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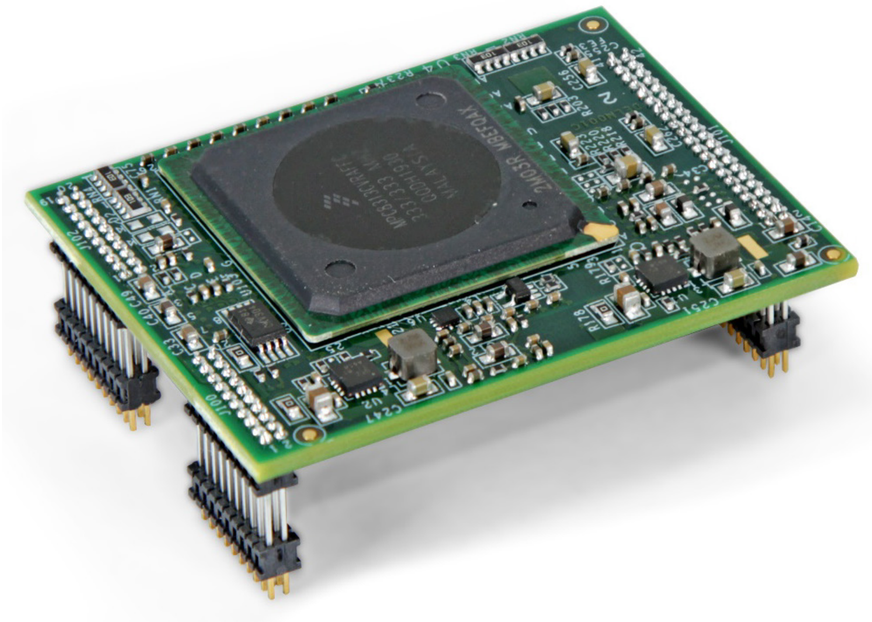
G-MAS BLM and GOLD LION Board Level Module Integration Design Guide



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Elmo Motion Control

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Catalog Number

GMAS-BLM&G-LION

Revision History

Version	Date	Details
Ver. 1.0	Mar 2012	Initial release
Ver 1.1	June 2012	
Ver 1.101	February 2013	The Korean office address under Elmo Worldwide was updated.
Ver 1.200	May 2013	Added Gold LION and its Environmental Conditions
Ver. 1.201	July 2014	General format updates
Ver. 1.300	Jan 2016	Correction to Print Side drawings of BLM
Ver. 1.400	Feb 2020	Front page picture change
Ver. 1.500	Apr 2024	Minor text changes

Table of Contents

Chapter 1: Warranty Information

The products covered in this manual are warranted to be free of defects in material and workmanship and conform to the specifications stated either within this document or in the product catalog description. The G-MAS BLM & GOLD LION Board Level Module is warranted for a period of 12 months from the time of installation, or 12 months from time of shipment, whichever comes first. No other warranties, expressed or implied – and including a warranty of merchantability and fitness for a particular purpose – extend beyond this warranty.

Chapter 2: Product Description

The G-MAS BLM & GOLD LION Board Level Module is an industrial application network motion controller, while the Lion is appropriate for applications in the military and/or extreme environmental conditions.

The G-MAS BLM & GOLD LION Board Level Module is compliant with the environmental conditions tabulated in section 4.2 G-MAS BLM Environmental Conditions. However, the Lion is the ExtrIQ or Military Standard G-MAS BLM & GOLD LION Board Level Module, compliant with the extreme environmental conditions tabulated in section 4.3 LION Environmental Conditions.

The G-MAS BLM & GOLD LION Board Level Module operates in a network based system in conjunction with Elmo's intelligent servo drives to provide a total multi-axis motion control system solution.

The G-MAS BLM & GOLD LION Board Level Module is designed to support both the existing SimplIQ drives, based on standard CANopen network architecture, as well as the new Gold Line, adding EtherCAT networking.

While being a true network controller, the G-MAS BLM & GOLD LION Board Level Module shares the motion processing workload with Elmo's SimplIQ and Gold Line drives, forming a distributed motion control system. The best servo and system performance is achieved combining the Gold Family drives, and the new real-time motion control capabilities of the G-MAS BLM & GOLD LION Board Level Module controller.

The G-MAS BLM & GOLD LION Board Level Module provides:

- Full, real-time, multi-axis motion synchronization
- Advanced user programming capabilities based on the leading standards
- Time deterministic control over motion, I/Os and processes in the system

The G-MAS BLM & GOLD LION Board Level Module offers real-time motion control support for full multi-axis system synchronization, using the well-known industry interface PLCopen for Motion Control standard.

Various programming capabilities, such as the IEC-61131-3 standard languages, as well as native C programming support, dramatically accelerate user level program execution. Standard solutions were selected for ease of use.

Low level communication with drives and I/O devices over the device network uses the CANopen industry standard (DS 301, DS 401 for I/O devices, and DS 402 for drives and motion device profiles). These are used over standard CAN networks, as well as with the new EtherCAT CoE (CANopen over EtherCAT) protocols.

Host interfaces are implemented using industry standard communications protocols, such as Ethernet TCP/IP and higher level protocols such as Ethernet/IP and Modbus.

Standardization in protocols, definitions and APIs allows users rapid system level integration and opens the system to third party devices on the device network.

2.1. Specifications

2.1.1. G-MAS BLM & GOLD LION Board Level Module Hardware

- Power Supply: Three DC power supplies: 7-12V, 5V, 3.3V
- **Processor:** PowerPC, 333 MHz, with double precision floating point support by hardware.
- Memory
  - Flash: 32 MB
  - RAM: 64 MB (DDR2, 333 MHz)
- Communication Hardware
  - **Host:**
    - Ethernet: 1 port, Standard Ethernet, 10/100 Mbps, automatically detected
    - USB: 1 port, USB2.0, 12 Mbps
  - **Device Networks:**
    - EtherCAT: 2 x EtherCAT master ports, with redundancy support (optional)
    - CAN: CANopen master port
- **I/O System:** All I/O interfaces are handled via the device network.
- **Internal System BIT:** The G-MAS BLM & GOLD LION Board Level Module supports internal hardware BIT (Built-in-tests) procedures to check the system integrity level on each power up.
- **Diagnostic LEDs:** EtherCAT and Ethernet activity
- Operational Temperature: 0 °C to 40 °C

2.1.2. G-MAS BLM & GOLD LION Board Level Module Software

- **Operating System:** Linux Operating System, with Elmo's RT extension for real-time motion control support
- Motion Programming and Debugging
  - Native C Programming, running on the target CPU. Compiling and debugging via the Eclipse IDE using GCC under Cygwin
  - IEC 61131-3 with PLCopen Motion Library extension, using Elmo IDE. The following languages are supported:
    - Structured text (ST), textual
    - Function block diagram (FBD), graphical

    - Ladder diagram (LD), graphical
    - Sequential function chart (SFC), has elements to organize programs for sequential and parallel control processing.

- **Number of Axes:** Up to 96 axes, allowing mixed single axis, multiple axis and coordinated axes motions

- Axis Types
  - Intelligent Servo Drives (Elmo), supporting both the SimplIQ and Gold lines
  - Operation of Maestro Profiler (real-time master synchronization) as well as non-Maestro profiler modes
  - DS 402 CoE for EtherCAT and standard DS 402 drives for CANopen

- Control System Update Rate
  - **EtherCAT**
    - Cycle Update Rate: ≥ 500 µs (up to 16 axes can be updated simultaneously at a rate of 500 µs)
    - Cycle Jitter: < 1 µs, based on Master DC (Distributed Clock) support, for the full network
  - **CAN**
    - Cycle Update Rate ≥ 1 ms (CAN physical network limitations only)
    - Cycle Jitter: < 100 µs for CAN Sync message initiation (actual jitter dependent on the CAN network's physical limitations)

- **Motion Modes and Interfaces:** The G-MAS BLM & GOLD LION Board Level Module motion interfaces use the PLCopen Standard.
  - 64 bit, real-time, double precision profile calculations, allowing full on-the-fly control over speed, acceleration, deceleration and jerk
  - Complex motion schemes, including look-ahead optimizing of trajectory speed calculations, for complex vector motions
  - Cyclic buffer for 1,000 function blocks (a buffer for 1,000 motion segments). The cyclical buffer removes any practical limit on the number of function blocks

- Communication Protocols
  - **Host**
    - Ethernet TCP-IP/UDP for operational modes
    - Telnet communication for setup and configuration
    - USB: Using binary protocol (maintenance)
    - Application level: Ethernet-IP/Modbus
  - **Device Network**
    - EtherCAT: CoE/EoE/FoE, supports distributed clock master
    - CAN: CANopen device profiles, e.g. DS 301, DS 305, DS 402, DS 401 (I/O device profile)

- Host and Internal Software Interface

  - TCP/IP interface from Host Computer. Software Library is provided for easy TCP/IP communication interface.
  - Future version will also support Ethernet-IP and Modbus over the TCP-IP.
  - Internal Software libraries, for "C" user programs are provided, to write user code running on the G-MAS BLM & GOLD LION Board Level Module target processor (native mode).

- Data Recording
  - 4 MB data recording
  - Up to 32 vectors can be recorded simultaneously.
  - Supports more than 10 advanced triggering options and real-time scope capabilities
  - Very fast data upload using Ethernet

- Upload/Download Support
  - Firmware update support (G-MAS BLM & GOLD LION Board Level Module and drives)
  - System resource files
  - Axis parameter files

- **Drive Communication Bridge Support:** The G-MAS BLM & GOLD LION Board Level Module supports full communication with any specific drive (EtherCAT and CAN), for the purpose of simple tuning or configuration at the drive level, i.e. there is no need for direct communication with the drive.

- Spatial Position-Based Pulse Generation
  - The G-MAS BLM & GOLD LION Board Level Module supports spatial (along the path) position-based pulse generation. This is a unique feature, required for the generation of position-based events in 3D scanning systems.
  - The G-MAS BLM & GOLD LION Board Level Module system, with Elmo's intelligent Gold servo drives, can support single axis and spatial enhanced position-based compare functions, resulting in trigger output signals accurate to 1 encoder count along the trajectory path.

- **Network Encoders:** Supports master based motion on network encoders

- **Position Error Mapping:** Supports 1-D and 2-D position-based error mapping compensation

- System Boot up Time: < 30 sec

2.2. System Architecture

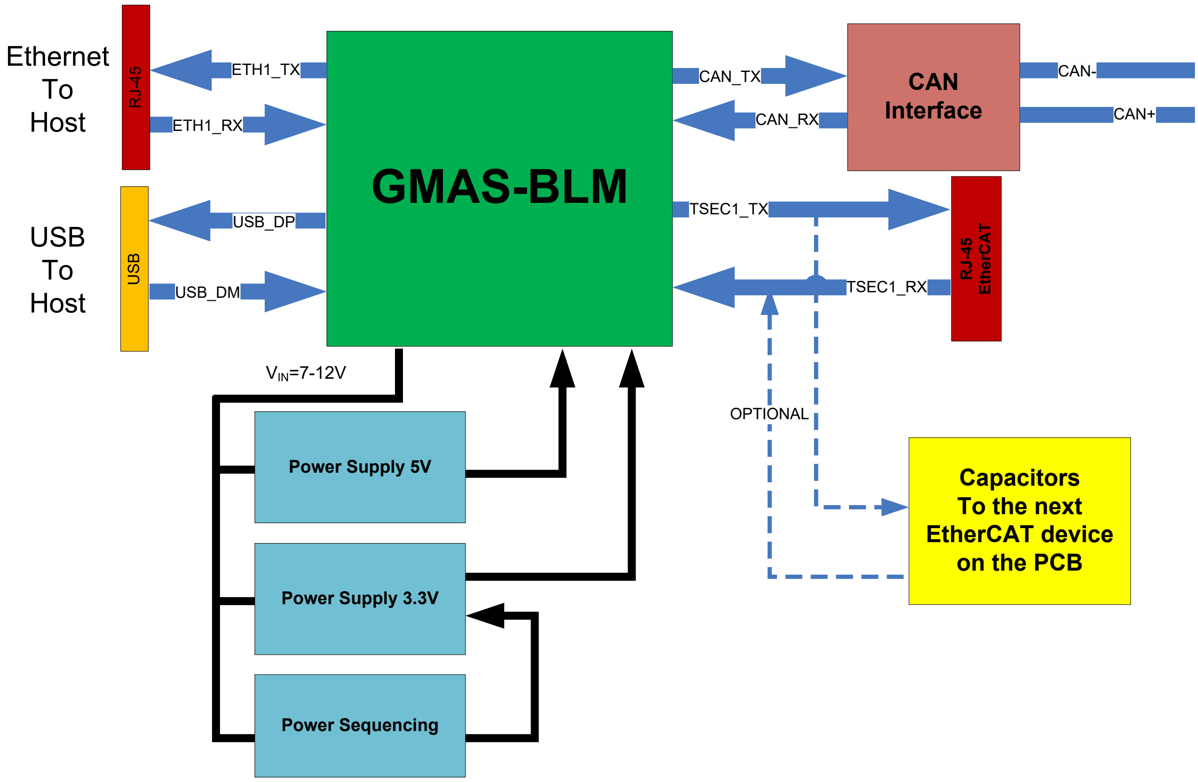


Figure 1: G-MAS BLM & GOLD LION Board Level Module Connections System Block Diagram

The G-MAS BLM is an integrated board that required the following interfaces:

- Power supply for V_{in}(7 to 12 V), 3.3V and 5V
- CAN interface
- EtherCAT connections, for which there are two options:
  - Connections to RJ-45 External connector
  - Connections to a Drive module such as G-WHISTLE or G-TROMBONE via the PCB
- Reset Circuit

2.3. Related Documents

This document describes the GMAS-BLM hardware connections, and is part of the set of assembly documents. This set includes the following:

- GMASS-BLM Integration Design Guide
- Schematic drawings in ORCAD 16.3 and PDF. The Schematic drawings are included in the following options:
  - Option 1: Non-isolated CAN
  - Option 2: Isolated CAN
  - Option 3: EtherCAT with RJ-45 External Connector
  - Option 4: EtherCAT to other drive via the PCB
- The following drawings are to be found within the manual compressed document collection:

  GMAS_BLM V3.DSN

  gmas_blm v3.pdf

  GMASS-BLM symbol for Algero (gmas_blm_v2.dra, gmas_blm_v2.psm)

  GMAS-BLM DXF (gmas_blm_v2.dxf)

When this manual is used in conjunction with the Drive Software series of manuals it describes everything necessary to get the G-MAS BLM & GOLD LION Board Level Module up and running.

Chapter 3: Assembly

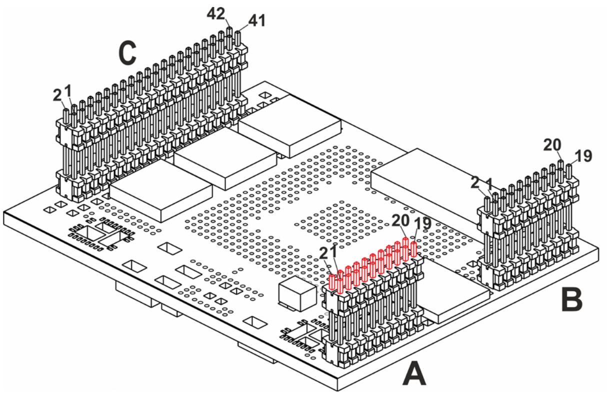
This chapter describes the pin to pin connections between the G-MAS BLM and the PCB.

3.1. Pin Connectors

3.1.1. Supply

Function	**Supply**	
Pin Name	J100 (Shown as A in diagram below)	
Type	Header 20 pin, 2 row, 1.27mm	
No	**Name**	**Description**
1A	GND	Ground
2A	GND	Ground
3A	3.3V	3.3V ±5%
4A	3.3V	3.3V ±5%
5A	3.3V	3.3V ±5%
6A	3.3V	3.3V ±5%
7A	5V	5V ±5%
8A	5V	5V ±5%
9A	VIN	Main power of the GMAS-BLM Interface
10A	VIN	Main power of the GMAS-BLM Interface
11A	GND	Ground
12A	GND	Ground
13A	GND	Ground
14A	GND	Ground
15A	LED1	Output Same as G-MAS Motion Controller The specifications and operation of the LEDs in the G-MAS BLM are similar to that of the G-MAS motion controller.
16A	LED2	Output Same as G-MAS Motion Controller The specifications and operation of the LEDs in the G-MAS BLM are similar to that of the G-MAS motion controller.
17A	NU	Not in use. Do not connect the pins.

Function	Supply	
18A	NU	Not in use. Do not connect the pins.
19A	NU	Not in use. Do not connect the pins.
20A	NU	Not in use. Do not connect the pins.



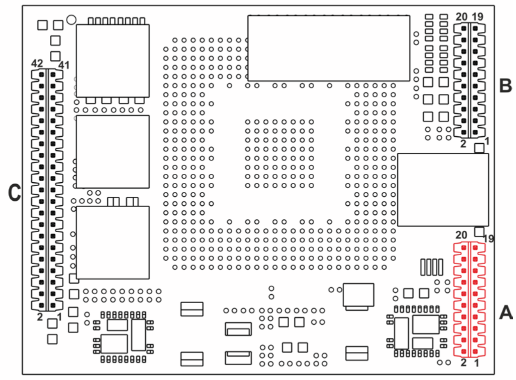
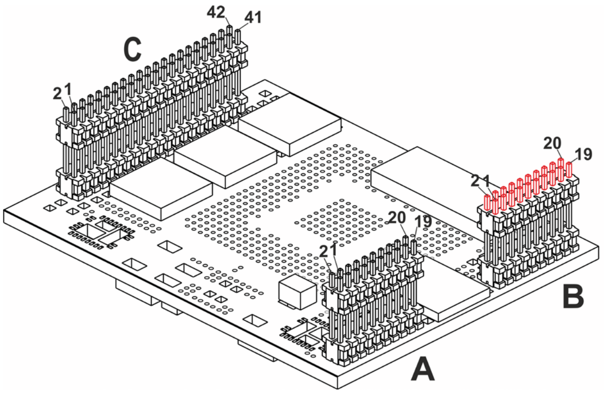


Table 1: Supply Pin Connector

3.1.2. Jtag, Reset & RS232

Function	**Jtag, Reset & RS232**		
Name	J102(Shown as B in diagram below)		
Type	Header 20 pin, 2 row, 1.27mm		
No	**Name**	**Type**	**Description**
1B	TCK	I	JTAG Clock Connect to 10Khom Pull up resistor to 3.3V. JTAG signals for factory manufacturing and debugging. Leave unused.
2B	RESET_N	I	Power on Reset The reset_N signal is Active low
3B	GND		Ground
4B	HRESET_N	I/O	Leave unused
5B	TRSTN	I	JTAG Reset Connect to 10Khom Pull up resistor to 3.3V. JTAG signals for factory manufacturing and debugging. Leave unused.
6B	SRESET_N	I	Leave unused
7B	TMS	I	JTAG TMS Connect to 10Khom Pull up resistor to 3.3V. JTAG signals for factory manufacturing and debugging. Leave them unused.
8B	GND		Ground
9B	TDI	I	TJAG Data IN Connect to 10Khom Pull up resistor to 3.3V. JTAG signals for factory manufacturing and debugging. Leave unused.
10B	RXD	I	Input RS232 RX – Leave unused
11B	TDO	O	JTAG Data Out Connect to 10Khom Pull up resistor to 3.3V. JTAG signals for factory manufacturing

Function	Jtag, Reset & RS232		
			and debugging. Leave unused.
12B	TXD	O	Output RS232 TX - Leave unused
13B	NU		Leave unused
14B	NU		Leave unused
15B	NU		Leave unused
16B	NU		Leave unused
17B	NU		Leave unused
18B	NU		Leave unused
19B	NU	I	Leave unused
20B	NU	I	Leave unused



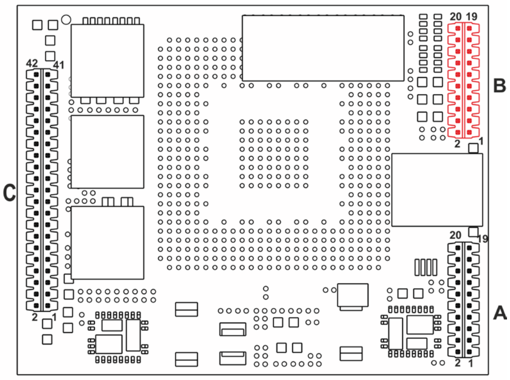


Table 2: Jtag, Reset & RS232 Pin Connectors

3.1.3. Communication

Function	COMM		
Name	J101(Shown as C in diagram below)		
Type	Header 42 pin, 2 row, 1.27mm		
No	**Name**	**Type**	**Description**
1C	GND		Ground
2C	ETH1_LINK_ACT	O	LED is ON when the link is OK
3C	ETH1_3.3V	O	3.3V to the RJ45 with Magnetic
4C	ETH1_SPEED	O	Indicates 10Mb/s or 100Mb/s
5C	GND		Ground
6C	TSEC1_LINK_ACT	O	LED will be ON when the link is OK
7C	ETH1_TX+	O	Differential Transmit signal Data+ from the Ethernet PHY to RJ-45 with Magnetic
8C	TSEC1_SPEED	O	Indicates 10Mb/s or 100Mb/s
9C	ETH1_TX-	O	Differential Transmit signal Data- from the Ethernet PHY to RJ-45 with Magnetic
10C	TSEC2_LINK_ACT	O	LED will be ON when the link is OK
11C	GND		Ground
12C	TSEC2_SPEED	O	Indicates 10Mb/s or 100Mb/s
13C	ETH1_RX+	I	Differential Receive signal Data+ from RJ-45 with Magnetic to Ethernet PHY
14C	GND		Ground
15C	ETH1_RX-	I	Differential Receive signal Data+ from RJ-45 with Magnetic to Ethernet PHY
16C	TSEC1_2.5V	O	2.5V to the RJ45 with Magnetic
17C	GND		Ground
18C	TSEC2_2.5V	O	2.5V to the RJ45 with Magnetic
19C	TSEC2_TX+	O	Differential Transmit signal Data+ for EtherCAT 2 from the Ethernet PHY
20C	GND		Ground
21C	TSEC2_TX-	O	Differential Transmit signal Date- for

Function	COMM		
			EtherCAT 2 from the Ethernet PHY
22C	CAN_TX	O	Output from the CAN controller to the CAN bus
23C	GND		Ground
24C	CAN_RX	I	Input from CAN BUS to the CAN controller
25C	TSEC2_RX+	I	Differential Receive signal Data+ for EtherCAT 2 to the Ethernet PHY
26C	GND		Ground
27C	TSEC2_RX-	I	Differential Receive signal Data- for EtherCAT 2 to the Ethernet PHY
28C	NU		**Connect to 10Khom Pull up resistor to 3.3V.**
29C	GND		Ground
30C	NU	I/O	Leave unused
31C	TSEC1_TX+	O	Differential Transmit signal Data+ for EtherCAT 1 from the Ethernet PHY
32C	GND		Ground
33C	TSEC1_TX-	O	Differential Transmit signal Date- for EtherCAT 1 from the Ethernet PHY
34C	USB_DP	I/O	USB Data+
35C	GND		Ground
36C	USB_DN	I/O	USB Date-
37C	TSEC1_RX+	I	Differential Receive signal Data+ for EtherCAT 1 to the Ethernet PHY
38C	GND		Ground
39C	TSEC1_RX-	I	Differential Receive signal Data- for EtherCAT 1 to the Ethernet PHY
40C	NU		Leave unused

Function	COMM		
41C	GND		Ground
42C	USB_VBUS_IN	I	Monitor for the USB voltage **Note: There is a voltage divider to reduce the voltage of USB_VBUS from 5V to appropriate voltage sense.**

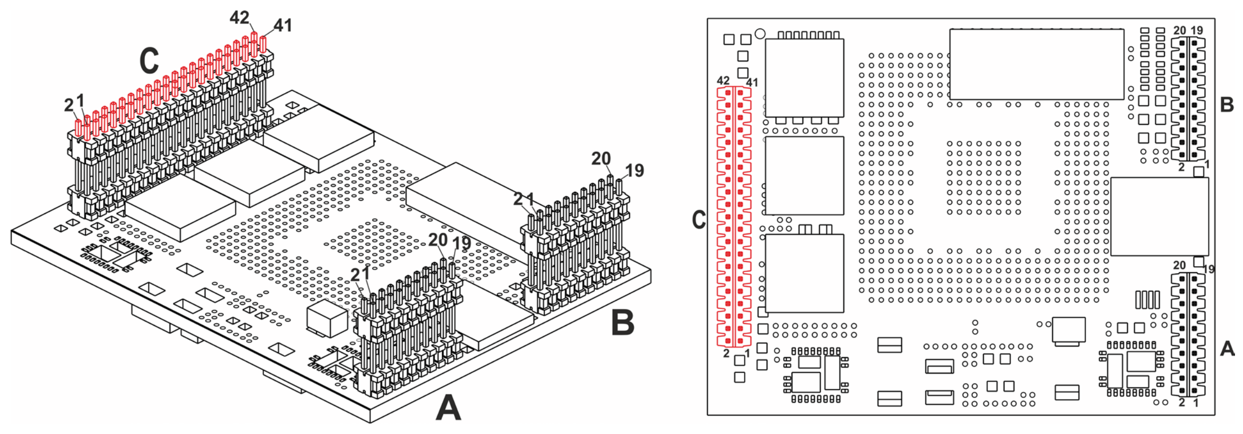


Table 3: Communication Pin Connectors

3.2. Mechanics

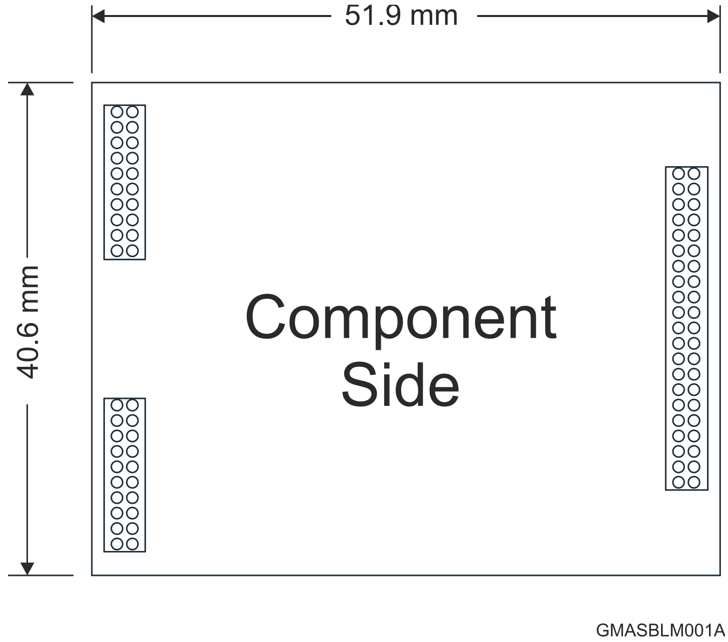


Figure 2: Pin Physical Dimensions

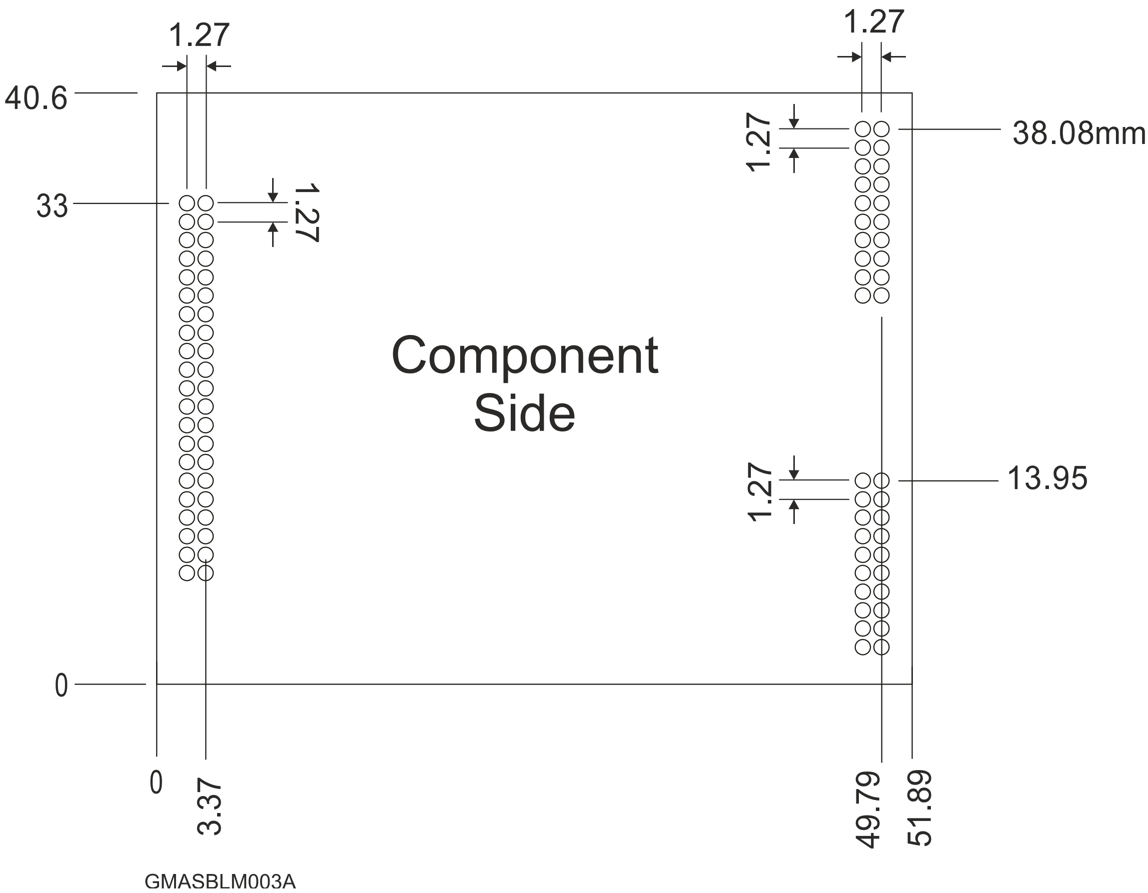


Figure 3: Pin Detail Measurements

3.3. Power Signals

The GMASS-BLM requires three power supplies.

Power	Range	Power Consumption
VIN	7V ÷ 12V	2.8W
5V	4.75V ÷ 5.25V	0.19W
3.3V	3.2V ÷ 3.4V	2.3W

The 3.3V and 5V required for the GMAS-BLM can be generated from the VIN or can be supplied from the other power supplies on the user board.

It is recommended to add capacitors of 10uf and 100nf near the power pins (VIN, 3.3V and 5V) of the G-MAS-BLM.

Figure 4 describes the power sequencing of the Power supplies. It is required that 3.3V (Green line) power supply will be raised 100msec after the VIN (V_{in} (red line)).

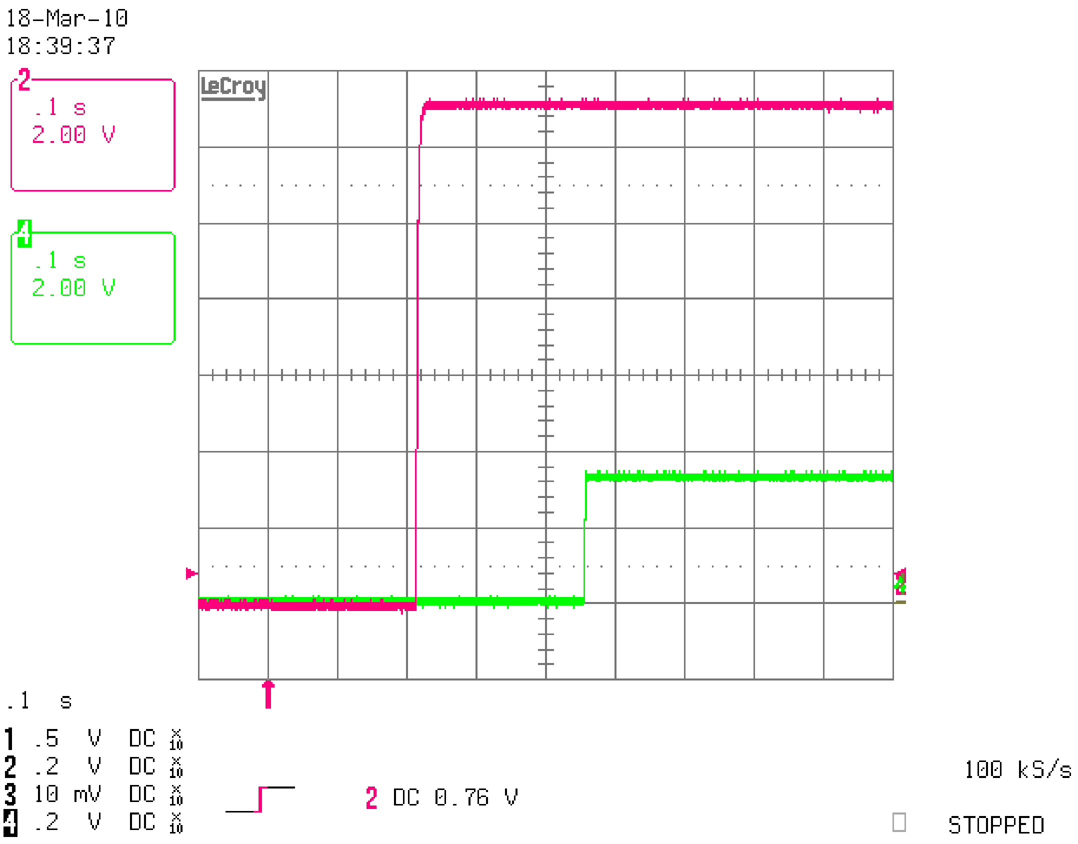


Figure 4. Power Sequencing signals at optimum

The power sequencing can be implemented for example with the Reset Control Chip that controls the power up of the 3.3V power supply.

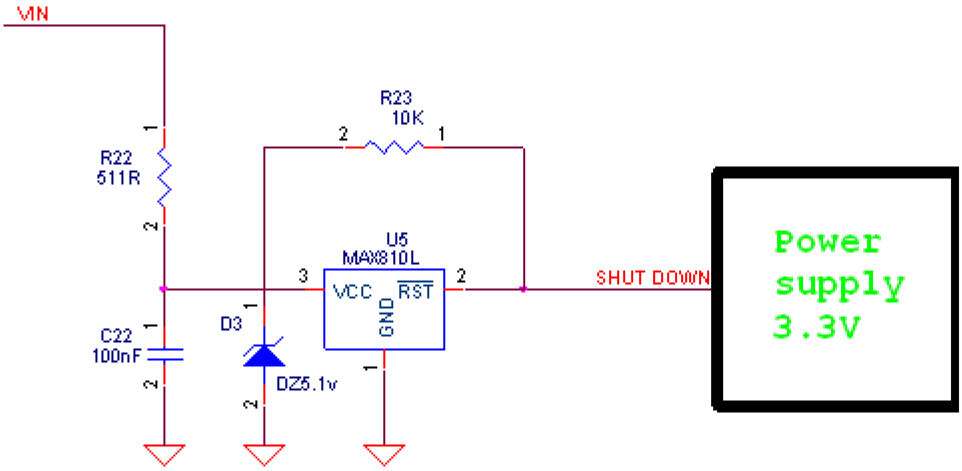


Figure 5. Power Sequencing using the Reset Control Chip

3.4. Reset Signals

LED	I/O	Description
RESET_N		Power on Reset The reset_N signal is Active low

The following figure is an example for reset implementation. The EXT_RESET signal (which is connected in schematic drawing to TP2) can be connected to the reset switch:

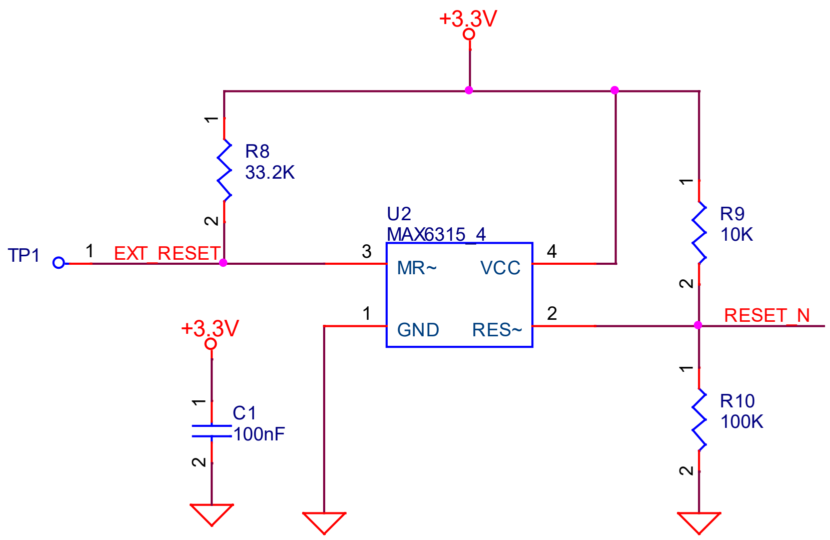


Figure 6. Power Reset Drawing

The following figure describes the Reset_N sequencing. The Reset_N signal (red line) should be raised 100msec after the 3.3V (red line).

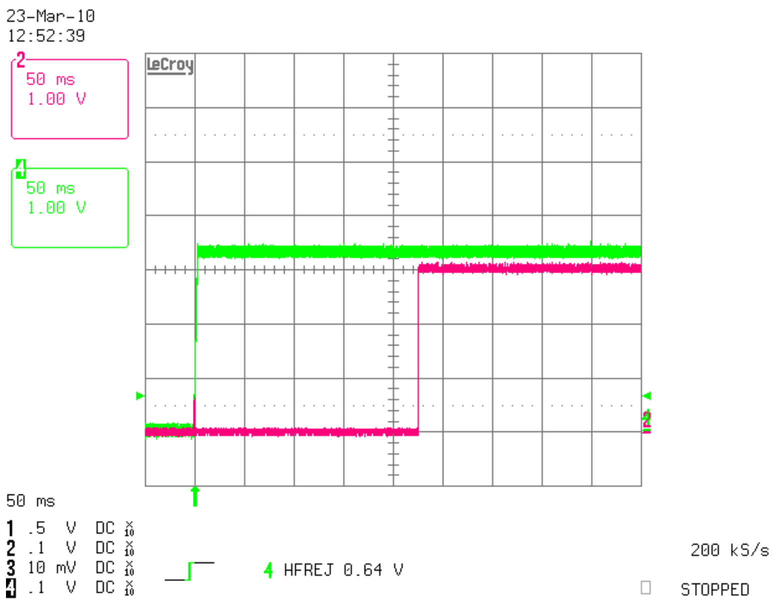


Figure 7. Power Reset Signals at optimum

3.5. CAN Communication

3.5.1. Overview

Typically, the CANbus is set with a pair of twisted wires. The Bus ends are terminated with a 120 ohm resistor at each end. This results in a bus load of 60 ohm. Close matching of the termination resistor with the cable impedance ensures that the data signals are not reflected at the bus ends.

It must be emphasized that the CANbus is actually a "3 wires" communication, especially out of the board. Theoretical the number of units that can be connected to the CAN bus is not limited. However, the total actual number of units that can be connected will be limited by the delay times and the bus loads in the bus lines.

The CANbus includes the following signals: CAN_LOW, CAN_HIGH and GND. Make sure that the GND signal also connected via the cable. Figure 22 displays the CAN connectivity.

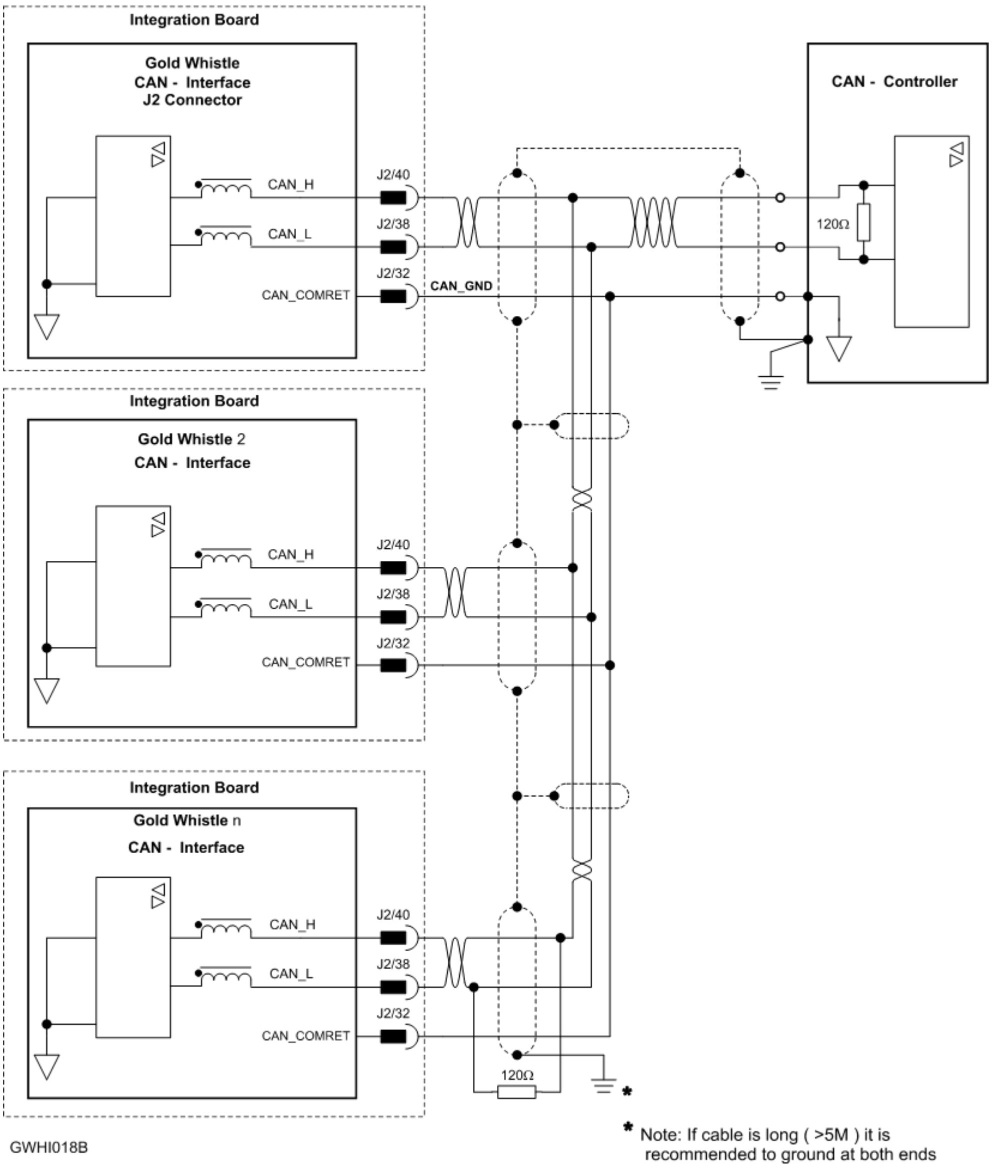


Figure 8. CANbus Connections

Important: A 120 Ω termination resistor should be connected at each end of the network cable.

CAN Speed

The CAN Bus standard specifies the Max theoretical cable length @1Mbits/sec as 40 meters. However, the CAN is determined by various factors such as:

- Loop delays of the connected bus nodes and the delay of the bus lines, consist of:
  - CAN controller and Transceiver Delays (vary between 30÷150 nano-sec)
  - Optional Isolation Delays (vary between 20÷75 nano-sec)
  - Typical Bus line delays
  - Delay connector
- Differences in bit time quantum length due to relative oscillator tolerance between nodes.
- Signal amplitude drop due to the series resistance of the bus cable and the input resistance of bus nodes.

In order to analyze the actual max cable length and number of nodes that can be safely used in a specific configuration, all the above factors should be taken into consideration.

3.5.2. CAN Communication over the PCB

Pin Descriptions of the G-MAS BLM:

CAN Pin	I/O	Description
CAN_RX	I	Input from CAN BUS to the CAN controller
CAN_TX	O	Output from the CAN controller to the CAN bus

It should be noted to leave the above pins unconnected if the CAN BUS is not used.

There are two options to connect the CAN: non-isolated CAN or isolated CAN.

3.5.3. Non-isolated CAN Interface

The CAN Interface block includes common mode choke and CAN Bus Protector for ESD and other harmful transient voltage events. Figure 9 describes an example for the G-MAS-BLM with non-isolated CAN interface connected to the RJ-45 in the PCB.

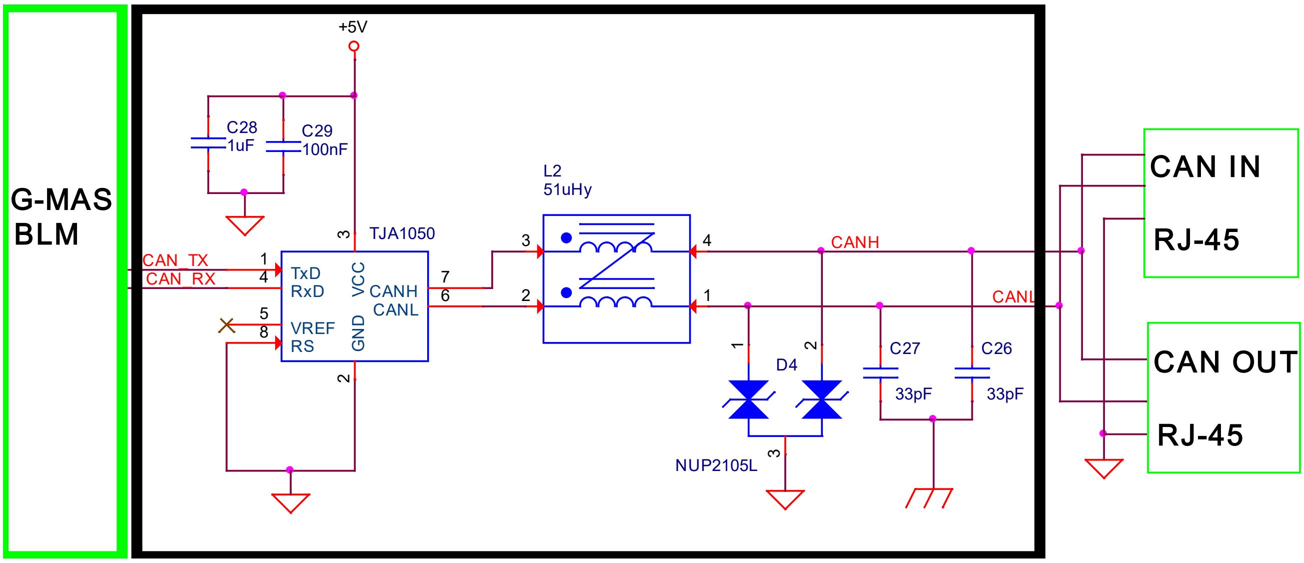


Figure 9: G-MAS-BLM non isolated interface connected to RJ-45

3.5.4. Isolated CAN Interface

The following figure describes an example for isolated CAN implementation.

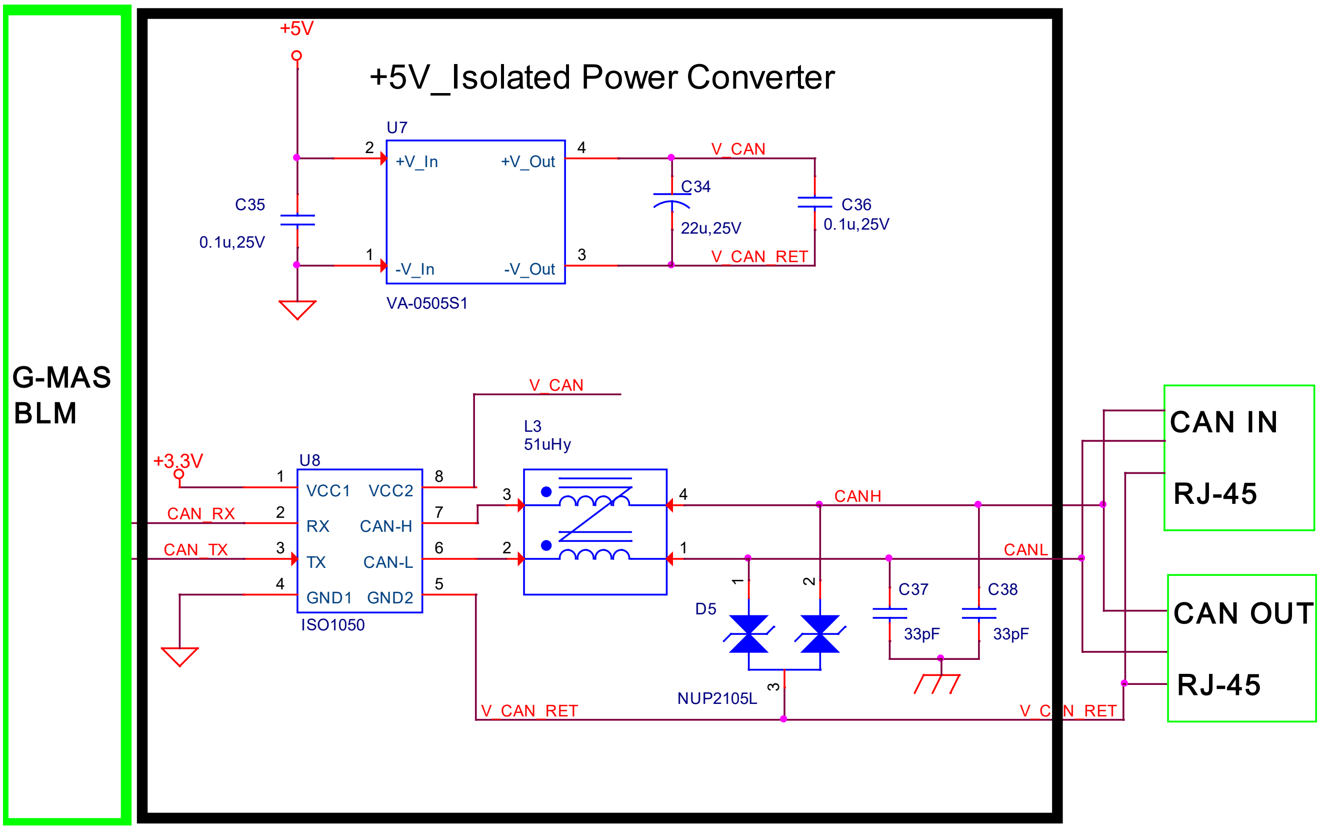


Figure 10: Isolated CANbus interface

3.5.5. CAN Communication over the PCB

Figure 11 describes the connections between the:

- GMAS-BLM to the External CAN network via J-45
- Connection to the drive module as in the G-Whistle or G-Trombone via PCB

The GMAS-BLM is connected to one of the CAN Interfaces, either Isolated or non-isolated.

The CANBUS (CAN-,CAN+) passes in the PCB to the other drive module, and also connects to the RJ-45 for CAN Devices external connectivity.

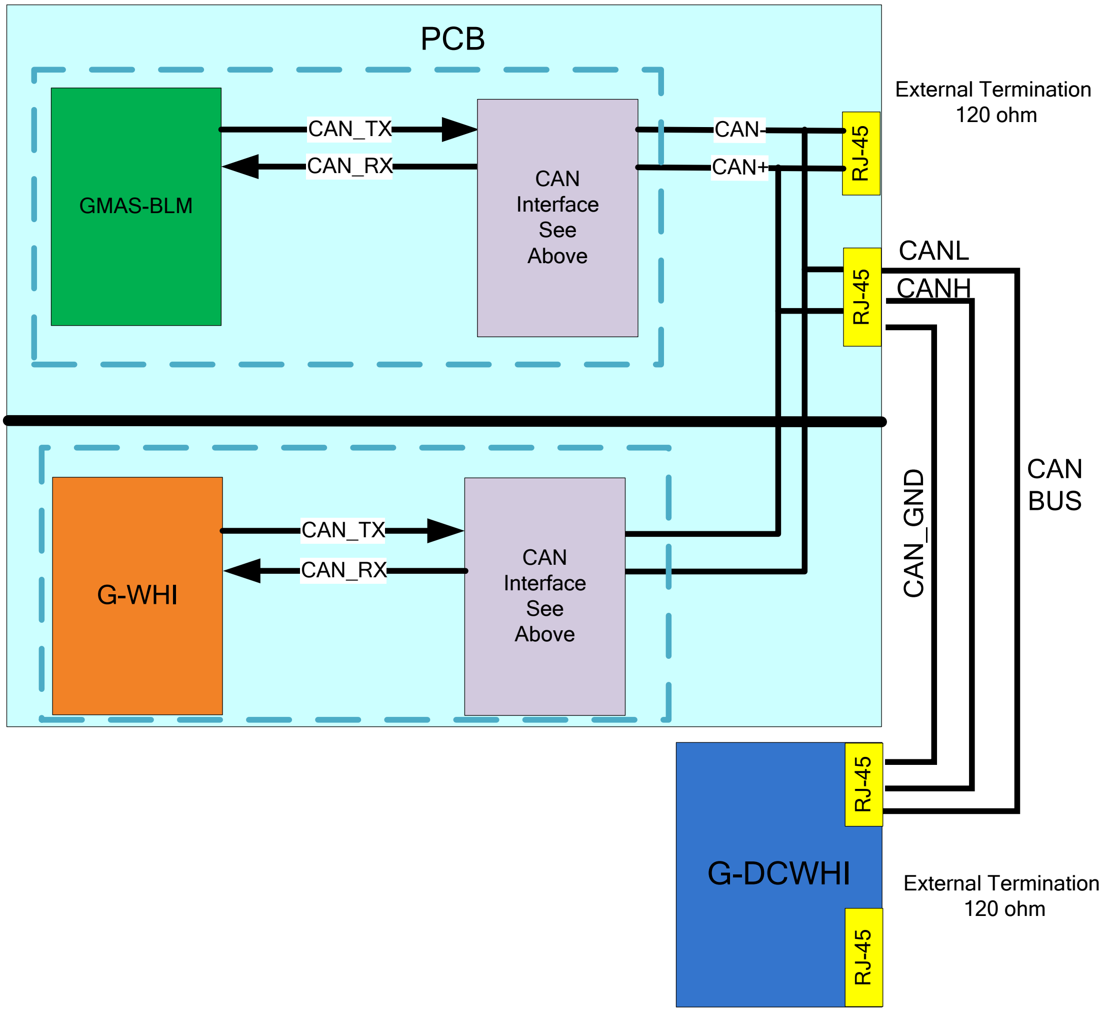


Figure 11: G-MAS-BLM Connections to the External CAN network via J-45 and also to G-WHI

3.5.6. Layout Guidelines for CAN

The guidelines are recommended:

- Locate the CAN Bus Protector Diodes, Common Mode Choke and filter capacitor close to the CAN Connector.
- The length traces of the CAN Bus Protector Diodes should be as short as possible.
- For optimum layout, there should be an inner ground layer. This is optimal from the immunity point of view.
- The digital ground planes should not be placed under the magnetic parts (common mode choke)
- The CAN lines are differential lines. They should be routed together and as close as possible.
- Do not route digital signals under the magnetic parts (Common mode choke)

3.6. USB Connections

Pin Descriptions:

USB Pin	I/O	Description
USB_DP	I/O	USB Data+
USB_DN	I/O	USB Date-
USB_VBUS_IN	I	Monitor for the USB voltage Note: There is a voltage divider to reduce the voltage of USB_VBUS from 5V to appropriate voltage sense.

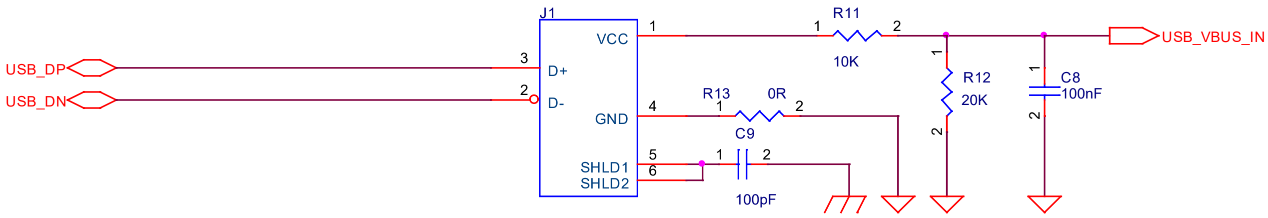


Figure 12: USB implementation

3.7. Ethernet Communications

The ETH1 signals are used to connect between the GMAS-BLM to the Host Computer. The following signals originate from the Physical Layer Transceiver (PHY) which provides the Ethernet 10Base-T/100Base-TX.

Pin Descriptions:

Ethernet Pins	I/O	Description
ETH1_TX+	O	Differential Transmit signal Data+ from the Ethernet PHY to RJ-45 with Magnetic
ETH1_TX-	O	Differential Transmit signal Data- from the Ethernet PHY to RJ-45 with Magnetic
ETH1_RX+	I	Differential Receive signal Data+ from RJ-45 with Magnetic, Ethernet PHY
ETH1_RX-	I	Differential Receive signal Data+ from RJ-45 with Magnetic, Ethernet PHY
ETH1_LED_LINK	O	LED is ON when the link is OK
ETH1_LED_SPEED	O	Indicates 10Mb/s or 100Mb/s
ETH1_3.3V	O	3.3V to the transformer

Figure 13 describes the RJ-45 magnetic connection to the Ethernet port.

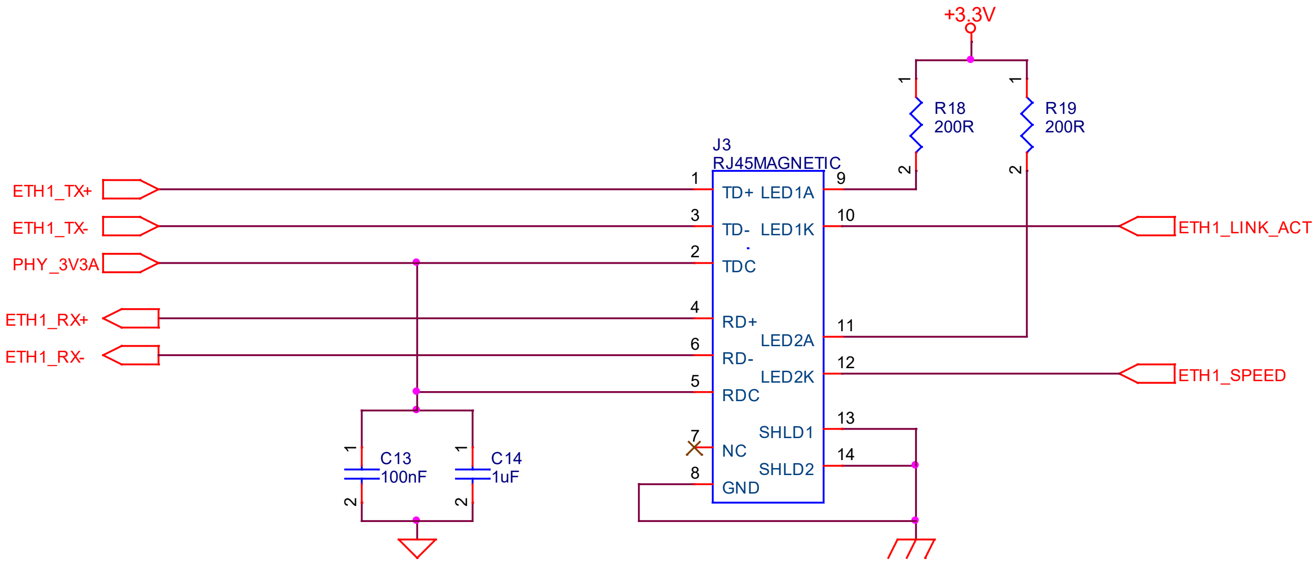


Figure 13: EtherNet implementation

3.8. EtherCAT Communications

There are two EtherCAT ports:

- **EtherCAT 1 port**: This is the main port. Connect the EtherCAT network to this port. This port should be the first device in the EtherCAT network.
- **EtherCAT 2 port**: Not used. It is an optional port for future requirements such as redundancy.

3.8.1. EtherCAT 1 Port

The following signals originate from the Physical Layer Transceiver (PHY) which provides the Ethernet 10Base-T/100Base-TX.

EtherCAT IN Pins	I/O	Description
TSEC1_TX+	O	Differential Transmit signal Data+ for EtherCAT 1 from the Ethernet PHY
TSEC1_TX-	O	Differential Transmit signal Date- for EtherCAT 1 from the Ethernet PHY
TSEC1_RX+	I	Differential Receive signal Data+ for EtherCAT 1 to the Ethernet PHY
TSEC1_RX-	I	Differential Receive signal Data- for EtherCAT 1 to the Ethernet PHY
TSEC1_LED_LINK	O	LED will be ON when the link is OK
TSEC1_LED_SPEED	O	Indicates 10Mb/s or 100Mb/s
TSEC1_2.5V	O	2.5V to the transformer RJ45 connection

3.8.2. EtherCAT 2 Port

The following signals originate from the Physical Layer Transceiver (PHY) which provides the Ethernet 10Base-T/100Base-TX.

EtherCAT IN Pins	I/O	Description
TSEC2_TX+		Differential Transmit signal Data+ for EtherCAT 2 from the Ethernet PHY
TSEC2_TX-		Differential Transmit signal Date- for EtherCAT 2 from the Ethernet PHY
TSEC2_RX+		Differential Receive signal Data+ for EtherCAT 2 to the Ethernet PHY
TSEC2_RX-		Differential Receive signal Data- for EtherCAT 2 to the Ethernet PHY

EtherCAT IN Pins	I/O	Description
TSEC2_LED_LINK		LED will be ON when the link is OK
TSEC2_LED_SPEED		Indicates 10Mb/s or 100Mb/s
TSEC2_2.5V		2.5V to the transformer RJ45 connection

3.8.3. EtherCAT Connectivity to RJ-45

The following figure describes the connectivity of the EtherCAT PHY signals to the RJ-45 with magnetic.

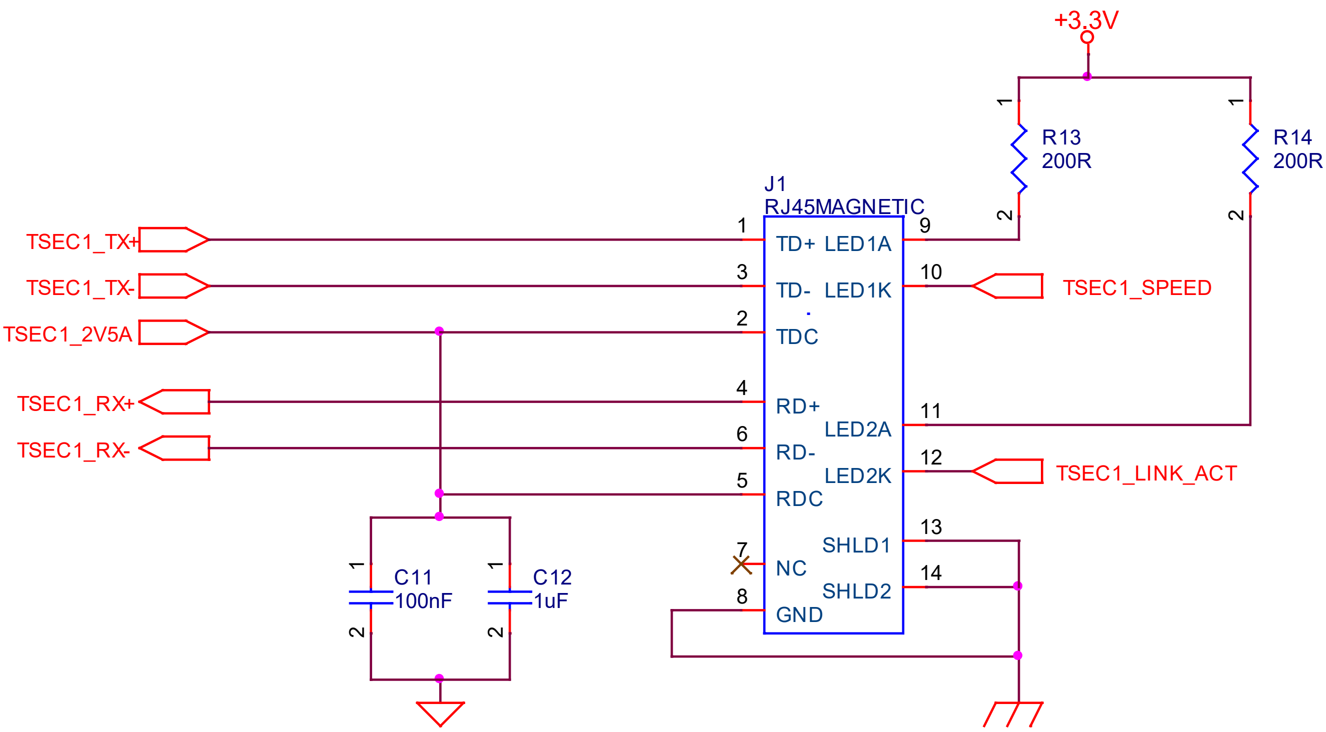


Figure 14: EtherCAT implementation with RJ-45

Figure 15 describes the G MAS-BLM with RJ-45 connected to the G-DC-Whistle via the Cable. The GMASS-BLM should be the first device in the EtherCAT network.

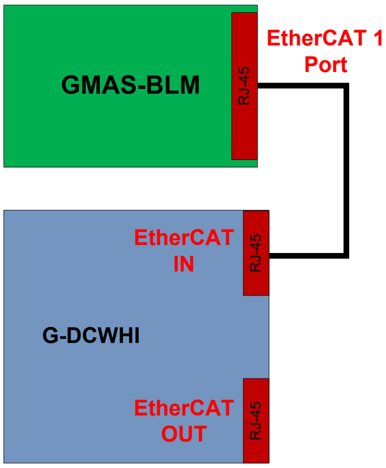


Figure 15: G MAS-BLM with RJ-45 connected to the G-DC-Whistle

3.8.4. Connecting the GMAS-BLM EtherCAT Port via the PCB with Capacitive Coupling

When the point to point Ethernet connection is made through a PCB (and not through a cable), the PCB replaces the RJ-45 and the twisted pair cable. The connection between the GMAS-BLM to the other EtherCAT drive module (G-WHISTLE or G-TROMBONE) in the PCB is made with Capacitive Coupling .

Figure 16 describes the EtherCAT network that includes:

- G MAS-BLM connected to G-WHISTLE via PCB with capacitive decoupling. The PHY signals of the GMAS-BLM (TSEC1) are connected to the G-WHI, PHY signals of the EtherCAT In, via capacitors. The GMASS-BLM should be the first device in the EtherCAT network.
- The G-MAS-BLM TX signals are connected to the G-WHI RX signals. Similarly, the G-MAS-BLM RX signals connected to the G-WHI RX signals.
- G-DCWHI connected to the G-WHI via the Cable. The cable is connected between the EtherCAT out port of the G-WHI to the EtherCAT In port of the G-DCWHI.

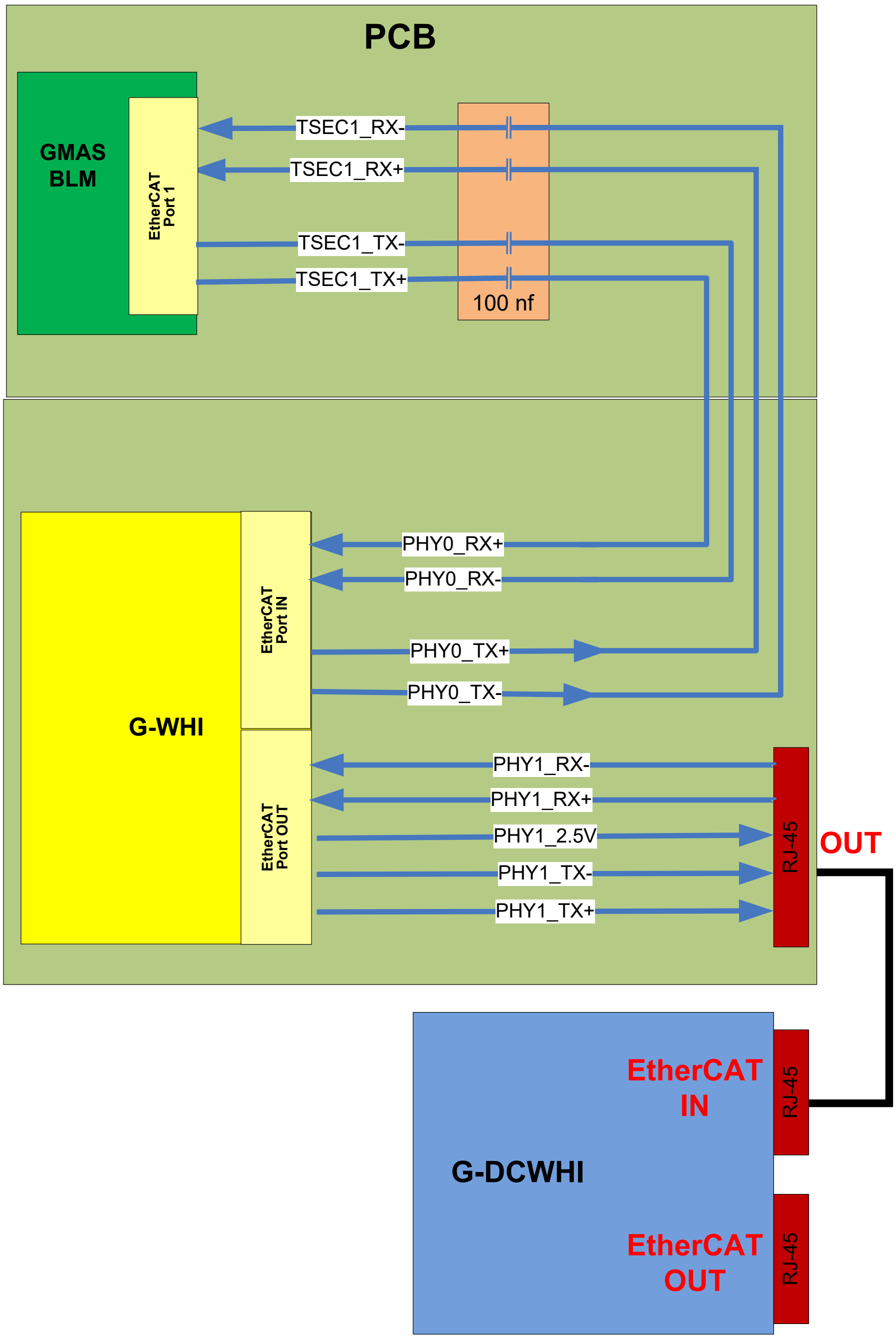


Figure 16: G-MAS-BLM and G-Whistle connections via PCB traces with Capacitors

3.9. Layout Guidelines

3.9.1. PCB

It is recommended to use at least 4 layers on the PCB, for the routing of the EtherCAT signals. The following is an example of the Stackup:

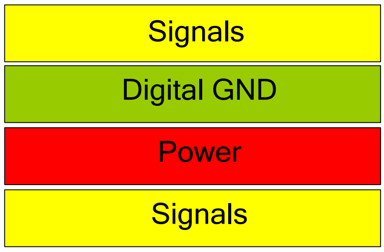


Figure 17: Example of Layered Stackup on PCB

The Digital plan should be continuous and not fragmented.

3.9.2. Connection to RJ-45 with Magnetic

The digital ground planes **should not** be placed under the RJ-45.

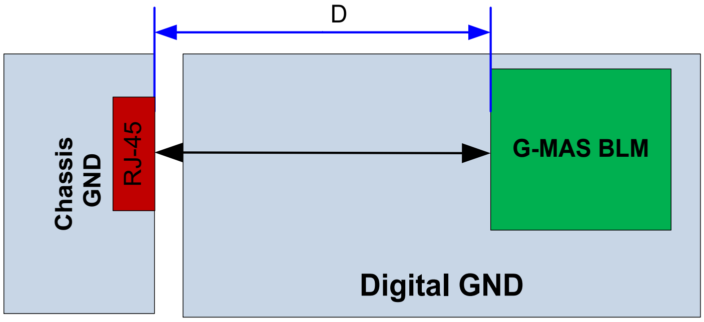


Figure 18: RJ-45 Layout

The G-MAS BLM should be placed as close as possible to the magnetic. If there are limitations on the PCB layout, preventing the G-MAS BLM from being positioned close to the magnet, then the trace length from the G-MAS BLM to the magnetic should not be longer than 5 inches (D).

3.9.3. Connection with Capacitor

The digital ground planes **should** be placed under the capacitor parts.

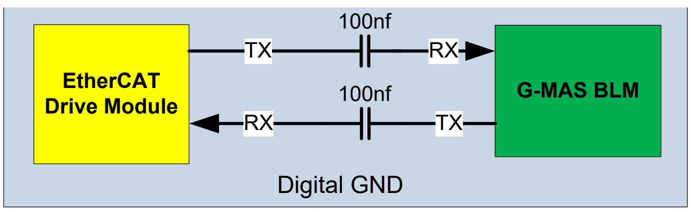


Figure 19: Transform Layout

3.9.4. Differential Signal Layout Guidelines

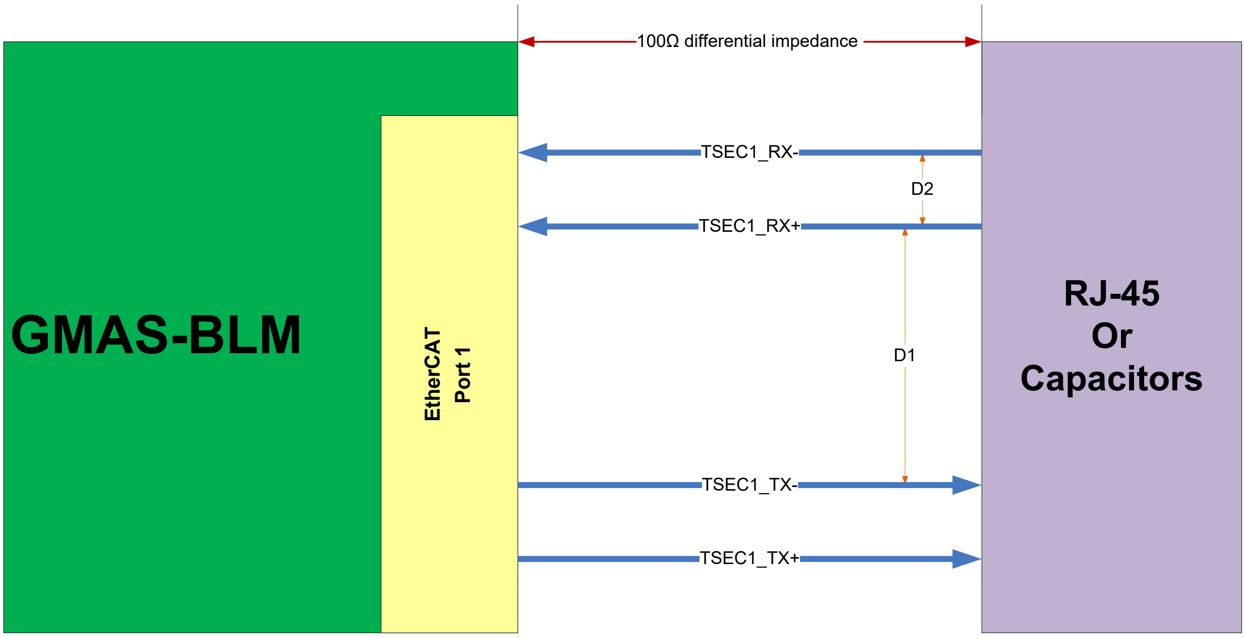


Figure 20: Differential Signal Layout

The following is a guide to the differential signal layout

- The differential pairs (TSEC1_TX± ,TSEC1_RX±) should be designed to a 100 ohm differential impedance.
- The differential pairs should be routed as close as possible (D2).
- The trace width should be determined by the required trace impedance.
- The spacing D1 between the differential pairs should be as large as possible.
- Route the differential pairs as straight as possible, maintaining them in parallel for differential pairs.
- Route the differential pairs symmetrically, at equal lengths and close together whenever possible.
- Do not route digital signals under the magnetic parts
- Avoid using VIAS on the traces of the differential pairs.
- Avoid routing the signal trace at a right-angle. Instead route it using multiple 45˚ angles.

Chapter 4: G-MAS BLM & GOLD LION Board Level Module Dimensions

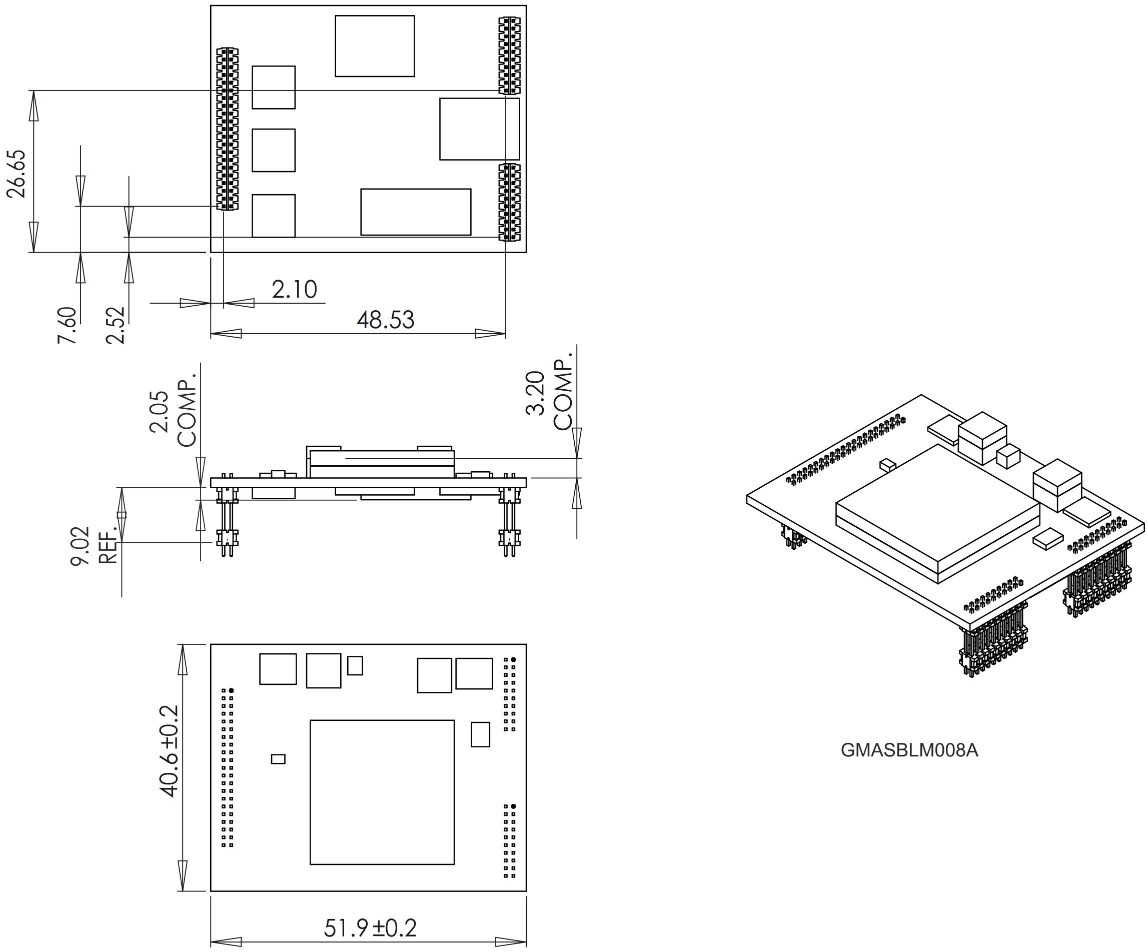


Figure 21: Physical Dimensions

All measurements are in mm.

4.1. General Specifications

Feature	Details
Weight	
Dimensions	51.9 x 40.6 x 12.22 mm

4.2. G-MAS BLM Environmental Conditions

Feature	Details
Operating ambient temperature	0 °C to 40 °C (32 °F to 104 °F)
Storage temperature	-20 °C to +85 °C (-4 °F to +185 °F)
Maximum non-condensing humidity	90%
Maximum Operating Altitude	2,000 m (6562 feet)
Vibration (operation)	5 GRMS, 50 Hz to 500 Hz

4.3. LION Environmental Conditions

Feature	Operation Conditions	Range
Ambient Temperature Range	Non-operating conditions	-40 °C to +100 °C (-58 °F to 212 °F)
	Operating conditions	-40 °C to +70 °C (-40 °F to 160 °F)
Temperature Shock	Non-operating conditions	-40 °C to +70 °C (-40 °F to 160 °F) within 3 min.
Altitude	Non-operating conditions	Unlimited
	Operating conditions	-400 m to 12,000 m (-1312 to 39370 feet)
Maximum Humidity	Non-operating conditions	Up to 95% relative humidity non-condensing at 35 °C (95 °F)
	Operating conditions	Up to 95% relative humidity non-condensing at 25 °C (77 °F), up to 90% relative humidity non-condensing at 42 °C (108 °F)
Vibration	Operating conditions	20 Hz to 2,000 Hz, 14.6g
Mechanical Shock	Non-operating conditions	±40g; Half sine, 11 msec
	Operating conditions	±20g; Half sine, 11 msec

4.4. Power Supply

Feature	Details
Auxiliary supply input power	4.5 W

4.5. Communications

Specification	Details
Ethernet	• 100 base-T • Baud Rate: 10/100 Mbit/sec, automatically detected • CAT5e Cable • UDP, Telnet, TCP
USB	One port, USB 2.0, 12 Mbps Used only for setup and determining IP address.
EtherCAT	• 100 base-T • Baud Rate: 100 Mbit/sec • CAT5e Cable • CoE, EoE, FoE
CANopen	**CAN bus Signals:** • CAN_H, CAN_L, CAN_GND • Maximum Baud Rate of 1 Mbits/sec. **CANopen Profile:** • DS 301 **Device Profile** (drive and motion control)**:** • CANopen device profiles, e.g. DS301, DS505, DS402, DS401 (for I/O)

4.6. Compliance with Standards

Specification	Details
PCB	
In compliance with **IPC-A-600**, level 2	Acceptability of printed circuit boards
Packing	
In compliance with **EN 100015**	Protection of electrostatic sensitive devices

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