 are in park position. For other use cases see the tables below.



7.5 Selecting the external clock / IRIGB and General Purpose signal levels at 50ohm(!) load

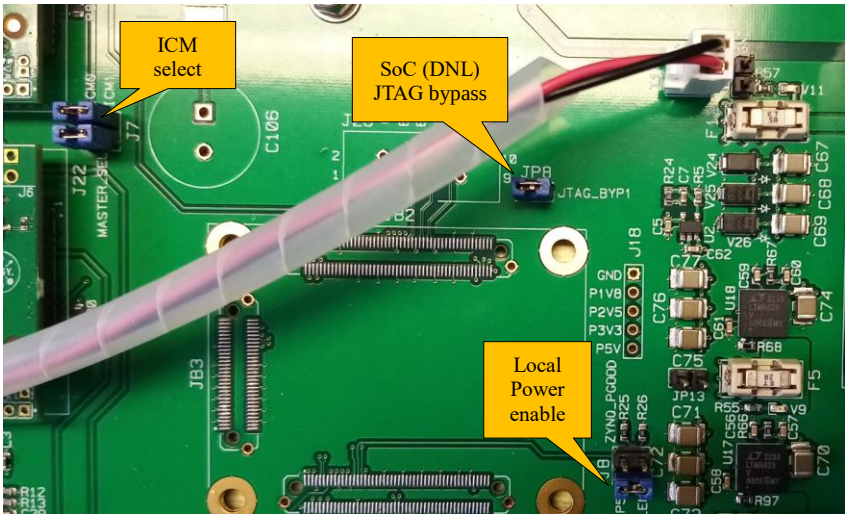
jumper	setting	remark
J4, for the Clock input (BNC) and the IRIGB input (BNC)	set	Top-down, logic levels: 5V, 3.3V, 2.5V The lowest two pins sind on GND (!)
J5, for the GP_In input (BNC)	set	Top-down, logic levels: 5V, 3.3V, 2.5V, 1.8V Has to be supported by ICM firmware

7.6 Selecting the internal clock / IRIGB source

jumper	setting	remark
JP2	set	10MHz ICM clock by local precision oscillator
JP4	set	Artificial IRIGB signal by ICM #0 or #1, firmware dependent

7.7 Other jumpers

The below shown jumpers must be set always.

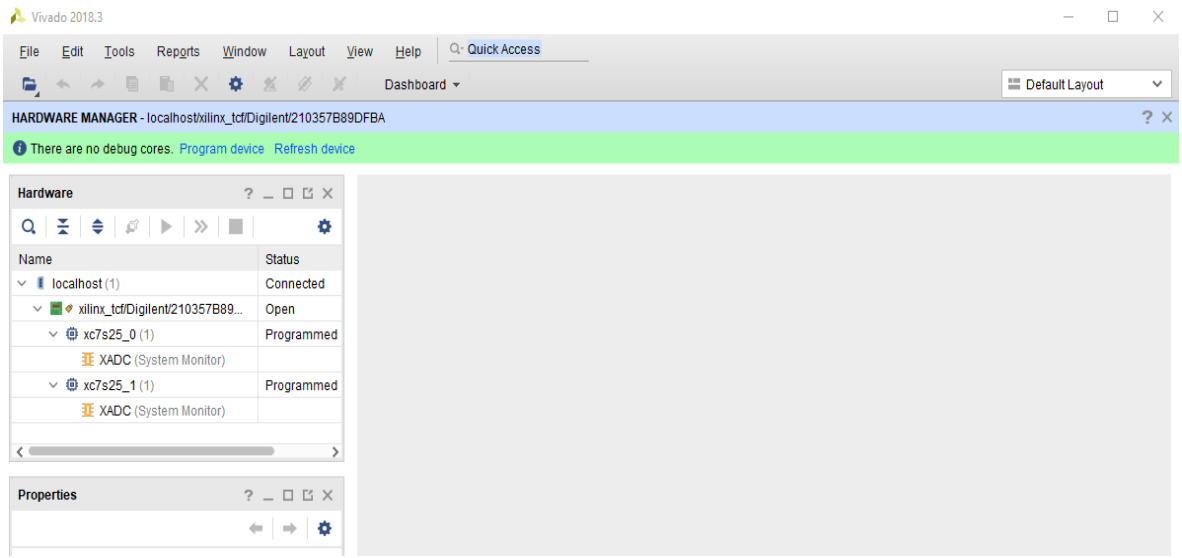


8 ICM firmware update via USB / JTAG

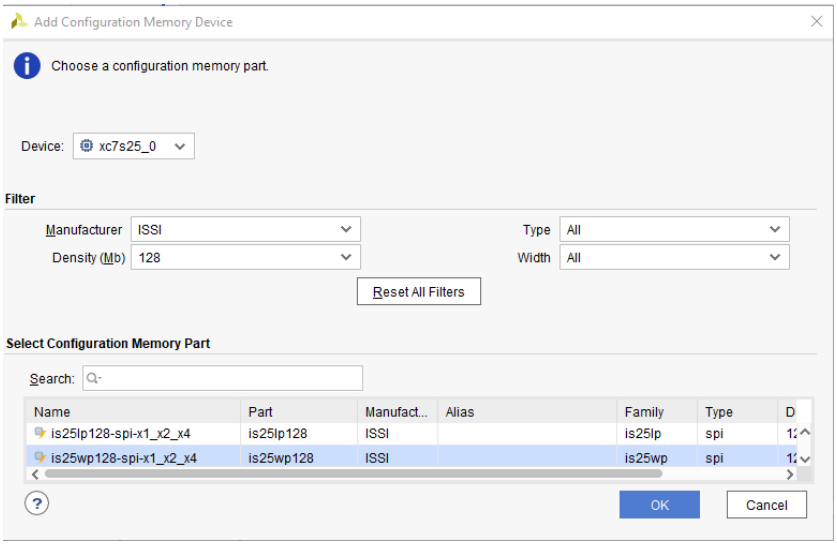
Depending on the ICM firmware, the ICMs FPGA-flash can be updated per software, using the ICM-USB connection. If this is not possible, the JTAG-USB connector allows the direct programming of both flash chips, provided the Xilinx development tool Vivado / Hardware Manager is available and the Digilent programmer driver is being installed. As an alternative, the Xilinx Platform Cable USB II can be used by directly connecting it to the onboard JTAG connector J16.

The following figures illustrate the steps required, e.g. using Vivado 2018.3 and the onboard Digilent programmer. After starting Vivado choose “Open Hardware Manager”.

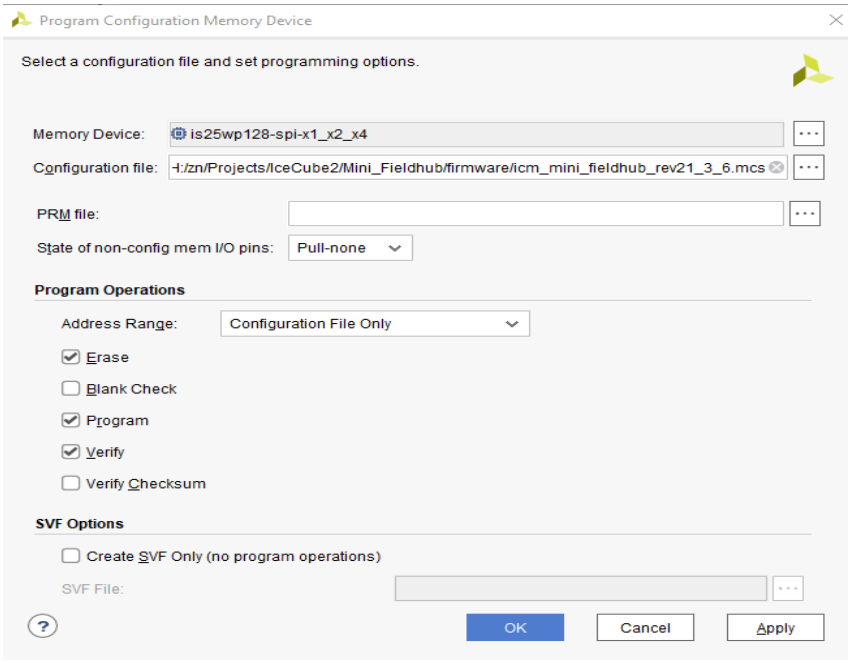
In the new window select “Open target / Auto Connect”, top left in blue. You should see two Xilinx FPGAs of the type XC7S25, belonging to the ICMs #0, #1, see below.



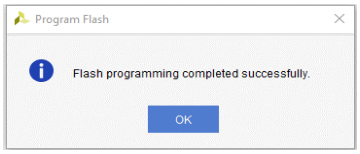
Right-click on the upper FPGA and select “Add Configuration Memory Device”. Pick the is25wp128-spi-1_x2_x4



Choose OK and select the Configuration file, e.g. /icm_mini_fieldhub_rev21_3_6.mcs



Wait for the message

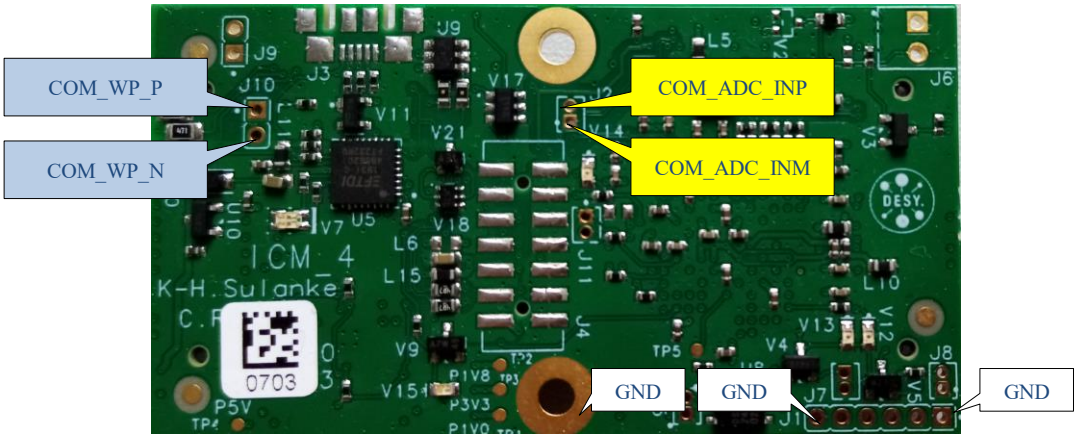


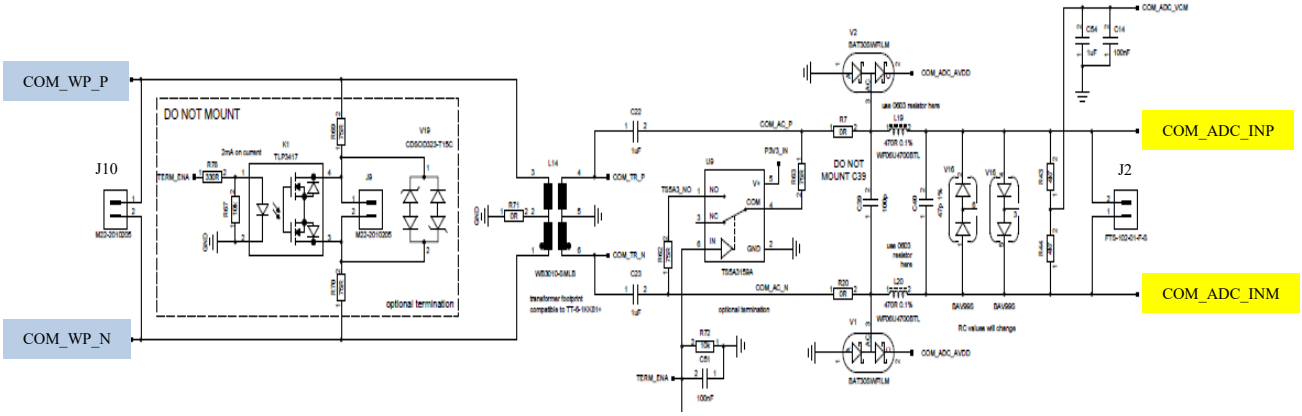
After repeating the operation for the second FPGA you are done. You need to power-cycle the mFH to activate the latest firmware!

9 Test Points on the ICM

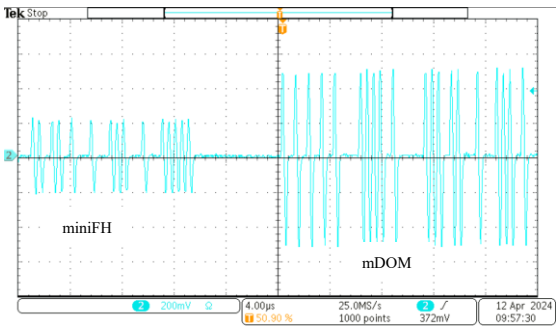
9.1 Communication, unfiltered Wire Pair- and filtered ADC Input signal

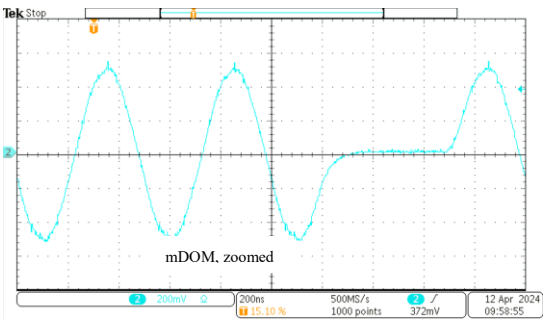
Best, use a differential probe. Or two single ended probes + GND connection in differential math-mode.





E.g., the half duplex comms. signal, measured at J2 of an mFH-ICM, talking to a mDOM, using a 1.5m 100ohm twisted pair cable and a diff. probe (Tektronix P6247).





10 Wire Pair Current and Voltage Monitoring

10.1 10bit-ADC Resolution

Wire pair voltage: **351mV / bit**
Wire pair current: **4.2mA / bit**