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Multi-Purpose ASIC Control & Interface Electronics (MACIE)

H A R D W A R E M A N U A L

Revision 5.0
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1 Scope

This Hardware Manual describes the mechanical and electrical interfaces to the Multi-Purpose ASIC Control & Interface Electronics (MACIE). The document furthermore provides all relevant information to set up the MACIE hardware and to configure the MACIE firmware.

Please refer to the respective MACIE Software Manuals for the use of the MACIE graphical user interface (GUI) and the MACIE Application Program Interface (API).

2 Introduction

The MACIE is a controller card for operating mixed-mode data acquisition application specific integrated circuits (ASICs). It supports the Teledyne SIDECAR ASIC as well as the WFIRST ACADIA ASIC running Teledyne H1RG, H2RG, and H4RG Sensor Chip Assemblies (SCAs) and other scientific imaging sensors.

The MACIE is designed as the mechanical, electrical, and software interface between the data acquisition ASIC and the instrument or laboratory computer. It is intended for ground-based and laboratory use at ambient temperature and pressure conditions.

Each MACIE card supplies configurable power for up to two ASICs and is capable to interface with two ASICs in parallel. It is fully compatible with existing Teledyne SIDECAR ASIC boards, i.e. cryo-board, development board, etc. via a custom adaptor which is provided as part of the MACIE kit. Multiple MACIE cards can be stacked on top of each other to control more than two ASICs through the same data interface.

All MACIE software is designed to run under Linux and under Windows operating systems. The MACIE card also facilitates the communication and synchronization with an external trigger, such as an external shutter or modulator. The MACIE offers extensive diagnostic capabilities, including LED indicators. When desired, all on-board LEDs can be turned off. The MACIE holds up to 2 different firmware configurations in the on-board EEPROM at the same time with user-commandable switching between them. Additional base firmware is present permanently (protected from user access) to guarantee MACIE operation even if both user-loadable firmware files are corrupted.

3 Interface Descriptions

3.1 Mechanical Dimensions and Mounting Interfaces

The MACIE consists of a 4 inch by 5 inch printed circuit board assembly (PCBA) with jack posts located in each of the four corners as shown in figure 1. The jack posts accommodate 2-56 fasteners, which can be used as the mechanical interface to the MACIE or to stack multiple MACIE PCBAs. A 3D Standard for the Exchange of Product Data (STEP) file of the MACIE PCBA can be provided upon request.

Two optional adaptors are currently available in order to operate the MACIE with the Teledyne SIDECAR ASIC: MACIE-to-SAM adaptor and MACIE-to-JADE2 adaptor. The MACIE-to-SAM adaptor provides the interface to the flex-cable of the Teledyne SIDECAR ASIC cryo-kit with SAM card; the MACIE-to-JADE2 adaptor provides the interface to the flexcable that is part of the Teledyne SIDECAR ASIC cryo-kit with JADE-2 card or the Teledyne SIDECAR ASIC development board. The mechanical dimensions and mounting interfaces for the MACIE-to-SAM and MACIE-to-JADE2 adaptors are shown in figure 2. Both adaptors mount with M3 screws to the MACIE PCB. 3D STEP files can be provided upon request.

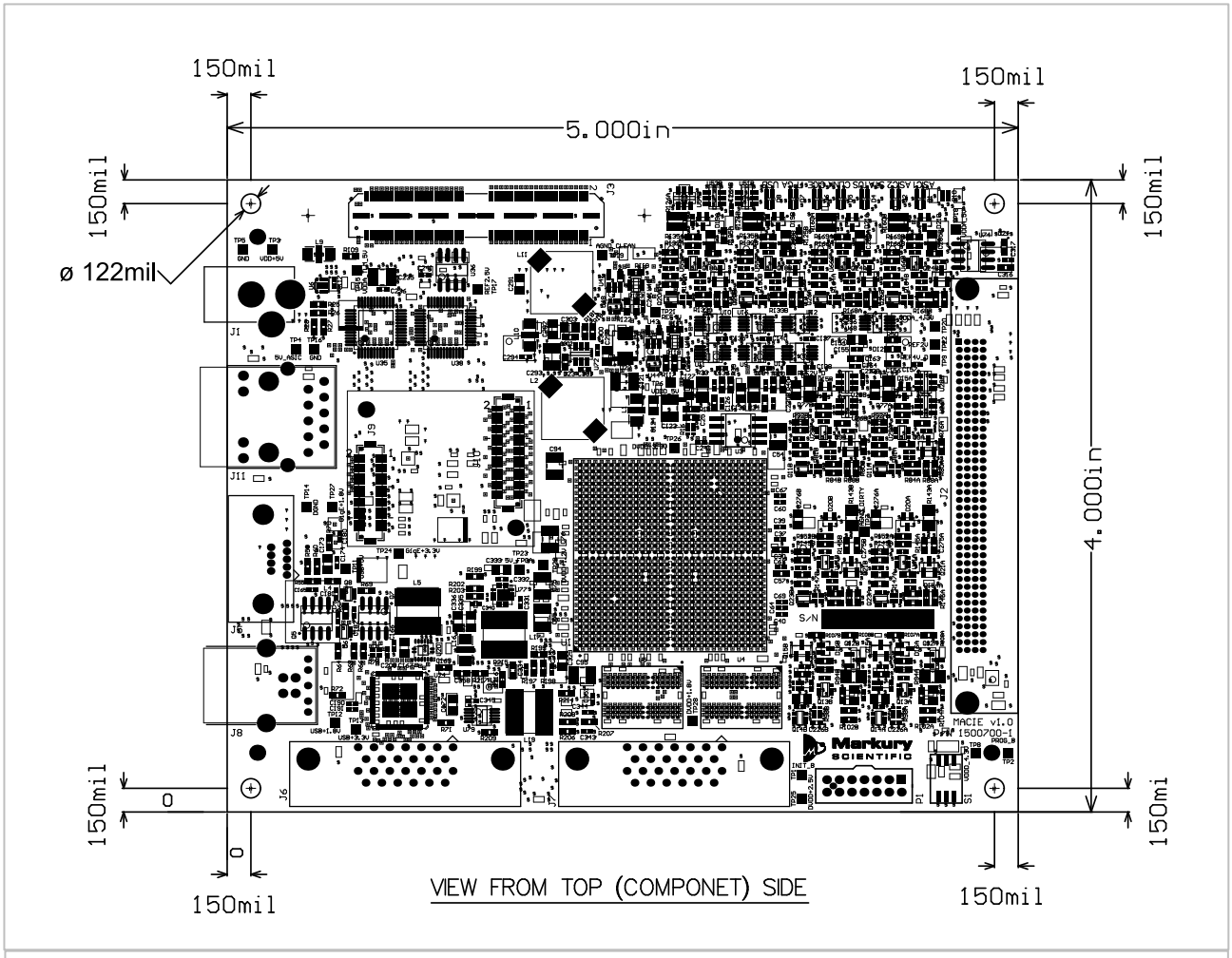


Figure 2: MACIE PCBA mechanical dimensions

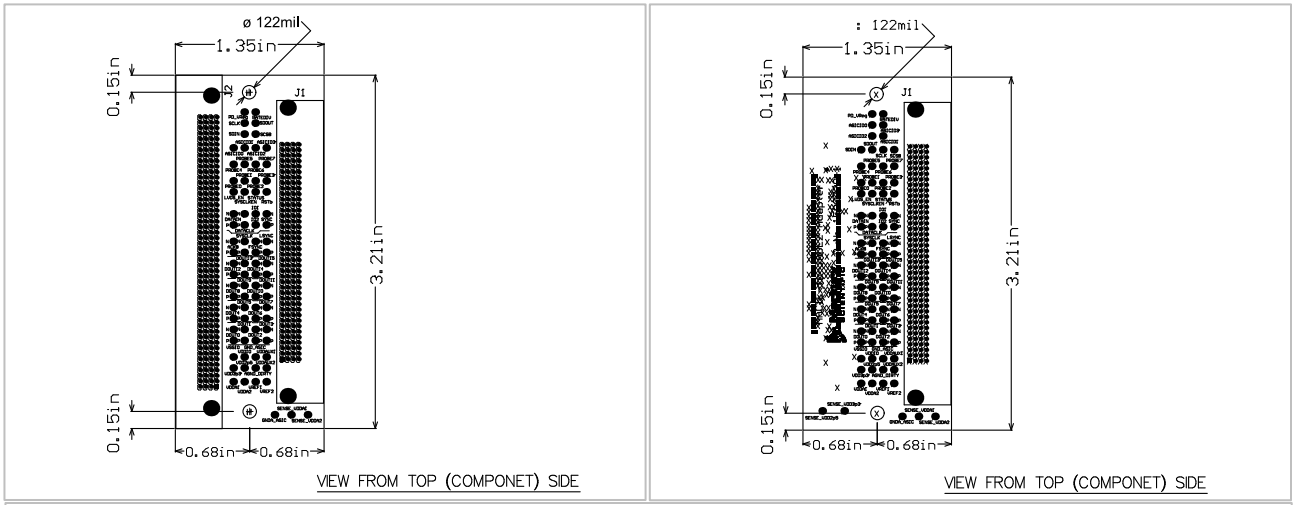


Figure 1: MACIE-to-SAM adaptor (left) and MACIE-to-JADE2 adaptor (right)

3.2 Electrical Interfaces

The MACIE block diagram and an overview of the MACIE electrical interfaces are shown in figures 3 and 4, respectively.

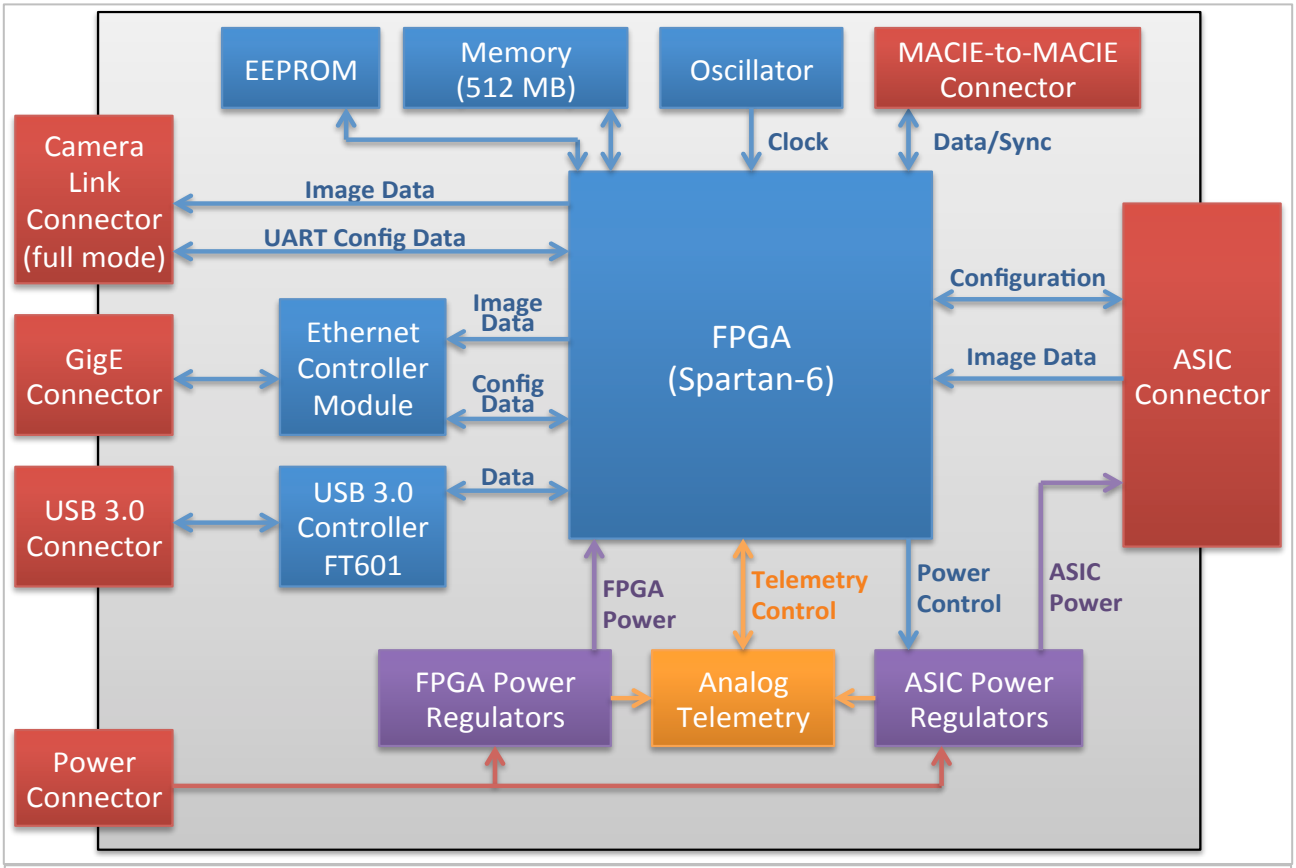


Figure 3: MACIE Block Diagram

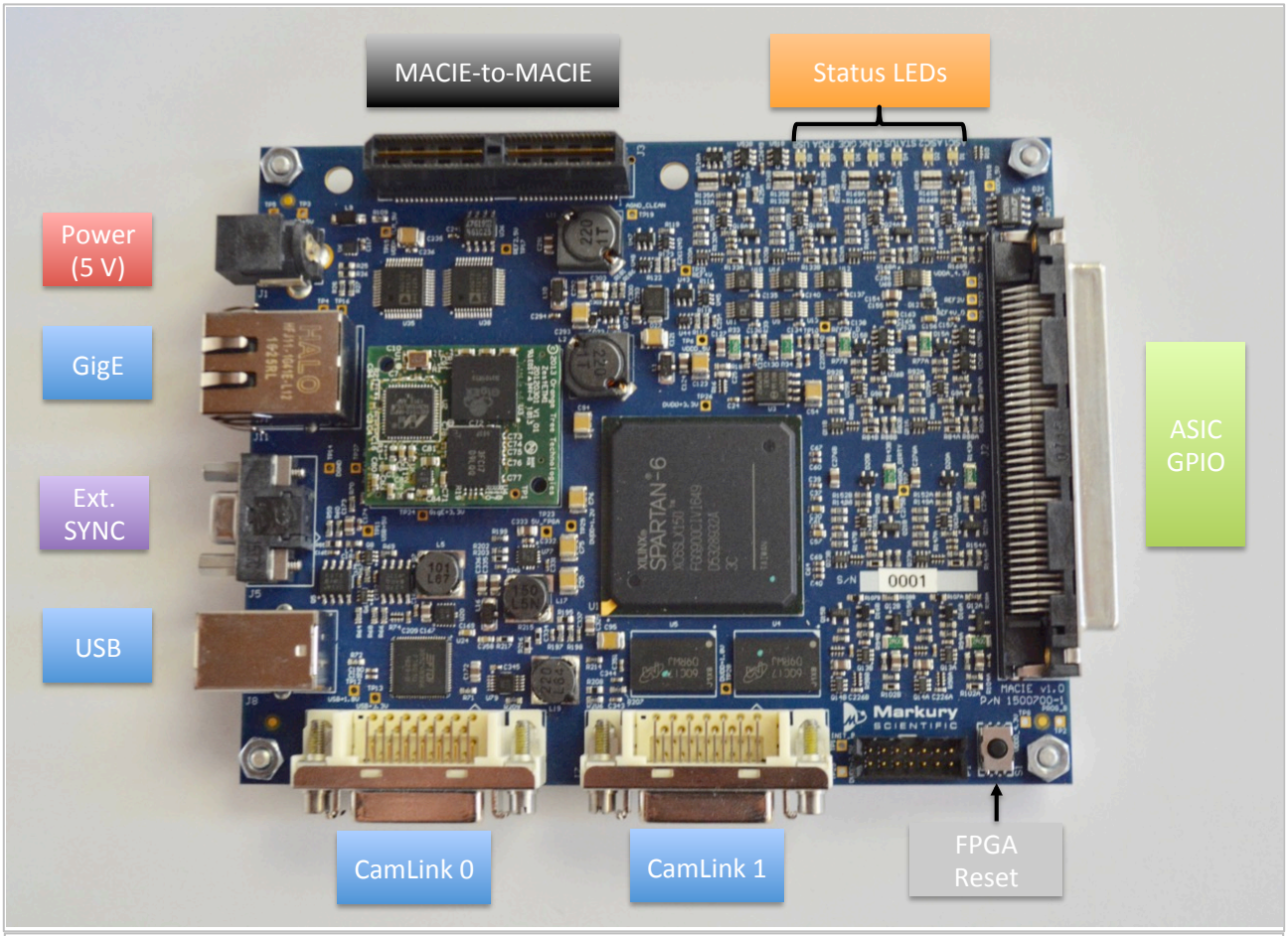


Figure 4: MACIE Electrical Interfaces Overview

3.2.1 Interfaces to Instrument or Laboratory Computer

The MACIE features three interfaces for connection to the instrument computer (indicated with blue boxes in figure 4):

- Gigabit Ethernet (GigE) with a maximum data rate of 100 MByte/sec (when run on dedicated network)
- USB 3.0 with a maximum data rate of 340 MByte/sec; backward compatible with USB 2.0
- Camera Link (CamLink) with a maximum data rate of 640 MByte/sec (when run in full CamLink mode).

Refer to sections 4 and 5 for the details about how to configure and setup these interfaces.

3.2.2 ASIC Interface

The MACIE uses a 160-pin Molex general-purpose input/output (GPIO) connector (part number: Molex 0051241040, Markury Scientific has stock for mating connectors if needed) for the ASIC interface. The signal assignments for the 160-pin Molex connector are shown in figure 5.

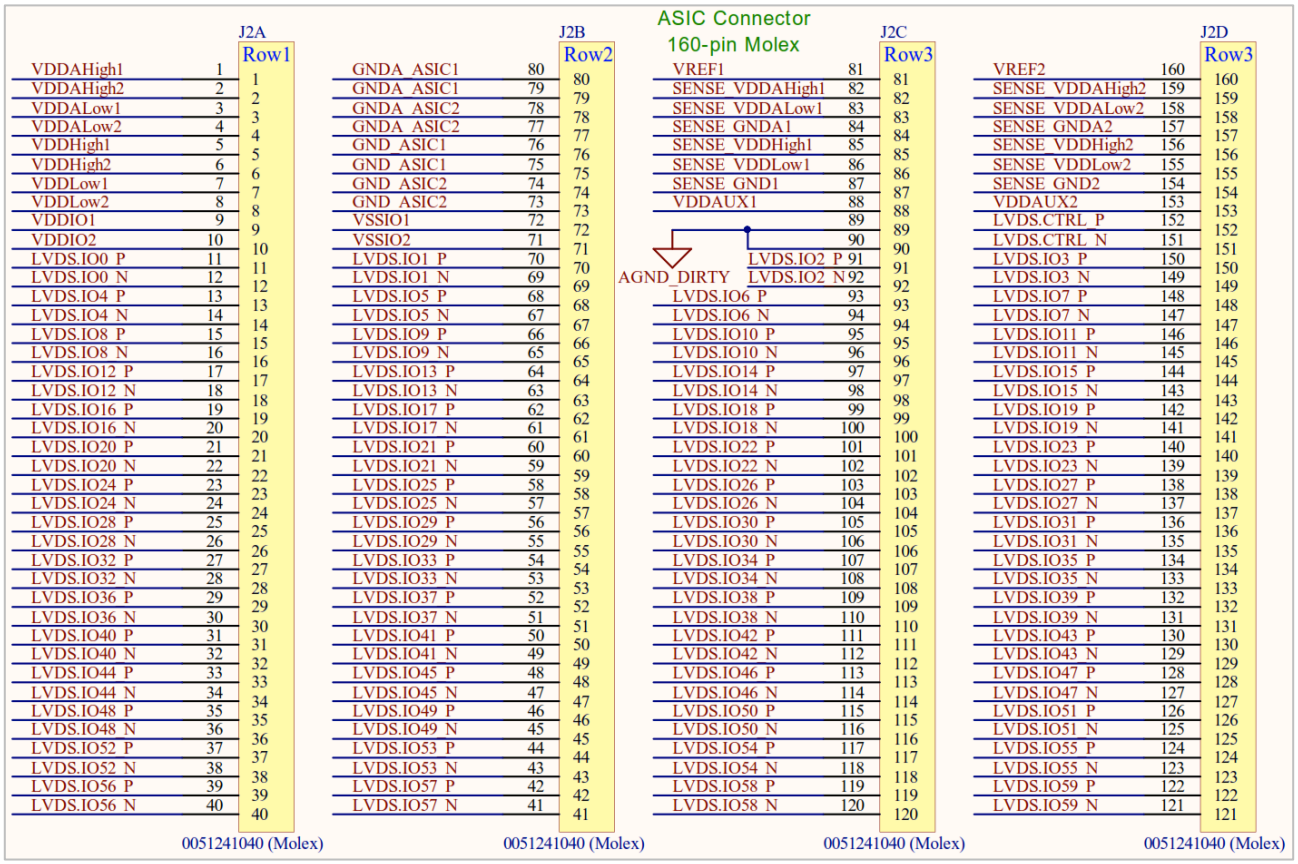


Figure 5: ASIC GPIB (160-pin Molex) Connector Pin-Assignment

The signal assignments, name mapping for the ACADIA and SIDECAR ASICs, and the adapter pinout for the SAM connector (200-pin Molex) and the JADE-2 connector (140-pin Hirose) are shown in figures 6 and 7, respectively.

Table 1: Connector pinout and signal names for ACADIA and SIDECAR ASICs

MACIE Signal name	MACIE pins, *J2 Molex 0051241040*	ACADIA ASIC signal name	SIDECAR ASIC signal name	SAM Adapter pins, *Molex 71718-2000*	JADE2 Adapter pins, *Hirose FX11LA-140S-SV*
VDDAHigh1	1	VDDA	VDDA1	198	4
VDDAHigh2	2		VDDA2	3	74
VDDALow1	3	VDDA1p8			
VDDALow2	4				
Vref1	81	VREF	VREF1	199	2
Vref2	160		VREF2	2	72
VDDHigh1	5	VDD3p3, VDDIO, VDD_CLKIO	VDD3p3	7, 94, 107, 194	10, 11, 81
VDDHigh2	6				
VDDLow1	7	VDDD	VDD	8, 93, 108, 193	12, 13, 83

MACIE Signal name	MACIE pins, *J2 Molex 0051241040*	ACADIA ASIC signal name	SIDECAR ASIC signal name	SAM Adapter pins, *Molex 71718-2000*	JADE2 Adapter pins, *Hirose FX11LA-140S-SV*
VDDLow2	8				
VDDIO1	9	VDD_LVDS	VDDIO	10, 91, 110, 191	15, 16, 85, 86
VDDIO2	10				
VSSIO1	72	VSS_LVDS	VSSIO	11, 90, 111, 190	17, 18, 87, 88
VSSIO2	71				
VDDAUX1	88	VDDAUX (opt.)	VDDAUX1	6, 95	9
VDDAUX2	153				
GNDA_ASIC1	80	GNDA	GNDA_ASIC	1, 100, 101, 200	1, 71, 78
GNDA_ASIC1	79	GNDA	GNDA_ASIC	1, 100, 101, 200	1, 71, 78
GNDA_ASIC2	78				
GNDA_ASIC2	77				
GND_ASIC1	76	GNDD, VSS_CLKIO	GND_ASIC	9, 92, 109, 192	14, 79, 84
GND_ASIC1	75	GNDD, VSS_CLKIO	GND_ASIC	9, 92, 109, 192	14, 79, 84
GND_ASIC2	74				
GND_ASIC2	73				
AGND_DIRTY	89	AGND_DIRTY (opt.)	AGND_DIRTY	5, 96, 195, 196	8
AGND_DIRTY	90	AGND_DIRTY (opt.)	AGND_DIRTY	5, 96, 195, 196	8
SENSE_VDDAHigh1	82	VDDA_SENSE	SENSE_VDDA1	197	6
SENSE_VDDAHigh2	159		SENSE_VDDA2	4	76
SENSE_VDDALow1	83	VDDA1p8_SENSE			
SENSE_VDDALow2	158				
SENSE_VDDHigh1	85	VDD3p3_SENSE (opt.)	VDD3p3	7, 94, 107, 194	80
SENSE_VDDHigh2	156				
SENSE_VDDLow1	86	VDDD_SENSE (opt.)	VDD	8, 93, 108, 193	82
SENSE_VDDLow2	155				
SENSE_GNDA1	84	GNDA_SENSE	GNDA_ASIC	1, 100, 101, 200	1, 71, 78
SENSE_GNDA2	157				
SENSE_GND1	87	GNDD_SENSE	GND_ASIC	9, 92, 109, 192	14, 79, 84
SENSE_GND2	154				
LVDS.CTRL_P	152		SysClk_En	135	134
LVDS.CTRL_N	151		DataRateDivide	150	65
LVDS.IO0_P	11	DataOutP[0]	DataOutP[0]	12	19
LVDS.IO0_N	12	DataOutN[0]	DataOutN[0]	13	89
LVDS.IO1_P	70	DataOutP[1]	DataOutP[1]	89	20
LVDS.IO1_N	69	DataOutN[1]	DataOutN[1]	88	90
LVDS.IO2_P	91	DataOutP[2]	DataOutP[2]	112	21
LVDS.IO2_N	92	DataOutN[2]	DataOutN[2]	113	91
LVDS.IO3_P	150	DataOutP[3]	DataOutP[3]	189	22
LVDS.IO3_N	149	DataOutN[3]	DataOutN[3]	188	92
LVDS.IO4_P	13	DataOutP[4]	DataOutP[4]	14	23
LVDS.IO4_N	14	DataOutN[4]	DataOutN[4]	15	93
LVDS.IO5_P	68	DataOutP[5]	DataOutP[5]	87	24
LVDS.IO5_N	67	DataOutN[5]	DataOutN[5]	86	94
LVDS.IO6_P	93	DataOutP[6]	DataOutP[6]	114	25
LVDS.IO6_N	94	DataOutN[6]	DataOutN[6]	115	95

MACIE Signal name	MACIE pins, *J2 Molex 0051241040*	ACADIA ASIC signal name	SIDECAR ASIC signal name	SAM Adapter pins, *Molex 71718-2000*	JADE2 Adapter pins, *Hirose FX11LA-140S-SV*
LVDS.IO7_P	148	DataOutP[7]	DataOutP[7]	187	26
LVDS.IO7_N	147	DataOutN[7]	DataOutN[7]	186	96
LVDS.IO8_P	15	DataOutP[8]	DataOutP[8]	16	27
LVDS.IO8_N	16	DataOutN[8]	DataOutN[8]	17	97
LVDS.IO9_P	66	DataOutP[9]	DataOutP[9]	85	28
LVDS.IO9_N	65	DataOutN[9]	DataOutN[9]	84	98
LVDS.IO10_P	95	DataOutP[10]	DataOutP[10]	116	29
LVDS.IO10_N	96	DataOutN[10]	DataOutN[10]	117	99
LVDS.IO11_P	146	DataOutP[11]	DataOutP[11]	185	30
LVDS.IO11_N	145	DataOutN[11]	DataOutN[11]	184	100
LVDS.IO12_P	17	DataOutP[12]	DataOutP[12]	18	31
LVDS.IO12_N	18	DataOutN[12]	DataOutN[12]	19	101
LVDS.IO13_P	64	DataOutP[13]	DataOutP[13]	83	32
LVDS.IO13_N	63	DataOutN[13]	DataOutN[13]	82	102
LVDS.IO14_P	97	DataOutP[14]	DataOutP[14]	118	33
LVDS.IO14_N	98	DataOutN[14]	DataOutN[14]	119	103
LVDS.IO15_P	144	DataOutP[15]	DataOutP[15]	183	34
LVDS.IO15_N	143	DataOutN[15]	DataOutN[15]	182	104
LVDS.IO16_P	19	DataClkOutP	SysClkP	181	70
LVDS.IO16_N	20	DataClkOutN	SysClkN	180	140
LVDS.IO17_P	62	SDoutP	AckbP	20	35
LVDS.IO17_N	61	SDoutN	AckbN	21	105
LVDS.IO18_P	99	FSyncP	FSyncP	81	37
LVDS.IO18_N	100	FSyncN	FSyncN	80	107
LVDS.IO19_P	142	LSyncP	LSyncP	120	38
LVDS.IO19_N	141	LSyncN	LSyncN	121	108
LVDS.IO20_P	21	MasterClkP	DataClkP	133	69
LVDS.IO20_N	22	MasterClkN	DataClkN	134	139
LVDS.IO21_P	60	SDinP	DataInP	168	68
LVDS.IO21_N	59	SDinN	DataInN	167	138
LVDS.IO22_P	101	PSyncP	SyncP	34	67
LVDS.IO22_N	102	PSyncN	SyncN	35	137
LVDS.IO23_P	140	SEnbP	IO1	33	66
LVDS.IO23_N	139	SEnbN	IO2	68	136
LVDS.IO24_P	23	RstbP	Rstb	66	133
LVDS.IO24_N	24	RstbN	SCLK	46	59
LVDS.IO25_P	58	ASIC_ID[0]	PD_Vreg	151	64
LVDS.IO25_N	57	ASIC_ID[1]	SCSB	55	129
LVDS.IO26_P	103	ASIC_ID[2]	LVDS_En	166	135
LVDS.IO26_N	104	ASIC_ID[3]	SDATAIN	146	60
LVDS.IO27_P	138	LVDS_mPSI_En	ASIC_Status	67	63
LVDS.IO27_N	137	LVDS_Rstb_En	SDATAOUT	156	130
LVDS.IO28_P	25	PD_LDO_Ana			
LVDS.IO28_N	26	PD_LDO_Dig			
LVDS.IO29_P	56	Status			

MACIE Signal name	MACIE pins, *J2 Molex 0051241040*	ACADIA ASIC signal name	SIDECAR ASIC signal name	SAM Adapter pins, *Molex 71718-2000*	JADE2 Adapter pins, *Hirose FX11LA-140S-SV*
LVDS.IO29_N	55	WatchDogEn			
LVDS.IO30_P	105	SCL_Debug			
LVDS.IO30_N	106	SDA_Debug			
LVDS.IO31_P	136	SyncP[0]			
LVDS.IO31_N	135	SyncN[0]			
LVDS.IO32_P	27	SyncP[1]	EMMP[0]	22	39
LVDS.IO32_N	28	SyncN[1]	EMMN[0]	23	109
LVDS.IO33_P	54	SyncP[2]	EMMP[1]	79	40
LVDS.IO33_N	53	SyncN[2]	EMMN[1]	78	110
LVDS.IO34_P	107	SyncP[3]	EMMP[2]	122	41
LVDS.IO34_N	108	SyncN[3]	EMMN[2]	123	111
LVDS.IO35_P	134	SyncP[4]	EMMP[3]	179	42
LVDS.IO35_N	133	SyncN[4]	EMMN[3]	178	112
LVDS.IO36_P	29	TestMuxSlct[0]	EMMP[4]	24	43
LVDS.IO36_N	30	TestMuxSlct[1]	EMMN[4]	25	113
LVDS.IO37_P	52	TestMuxSlct[2]	EMMP[5]	77	44
LVDS.IO37_N	51	TestMuxSlct[3]	EMMN[5]	76	114
LVDS.IO38_P	109		EMMP[6]	124	45
LVDS.IO38_N	110		EMMN[6]	125	115
LVDS.IO39_P	132		EMMP[7]	177	46
LVDS.IO39_N	131		EMMN[7]	176	116
LVDS.IO40_P	31	ConfigOut[0]	EMMP[8]	26	47
LVDS.IO40_N	32	ConfigOut[1]	EMMN[8]	27	117
LVDS.IO41_P	50	ConfigOut[2]	EMMP[9]	75	48
LVDS.IO41_N	49	ConfigOut[3]	EMMN[9]	74	118
LVDS.IO42_P	111	ConfigOut[4]	EMMP[10]	126	49
LVDS.IO42_N	112	ConfigOut[5]	EMMN[10]	127	119
LVDS.IO43_P	130	ConfigOut[6]	EMMP[11]	175	36
LVDS.IO43_N	129	ConfigOut[7]	EMMN[11]	174	106
LVDS.IO44_P	33	ConfigOut[8]	SW_EN1	169	123
LVDS.IO44_N	34	ConfigOut[9]	SW_EN2	73	124
LVDS.IO45_P	48	ConfigOut[10]	SW_EN4	129	52
LVDS.IO45_N	47	ConfigOut[11]	SW_EN5	173	51
LVDS.IO46_P	113	ConfigOut[12]			
LVDS.IO46_N	114	ConfigOut[13]	IForce_Temp	72	120
LVDS.IO47_P	128	ConfigOut[14]			
LVDS.IO47_N	127	ConfigOut[15]			
LVDS.IO48_P	35		SW_EN3	128	121
LVDS.IO48_N	36		Probebus[0]	30	55
LVDS.IO49_P	46		SW_EN6	172	50
LVDS.IO49_N	45		Probebus[1]	71	125
LVDS.IO50_P	115				
LVDS.IO50_N	116		Probebus[2]	130	56
LVDS.IO51_P	126				
LVDS.IO51_N	125		Probebus[3]	171	126

MACIE Signal name	MACIE pins, *J2 Molex 0051241040*	ACADIA ASIC signal name	SIDECAR ASIC signal name	SAM Adapter pins, *Molex 71718-2000*	JADE2 Adapter pins, *Hirose FX11LA-140S-SV*
LVDS.IO52_P	37		Probebus[4]	31	57
LVDS.IO52_N	38		OE_Enable_n_1	32	122
LVDS.IO53_P	44		Probebus[5]	70	127
LVDS.IO53_N	43		OE_Enable_n_2	69	53
LVDS.IO54_P	117		Probebus[6]	131	58
LVDS.IO54_N	118		OE_Enable_n_3	132	54
LVDS.IO55_P	124		Probebus[7]	170	128
LVDS.IO55_N	123				
LVDS.IO56_P	39		ASICID[0]	47	61
LVDS.IO56_N	40		ASICID[1]	54	131
LVDS.IO57_P	42		ASICID[2]	147	62
LVDS.IO57_N	41		ASICID[3]	154	132
LVDS.IO58_P	119				
LVDS.IO58_N	120				
LVDS.IO59_P	122				
LVDS.IO59_N	121				

3.2.3 Input Power

The MACIE uses a Switchcraft RAPC712BK power jack (indicated with a red box in figure 4) for external power for use with a MSci/ABS supplied power cable to connect to an external, customer supplied, linear power supply. The matching plug is a Switchcraft 760BK. Refer to section 4 on how to power up the MACIE.

3.2.4 SYNC Connector

A 9-pin micro-D socket connector (indicated with a purple box in figure 4, part number: Molex 0836119006) is used to supply external sync signals to the MACIE card, or to send out sync signals from the MACIE card to external systems. The pin assignment is shown in table 2.

Table 2: Sync connector pin assignment

Pin	Signal
1	SYNC_IO_P[0]
2	SYNC_IO_N[0]
3	SYNC_IO_P[2]
4	SYNC_IO_N[2]
5	DGND
6	VDD+5V
7	DVDD+3.3V
8	SYNC_IO_N[1]
9	SYNC_IO_P[1]

3.2.5 MACIE-to-MACIE Connector

The MACIE-to-MACIE connector (indicated with a black box in figure 4) provides connectivity between multiple MACIE cards, which can be stacked on top of each other. The mating connector is located on the bottom of the MACIE PCBA.

3.2.6 FPGA Reset

The MACIE reset button (indicated with a grey box in figure 4) re-loads the FPGA base firmware, thereby resetting the MACIE card.

3.2.7 Status LEDs

The MACIE PCBA has status LEDs for ASIC1, ASIC2, general status, and CamLink, GigE, and USB interfaces to indicate specific states or activities related to the corresponding component or interface. Refer to the section 4 for details.

4 Hardware Setup

This section outlines the hardware setup and connection options of the MAICE card.

4.1 Setup for GigE Operation

The provided Gigabit (GigE) link is best suited for data acquisition modes where the required bandwidth is in the range of several 10 MByte/s or less (maximum is about 100MByte/s). For higher bandwidth acquisitions (like H2RG fast mode) use the CamLink interface as described in section 4.2. To establish operation of the MACIE card through the GigE port, follow these steps:

- Set power supply to between 5 to 5.5 V with compliance of about 1 A
- Turn off power supply
- Connect power cable to MACIE card and to power supply (do not turn on yet)
- Connect ASIC board to MACIE card, either using MACIE-to-SAM or MACIE-to-JADE2 adapter board (SIDECAR ASIC) or custom cable connection (e.g. ACADIA ASIC)
- Turn on power supply
- The blue FPGA LED should light up after about 1 second.
- Connect MACIE card to Ethernet port on acquisition computer or to network router or switch using a Cat5e or Cat6 Ethernet patch cable with RJ45 connectors (= standard Ethernet patch cable)
- Once the GigE connection has been established, the corresponding GigE LED on the MACIE card will light up. This may take up to 10 seconds after power cycling due to the boot-up period of the MACIE GigE interface module. Also, one of the two LEDs on the Ethernet jack will start to flash. The orange LED indicates a 100Mbit connection; the green LED a 1Gbit connection.

- Open a web browser (Windows Explorer, Firefox, Chrome, Safari, etc.) and type 192.168.1.100 into the URL field. This is the default MACIE IP address. If the computer is able to communicate with the MACIE card, the screen shown in figure 6 will appear.
- If the screen shown in figure 8 appears in the browser, communication with the MACIE card has been established. Follow the instructions provided in the MACIE Software Manuals to start and use the acquisition GUI or API.
- If the screen shown in figure 8 does not appear, or if the acquisition software cannot detect the MACIE card even though the web server can be accessed, a communication problem exists and further debugging is required (section 4.1.1).

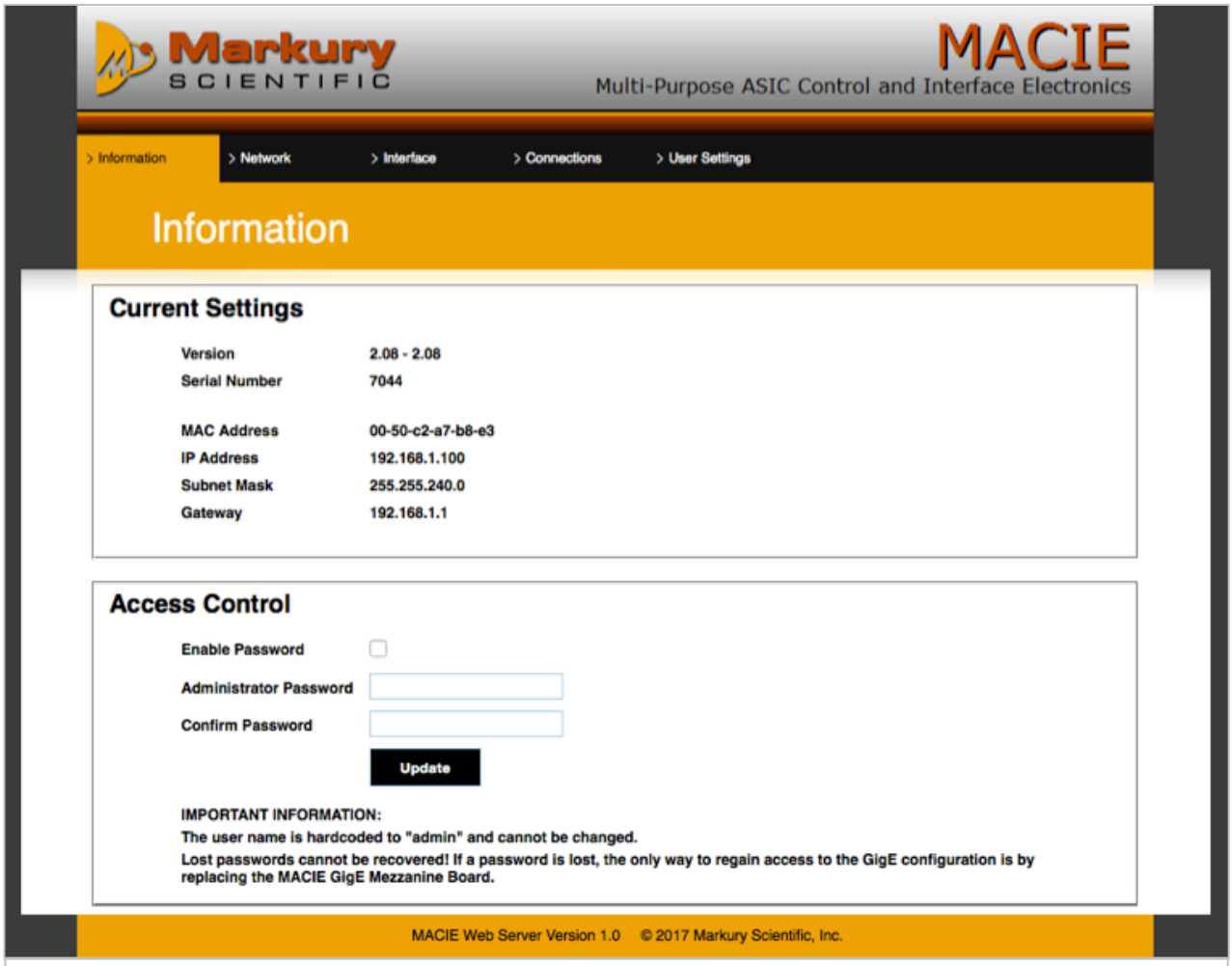


Figure 6: MACIE GigE Port Configuration Interface

4.1.1 Troubleshooting GigE Connection Issues

If the GigE connection to the MACIE card cannot be established as described in section 4.1, follow the guidelines below to troubleshoot the problem:

1. The default IP address of the MACIE card is set to 192.168.1.100, with a subnet mask of 255.255.240.0. In order to communicate to the MACIE card, the computer has to have an IP address that is allowed within this subnet mask (e.g. 192.168.1.50 or 192.168.2.70), and has to also have a subnet mask that lets traffic through from the MACIE card (e.g. 255.255.255.0 if the computer IP address is on subnet 192.168.1). If the given network structure does not allow the MACIE IP address to be recognized, it may be necessary to temporarily connect the MACIE card directly to a computer, and set the computer IP address accordingly. Then bring up the MACIE web server by entering the 192.168.1.100 MACIE IP address into the URL field, and change the MACIE IP address and subnet as needed on the "Network" tab of the web server. If desired, the MACIE card can also be configured for DHCP mode or AutoIP for automatic IP address assignment (note that the DHCP mode requires a DHCP server to be present on the network).

2. If even a direct link between the computer and the MACIE card is not successful (with the computer IP address set to an address on subnet 192.168.1.x, e.g. 192.168.1.20), it is possible that the computer firewall is blocking communication on the HTTP port 80.

3. Try pinging the MACIE card by typing "ping 192.168.1.100" in the command window or terminal shell. If a reponse from the MACIE card is received, but the web server cannot be loaded, there may be an issue with port 80 as described under point 2.

4. If the web server can be accessed but the MACIE software cannot detect the MACIE card (either the Acquisition GUI or the MACIE Configuration Tool), please check that:

    a. The computer/network firewall does not block the TCP ports 42306 or 42307. These ports are being used for MACIE commanding and science data collection.

    b. The computer/network firewall does not block the UDP port 1900 on multicast address 239.255.255.250. UPnP M_SEARCH messages on this port are used to detect the MACIE card on the network, and to find its IP address for use in the acquisition and control software.

4.2 Setup for CamLink Operation

For single-ASIC operation via Camera Link (CamLink), follow these steps to setup the system. Note that if the provided acquisition GUI is to be used, a Matrox Solios frame grabber has to be present in the acquisition computer, and the Maxtrox MIL-lite drivers have to be installed:

- Set power supply to between 5 to 5.5 V with compliance of about 1 A

- Turn off power supply

- Connect power cable to MACIE card and to power supply (do not turn on yet)
- Connect Camera Link cable to MACIE connector 0, and to frame grabber connector 0
- Connect ASIC board to MACIE card, either using MACIE-to-SAM or MACIE-to-JADE2 adapter board (SIDECAR ASIC) or custom cable connection (e.g. ACADIA ASIC)
- Turn on power supply
- The blue FPGA LED should light up after about 1 second.
- If the COM port of the frame grabber is active on the PC side, the CLink LED will be green.
- Follow the instructions provided in the MACIE Software Manuals to start and use the acquisition GUI or API.

4.3 Setup for USB Operation

For single-ASIC operation via USB 3.0, follow these steps to setup the system:

- Option 1: Power through USB
    - This option is acceptable as long as power demand of the ASIC for the given application is less than the USB supply limit (typically 500mA for USB2.0 and 900mA for USB3.x)
    - GigE interface is disabled by default when powering through USB to save power. Can be re-enabled by command through USB once USB connection is established.
    - Make sure, power cable is not plugged into MACIE card. USB power will be disabled on the MACIE card as soon as the power connector is plugged in (independent of whether power is supplied or not through this connector)
- Option 2: Power through separate power supply
    - Set power supply to between 5 to 5.5 V with compliance of about 1 A
    - Turn off power supply
    - Connect power cable to MACIE card and to power supply (do not turn on yet)
- Connect ASIC board to MACIE card, either using MACIE-to-SAM or MACIE-to-JADE2 adapter board (SIDECAR ASIC) or custom cable connection (e.g. ACADIA ASIC)
- Connect USB cable to MACIE.
- Turn on power supply (if powered through separate supply)

- Windows: If this is the first time the MACIE card is connected, the computer will install the necessary drivers automatically (make sure that a internet connection is available). Please ensure that the correct driver version is used (see device manager on Windows and find the FTDI FT601 USB 3.0 Bridge Device), which should either be v1.2.0.6 or v1.3.0.4. It must not be v1.3.0.2 since this version has a bug.
- Linux: Follow the instructions in the MACIE Software Manual for setup of USB

- The blue FPGA LED should light up after about 1 second, and the USB LED should light up green.
- Follow the instructions provided in the MACIE Software Manuals to start and use the acquisition GUI or API.

4.4 Status LEDs

Figure 9 shows a magnified section of the MACIE card containing the 7 status LEDs. The LEDs are labeled ASIC1, ASIC2, STATUS, CLINK, GIGE, FGPA, and USB to indicate specific states or activities related to the corresponding component or interface.

Figure 7: MACIE Status LEDs

Meaning of LED indicators:

- USB LED
  - Green Solid: USB interface is correctly enumerated and ready
  - Red Solid: USB power is provided, but interface communication is not available (e.g. computer might be asleep or powered down)
  - Red fast flashing: Indicates USB communication from host computer to MACIE card
  - Blue fast flashing: Indicates USB communication from MACIE card to host computer
  - Green slow flashing (~1Hz): USB FIFO has data
  - Red slow flashing (~1Hz): USB communication error or FIFO overflow error detected
- GigE LED

  - Green Solid: GIGE interface is correctly configured and connected. May take up to 10 seconds after power up to light up due to boot-up time of GigE embedded controller.
  - Red fast flashing: Indicates GigE communication from host computer to MACIE card
  - Blue fast flashing: Indicates GigE communication from MACIE card to host computer
  - Green slow flashing (~1Hz): GigE FIFO has data
  - Red slow flashing (~1Hz): GigE communication error or FIFO overflow error detected

- Camera Link LED
  - Green Solid: Camera Link UART interface is connected and active.
  - Red fast flashing: Indicates UART communication from host computer to MACIE card
  - Blue fast flashing: Indicates UART communication from MACIE card to host computer
  - Red slow flashing (~1Hz): UART communication error detected

- FPGA LED
  - Blue Solid: Baseline firmware has been loaded (should only be used for initialization)
  - Green Solid: Slot 1 or Slot 2 firmware has been loaded
  - Red Solid: FPGA is not configured. No firmware has been loaded.

- STATUS LED
  - Green Solid: Power to the analog MACIE board section has been enabled
  - Green slow flashing (~1Hz): Main FIFO has data
  - Red slow flashing (~1Hz): internal FIFO overflow error has been detected

- ASIC1 LED (= status for ASIC1)
  - Green Solid: ASIC power supplies have been enabled
  - Red fast flashing: Indicates communication from MACIE card to ASIC
  - Blue fast flashing: Indicates communication from ASIC to MACIE card
  - Red slow flashing (~1Hz): Communication error detected
  - Red Solid: Over-current or Over-voltage condition detected

- ASIC2 LED (= status for ASIC2)
    - Green Solid: ASIC power supplies have been enabled
    - Red fast flashing: Indicates communication from MACIE card to ASIC
    - Blue fast flashing: Indicates communication from ASIC to MACIE card
    - Red slow flashing (~1Hz): Communication error detected
    - Red Solid: Over-current or Over-voltage condition detected

5 Firmware Configuration

The MACIE Configuration Tool is a GUI that runs on Microsoft Windows to provide status information about the MACIE card and to program new firmware into the MACIE EEPROM. The following description explains how to install and start the application, and how to update the MACIE firmware configuration.

Note: Each MACIE card has been pre-configured with the latest versions of the MACIE Base Firmware and the Applications or Customer Firmware required for MACIE operation. For most standard applications, no modifications or updates are required.

5.1 Installing the MACIE Configuration Tool Software

The MACIE Configuration Tool is provided as a binary file that can be directly executed (MACIE_ConfigTool.exe). The application is automatically installed when running the MACIE Installer that is provided as part of the software package. To launch the application, find it in the Windows Start Menu in the MACIE folder, or navigate to C:\Program Files\MACIE V2.0\MACIE Tools. Make sure that at least one interface to the MACIE card is connected (GigE, USB, or Camera Link) to establish communication.

Important: The MAICE Configuration Tool requires the Microsoft .net framework 4.0 (or higher), and also the Microsoft Visual Studio C++ Redistributable x86 2010 (or possibly 2012 / 2013 which may or may not work; 2015 and higher will not work). The .net framework is typically already installed on newer Windows versions, the 32-bit (i.e. x86) Redistributable may or may not be. Both can be found on the Microsoft website for download, by searching for ".net 4.0", or "C++ Redistributable".

Gigabit Ethernet: If using the GigE connection, the MACIE card must either be connected directly to the computer with an Ethernet cable, or must be connect to the same network through a router or switch. Refer to section 4 for further information, specifically regarding troubleshooting GigE connection problems.

USB: If using the USB connection, ensure that the FDTI D3XX driver is installed (i.e. FTDI FT601 USB 3.0 Bridge Device is listed in the Device Manager under Universal Serial Bus controllers whenever the MACIE card is connected). This driver is typically downloaded automatically by Windows when the MACIE card is first plugged into the USB port (requires the computer to be online). However, if Windows fails to find the

driver, it can be manually installed by either directing the Windows installer to the "USB Driver/ FTD3XXDriver_WHQLCertified_v1.3.0.4" directory (select correct operation system folder), or by launching the "FTD3XXDriver_WHQLCertified_v1.3.0.4_Installer.exe" application in the "USB Driver" directory.

Note: If the USB interface on the MACIE card has never been used before, or has been corrupted, the MACIE Configuration Tool may pop up a message stating that the USB port may have to be reconfigured (either the whole port or just the serial number). If this occurs, it is usually best to agree to the proposed action of updating the USB configuration. However, sometimes, this message can be displayed even though the USB interface is correctly configured, due to a temporary communication issue. In that case (i.e. you already know that USB has been working before), simply ignore the message (i.e. cancel), and push the "Check Interfaces" button to refresh the interface status.

Camera Link: If using Camera Link, a frame grabber must be installed with the serial COM port visible within Windows. No image capture support is needed for this application. Refer to section 4 for further information.

Note: CamLink will take up to 15 minutes to load new firmware, while GigE and USB will finish in about 2 minutes.

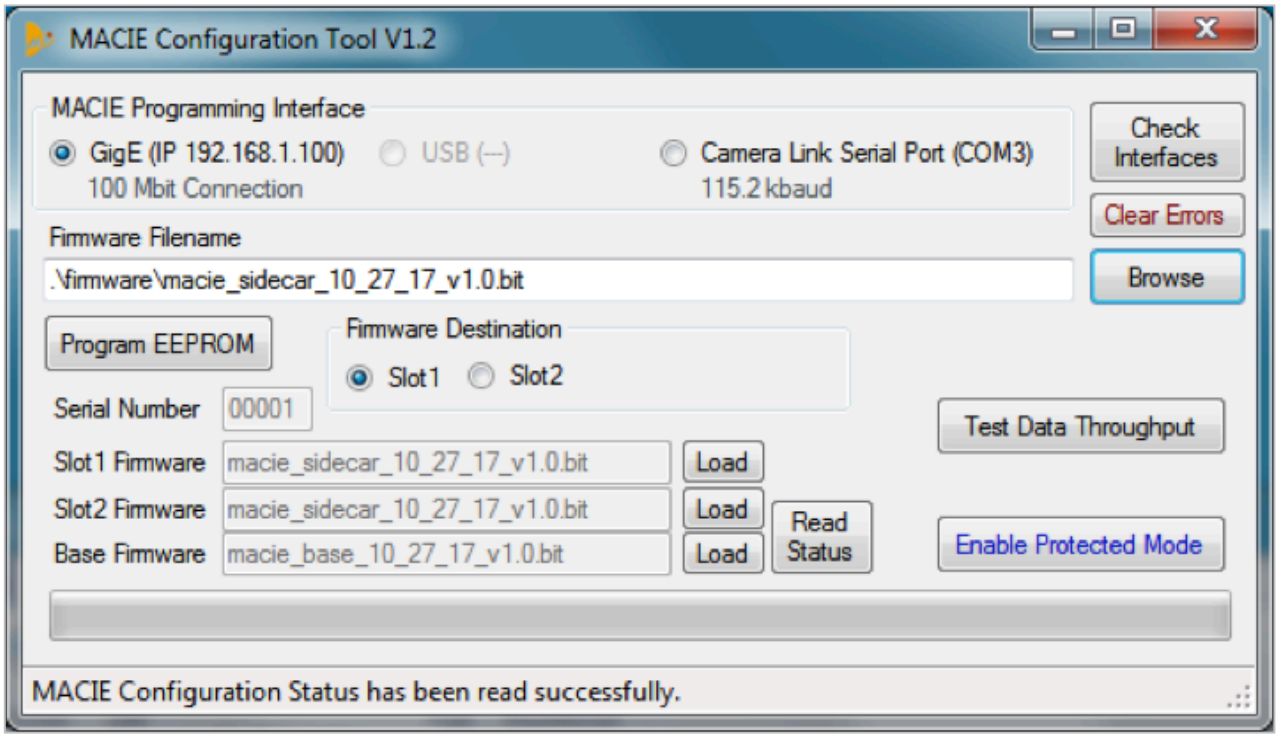
5.2 Launching the MACIE Configuration Tool

In the MACIE ConfigTool folder, double-click the file MACIE_ConfigTool.exe to launch the application. The GUI shown in figure 10 should appear.

In case of a missing file (like .net environment), please follow the on-screen instructions to install any missing software packages or updates from Microsoft.

Once the application has launched, it will search for any connected MACIE cards and report the status. If a MACIE card can be found, the corresponding interface radio buttons in the "MACIE Programming Interface" section will be activated. All 3 interfaces (GigE, USB, CamLink serial port) can be connected, allowing the user to select which interface to use. If multiple MACIE cards are connected at the same time, the application will prompt the user to select which card to use.

Figure 8: MACIE Configuration Tool GUI



There are 4 read-only text fields that include the information for the serial number and the three available firmware slots. Once the firmware is programmed into the EEPROM, the corresponding firmware file names will be visible in these fields.

Note: If the firmware programming is interrupted or fails for any reason, the phrase **** Slot not yet programmed **** may be shown in the corresponding text field. In that case, repeating the programming cycle should resolve the issue.

The slots “Slot 1 Firmware” and “Slot 2 Firmware” are available for programming custom firmware; a third slot called “Base Firmware” cannot be altered by the user. The Base Firmware constitutes the boot firmware of the MACIE card and is always available in case both other firmware slots have been corrupted.

By pushing the "Load" buttons next to the firmware fields, the MACIE card can be forced to boot from the corresponding firmware slot. When this button is pushed, the FPGA LED on the MACIE card will first turn red (i.e. FPGA not configured), and after about 1 second will turn either blue or green. Blue indicates that the base firmware has been loaded and green indicates that the firmware from either slot 1 or slot 2 has been loaded.

The following is a brief description of the individual GUI control buttons:

Check Interfaces: Refreshes interface status, in case there has been a change to the GigE, USB, or Camera Link interfaces.

Clear Errors: Clears communication error counters inside the MACIE card (indicated by any of the LEDs flashing red).

Browse: Select firmware file to be programmed into MACIE EEPROM.

Program EEPROM: Start programming process using the selected firmware file.

Load: Trigger MACIE to boot from the corresponding firmware slot.

Read Status: Update MACIE firmware and serial number text fields with current values from MACIE card.

Test Data Throughput: Runs performance test to measure data throughput (GigE and USB only).

5.3 Programming new Firmware into the MCIE

The main purpose of the MACIE Configuration Tool GUI is to allow updating the firmware stored inside the MACIE EEPROM. Before performing an update, please ensure that the MACIE card is powered with a 5V supply, and that the blue FPGA LED is on (green is ok as well as long as a valid firmware is present in slot 1 or slot 2, but if unsure load the base firmware before programming). If the blue LED is not on, power-cycle the 5V to reboot the MACIE card or push the reboot button on the MACIE card. Also, ensure that at least one interface (GigE, USB, CamLink) is available, indicated by a green LED on the corresponding port.

Next, click the Browse button to select the desired firmware file. The latest firmware available for the various ASICs and operational modes can be found in the firmware folder of the Configuration Tool path.

After that, select the firmware slot to be programmed: Slot1 or Slot2. If only one firmware is going to be used, it is recommended to use Slot 1.

Finally, push the Program EEPROM button. If everything works as expected, the progress bar should start to move, and the GUI should first erase the EEPROM slot, and then program the new firmware. Depending on the selected interface, the programming cycle will take a different amount of time. CamLink will take up to 15 minutes, while GigE and USB will finish in about 2 minutes.

After the programming cycle has completed, the new firmware can be loaded into the MACIE FPGA by clicking the "Load" button next to the corresponding slot name.

6 Acronyms & Abbreviations

Definition	Meaning
ABS	AstroBlank Scientific LLC
API	Application Program Interface
ASIC	Application Specific Integrated Circuit

GPIO	General Purpose Input/Output
GUI	Graphical User Interface
ICD	Interface Control Document
LED	Light Emitting Diode
MAC	MACIE Acquisition Control
MACIE	Multi-purpose ASIC Control & Interface Electronics
MSci	Markury Scientific Inc.
PCB	Printed Circuit Board
PCBA	Printed Circuit Board Assembly
SCA	Sensor Chip Assembly
STEP	Standard for the Exchange of Product data