G-MUX Quad I/O 1 to 8 Multiplexer

Technical Data Sheet

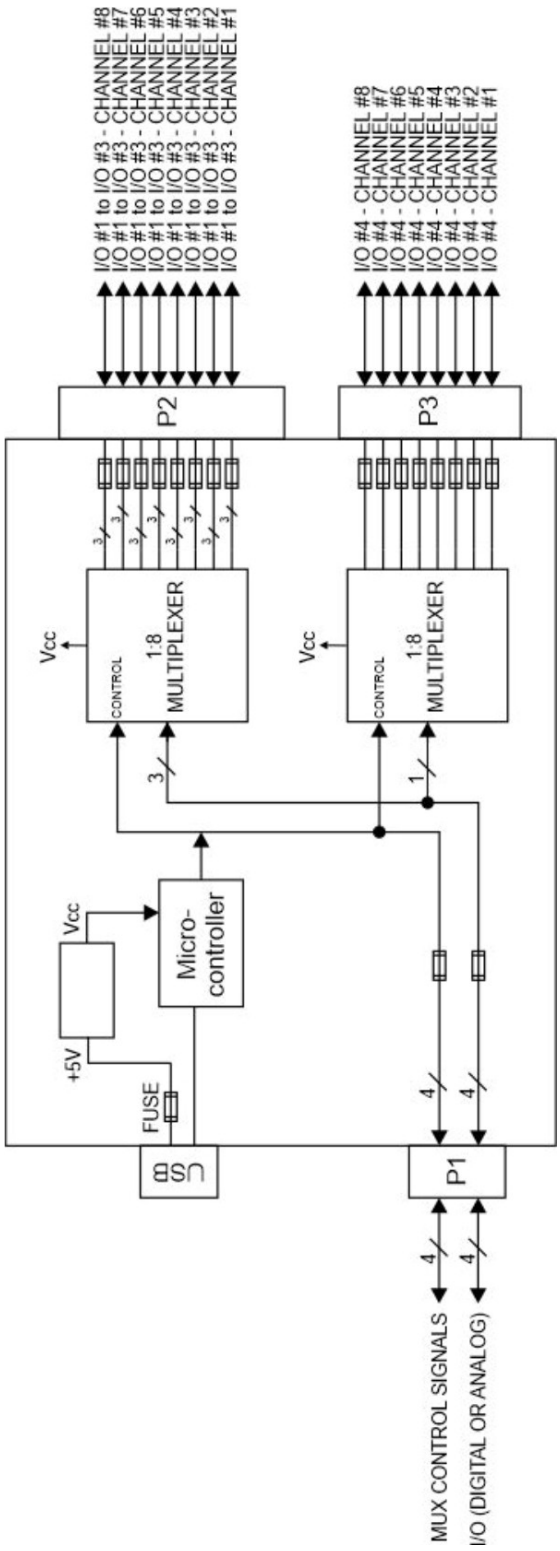
The Goneco Technologies G-MUX (Model Number GMX-2401) provides the ability to multiplex a group of four individual analog and/or digital signals to 1 of 8 output channels. This feature is particularly useful in such environments as production testing or production programming. The four individual signals can be used for both analog and digital signals, thus making the G-MUX useful for multiplexing analog signals as well as common serial protocol systems such as UART, SPI, and I2C.
In addition, popular programming protocols such as J-Link and JTAG are also supported.

Multiplexing of the signal group is controlled either through a USB interface, or discrete control signals. The G-MUX enumerates as a Virtual COM Port. A simple communication protocol is used to control operation of the G-MUX. Several G-MUX devices can also be connected in parallel to expand the group width.

Key performance specifications

- A group of four I/O signals can be routed to one of 8 output channels.
- I/O signals can be mixed (digital or analog signals).
- I/O signals are bi-directional.
- USB powered.
- Multiplexing function and channel selection can be controlled either via USB, or via externally controlled discrete control signals.
- Voltage range for I/O signals is 0V to +3.3V (analog or digital).
- Several G-MUX devices can be connected in parallel in order to increase the group width.
- Housed in a robust aluminum enclosure.

G-MUX - Simplified Block Diagram



Front Panel Layout

Rear Panel Layout

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1 Maximum ratings [1]

Symbol	Parameter	Conditions	Min	Max	Unit
V_{USB}	USB supply voltage	G-MUX powered from standard USB port	4.75	5.5	V
$V_{I/O}$	Voltage applied to any of the I/Os		0	+3.3	V
$I_{I/O}$	Current flow through any one of the I/Os	Source or sink current		20 [2]	mA
P_{MAX}	Maximum total power dissipation	Over the specified temperature range of 0 °C to +50 °C		2500	mW

Note 1: Operating conditions greater than those listed under “Maximum Ratings” can cause permanent damage to the device.
Note 2: Typical MUX ON resistance is 12 Ohm. Voltage drop across the MUX switch at 20mA is therefore 240mV.

2 Static Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IH}	HIGH-level input voltage		1.7	-	-	V
V_{IL}	LOW-level input voltage		-	-	0.6	V
R_{ON}	ON resistance		10.5	12	14	Ω
Icc	Current draw	Powered by USB	-	12	20	mA

3 Dynamic Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{change}	Time to switch from one channel to another channel	Falling edge of MUX_EN to rising edge of MUX_EN	-	1	-	ms
$f_{(-3dB)}$	-3 dB frequency response	R_L = 45 Ω unbalanced	-	500	-	MHz
α_{ISO}	isolation (OFF-state)	Any switch to non-paired switch at 240MHz	-	-27	-	dB
X_{talk}	crosstalk	Any switch to non-paired switch at 500MHz	-	-30	-	dB

4 Physical Characteristics

Parameter		
Width	110 mm	4.33 inches
Length	66 mm	2.6 inches
Height	28 mm	1.1 inches
Weight	190 grams	6.7 ounces

5 Environmental Conditions

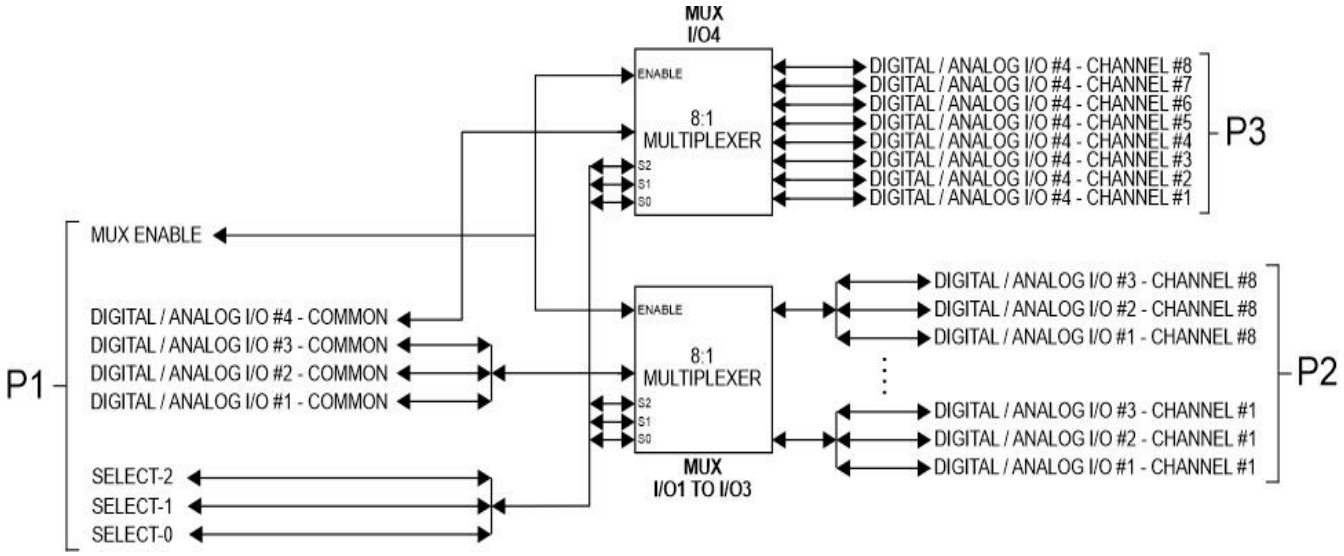
Parameter		
Operating temperature	0 °C to +50 °C	
Storage temperature	-30 °C to +70 °C	
Humidity (operating)	5% to 90% relative humidity (% RH) at up to +30 °C, 5% to 60% RH above +30 °C up to +50 °C, non-condensing.	

6 Regulatory

Parameter	
EMC	EN 55032:2015/A11:2020, AS/NZS CISPR 32:2015 AMD 1: 2020, FCC 47 CFR Part 15, Subpart B, ICES-003 Issue 7 October 2020, EN 55035:2017/A11:2020, VCCI-CISPR 32:2016
Safety	Complies with IEC 62368-1, Edition 4.0 2023-05, Audio/video, information and communication technology equipment – Part 1: Safety requirements

7 Functional description

The G-MUX is a multi signal 1-to-8 bidirectional multiplexer. It will route a group of four I/O signals (these can be digital and/ or analog) to one of eight input/output channels. Selection of the channel is accomplished either via USB commands, or discrete MUX control signal inputs. In addition, the MUX's can be disabled and put into a high impedance state, if required.



The I/O group width can easily be extended by operating several G-MUX devices in parallel. One G-MUX device can be the Master device (controlled via USB). The other devices can be controlled by the MUX Control signals which are available on P1 of the Master device (see section G-MUX usage examples for examples of how several G-MUX devices can be connected together).

All inputs and outputs are protected against over-current by a PTC type re-settable overcurrent protection fuse with a holding current of 125mA and a trip current of 290mA.

NOTE: These fuses are implemented in order to meet the safety requirements for IEC 62368-1, and to prevent potentially unsafe conditions. If operating conditions lead to activation of these fuses (such as short circuits or overvoltage conditions) then the maximum ratings for the device have been exceeded and will likely result in permanent damage to the device.

8 USB enumeration

When connected via USB, the G-MUX will enumerate as a Virtual COM port. The G-MUX USB protocol is described in detail in section G-MUX USB Protocol.
It is possible to prevent the G-MUX from enumerating as a USB device by connecting P1-13 to P1-8 (Ground). The G-MUX will power up in Slave mode. In this mode it can be controlled by the external MUX control signals on P1 (MUX_EN, SEL_2..0) only. Slave mode can be useful, for example, if several G-MUX devices are connected together in parallel in order to widen the group width. The Slave G-MUX device is still powered by the USB connection, but it will not enumerate as a USB Virtual COM port. A Master G-MUX device is then controlled via USB, and the MUX control signals of the Master, which are connected to the MUX control signals of the Slave device, then also drive the Slave device.

9 Location of the Serial Number

The serial number of the G-MUX is stored in internal non-volatile memory. It can be retrieved via a USB command. The serial number is also printed on the bottom of the enclosure. If several G-MUX devices are utilized in a system, and they are connected to a Host computer via USB then they can be individually enumerated and identified by their specific serial numbers.

10 Connector pinout and description

10.1 USB connector

The Mini B USB connector is used to connect the G-MUX to a PC in order to control the operation of the G-MUX via a remote PC. It is also used to power the G-MUX device.

10.2 Connector P1 (D-SUB 15 pin female connector)

Pin	Name	Description	Comments
1	DIGITAL / ANALOG I/O #1 - COMMON	Common terminal of Multiplexer for Digital / Analog I/O signal #1	
9	DIGITAL / ANALOG I/O #2 - COMMON	Common terminal of Multiplexer for Digital / Analog I/O signal #2	
2	DIGITAL / ANALOG I/O #3 - COMMON	Common terminal of Multiplexer for Digital / Analog I/O signal #3	

10	DIGITAL / ANALOG I/O #4 - COMMON	Common terminal of Multiplexer for Digital / Analog I/O signal #4	
3	Reserved		
11	MUX_ENABLE	LOW = MUXes disabled (all MUX switches are in the off STATE) HIGH = MUXes enabled	This control signal has an internal 10k pulldown.
4	SELECT-2	SELECT2 MUX Control signal	See section MUX Control signals – truth table for MUX Channel selection truth table
12	SELECT-1	SELECT1 MUX Control signal	See section MUX Control signals – truth table for MUX Channel selection truth table
5	SELECT-0	SELECT0 MUX Control signal	See section MUX Control signals – truth table for MUX Channel selection truth table
13	USB_DISABLE	Disable USB Enumeration	If this pin is connected to Ground then the device will not enable its USB functionality, and it will not enumerate as a USB device. However, it can still be used as a Slave device (see section USB enumeration for more details)
6	Reserved		
14	Reserved		
7	Reserved		
15	Reserved		
8	GROUND		

10.3 Connector P2 (D-SUB 25 pin female connector)

Pin	Name	Description	Comments
1	DIGITAL / ANALOG I/O #1 - CHANNEL #1	Channel 1 input/output for I/O #1	
14	DIGITAL / ANALOG I/O #2 - CHANNEL #1	Channel 1 input/output for I/O #2	
2	DIGITAL / ANALOG I/O #3 - CHANNEL #1	Channel 1 input/output for I/O #3	
15	DIGITAL / ANALOG I/O #1 - CHANNEL #2	Channel 2 input/output for I/O #1	
3	DIGITAL / ANALOG I/O #2 - CHANNEL #2	Channel 2 input/output for I/O #2	
16	DIGITAL / ANALOG I/O #3 - CHANNEL #2	Channel 2 input/output for I/O #3	
4	DIGITAL / ANALOG I/O #1 - CHANNEL #3	Channel 3 input/output for I/O #1	
17	DIGITAL / ANALOG I/O #2 - CHANNEL #3	Channel 3 input/output for I/O #2	
5	DIGITAL / ANALOG I/O #3 - CHANNEL #3	Channel 3 input/output for I/O #3	
18	DIGITAL / ANALOG I/O #1 - CHANNEL #4	Channel 4 input/output for I/O #1	
6	DIGITAL / ANALOG I/O #2 - CHANNEL #4	Channel 4 input/output for I/O #2	
19	DIGITAL / ANALOG I/O #3 - CHANNEL #4	Channel 4 input/output for I/O #3	
7	DIGITAL / ANALOG I/O #1 - CHANNEL #5	Channel 5 input/output for I/O #1	
20	DIGITAL / ANALOG I/O #2 - CHANNEL #5	Channel 5 input/output for I/O #2	
8	DIGITAL / ANALOG I/O #3 - CHANNEL #5	Channel 5 input/output for I/O #3	

21	DIGITAL / ANALOG I/O #1 - CHANNEL #6	Channel 6 input/output for I/O #1	
9	DIGITAL / ANALOG I/O #2 - CHANNEL #6	Channel 6 input/output for I/O #2	
22	DIGITAL / ANALOG I/O #3 - CHANNEL #6	Channel 6 input/output for I/O #3	
10	DIGITAL / ANALOG I/O #1 - CHANNEL #7	Channel 7 input/output for I/O #1	
23	DIGITAL / ANALOG I/O #2 - CHANNEL #7	Channel 7 input/output for I/O #2	
11	DIGITAL / ANALOG I/O #3 - CHANNEL #7	Channel 7 input/output for I/O #3	
24	DIGITAL / ANALOG I/O #1 - CHANNEL #8	Channel 8 input/output for I/O #1	
12	DIGITAL / ANALOG I/O #2 - CHANNEL #8	Channel 8 input/output for I/O #2	
25	DIGITAL / ANALOG I/O #3 - CHANNEL #8	Channel 8 input/output for I/O #3	
13	GROUND		

10.4 Connector P3 (D-SUB 9 pin female connector)

Pin	Name	Description	Comments
1	DIGITAL / ANALOG I/O #4 - CHANNEL #1	Channel 1 input/output for I/O #4	
6	DIGITAL / ANALOG I/O #4 - CHANNEL #2	Channel 2 input/output for I/O #4	
2	DIGITAL / ANALOG I/O #4 - CHANNEL #3	Channel 3 input/output for I/O #4	
7	DIGITAL / ANALOG I/O #4 - CHANNEL #4	Channel 4 input/output for I/O #4	
3	DIGITAL / ANALOG I/O #4 - CHANNEL #5	Channel 5 input/output for I/O #4	
8	DIGITAL / ANALOG I/O #4 -	Channel 6 input/output for I/O #4	

	CHANNEL #6		
4	DIGITAL / ANALOG I/O #4 - CHANNEL #7	Channel 7 input/output for I/O #4	
9	DIGITAL / ANALOG I/O #4 - CHANNEL #8	Channel 8 input/output for I/O #4	
5	GROUND		

11 MUX Control signals – truth table

Input				Channel ON
MUX ENABLE	SELECT-2	SELECT-1	SELECT-0	
HIGH	LOW	LOW	LOW	I/O #1 - COMMON to I/O #4 - COMMON connected to I/O #1 CHANNEL #1 to I/O #4 CHANNEL #1
HIGH	LOW	LOW	HIGH	I/O #1 - COMMON to I/O #4 - COMMON connected to I/O #1 CHANNEL #2 to I/O #4 CHANNEL #2
HIGH	LOW	HIGH	LOW	I/O #1 - COMMON to I/O #4 - COMMON connected to I/O #1 CHANNEL #3 to I/O #4 CHANNEL #3
HIGH	LOW	HIGH	HIGH	I/O #1 - COMMON to I/O #4 - COMMON connected to I/O #1 CHANNEL #4 to I/O #4 CHANNEL #4
HIGH	HIGH	LOW	LOW	I/O #1 - COMMON to I/O #4 - COMMON connected to I/O #1 CHANNEL #5 to I/O #4 CHANNEL #5
HIGH	HIGH	LOW	HIGH	I/O #1 - COMMON to I/O #4 - COMMON connected to I/O #1 CHANNEL #6 to I/O #4 CHANNEL #6
HIGH	HIGH	HIGH	LOW	I/O #1 - COMMON to I/O #4 - COMMON connected to I/O #1 CHANNEL #7 to I/O #4 CHANNEL #7
HIGH	HIGH	HIGH	HIGH	I/O #1 - COMMON to I/O #4 - COMMON connected to

				I/O #1 CHANNEL #8 to I/O #4 CHANNEL #8
LOW	X	X	X	I/O switches are OFF (high impedance)

12 Device state after power-up

After power-up the G-MUX shall disable all MUXes (MUX switches are in the OFF state). The MUX control signals (MUX_EN, SEL_2..0) are inputs. The G-MUX is in Slave mode.

13 MUX Control Signals

The MUX Control signals are either inputs or outputs, depending on the operating mode of the G-MUX.

In Master Mode the MUX Control signals are driven internally by the G-MUX. The MUX Control signals at connector P1 are outputs, as they reflect the internal MUX Control signals state of the G-MUX. In this case the MUX Control signal outputs on P1 can be used to drive several other G-MUX devices. This can be useful when several G-MUX devices are implemented within a system, but only one needs to be connected via USB (the Master device), and the other G-MUX devices are Slave devices (driven by the Master device).

In Slave mode all MUX control signals are inputs. The G-MUX can be controlled externally by appropriate signals that are applied to the MUX control signals on P1.

Note that the G-MUX powers up in Slave mode. However, if a command is received over USB to switch the MUX channel then the G-MUX will automatically switch to, and stay in, Master mode.

The G-MUX can be commanded to enter Slave mode or Master Mode via a USB command (see section G-MUX USB Protocol)

14 G-MUX LEDs

The G-MUX contains one Green LED and one Red LED. The Green LED is always on after power-up to indicate that the G-MUX is powered. The Red LED will blink briefly whenever a device state change is commanded via USB (e.g. changing to a different MUX channel).

15 G-MUX USB Protocol

The G-MUX enumerates as a Virtual COM port. The G-MUX uses a simple protocol to exchange commands and data with the Host PC.

15.1 General protocol structure

The protocol is a command response protocol, meaning that the G-MUX will send a response to an issued command.

Commands are sent to the G-MUX in variable length packets, as follows:

- Byte 0: Command byte
- Byte 1: Error code (only relevant for command responses)
- Byte 2: Length of data (if any required with the command, or returned in the response)
- Byte 3 to n: Data byte(s)

All commands are replied to with a command response. The Command response structure is equal to the command structure outlined above.

- Byte 0 is the echo of the received command.
- If an error occurred, then no data that may be required by the command is returned, only the error code itself.

15.2 Commands

Command byte value	Description	Comments
01	Get Goneco Technologies Identifier	Returns a string with the value “Goneco Tech”
02	Get Model number	Returns the model number string, for example "GMX-2401"
03	Get Bootloader Firmware version	Returns one byte that contains the BCD coded version of the G-MUX bootloader version. For example, if the returned byte value is 0x12, then the bootloader version is 1.2
04	Get App Firmware version	Returns one byte that contains the BCD coded version of the G-MUX Application version. For

		example, if the returned byte value is 0x21, then the Application version is 2.1
05	Get Device Hardware version	Returns one byte that contains the BCD coded version of the G-MUX Hardware version. For example, if the returned byte value is 0x10, then the Hardware version is 1.0
06	Set device state to default state	This will set the G-MUX to the default (Slave) state. In this state all MUX switches are set to the OFF state, and the MUX Control signals are set as inputs at P1.
07	Set device state	The bit fields in the data byte sent with this command have the following meaning: - bit 0: 0 = MUXes disabled, 1 = MUXes enabled - bit 1: 0 = MUX Control signals driven internally, 1 = MUX Control signals driven externally - bits 2 to 7: reserved
08	Get device state	See previous command for the meaning of the individual bit fields of the returned data byte.
09	Set MUX address	One data byte is sent. Valid values are 0 to 7.
0A	Get current MUX address	See previous command for the meaning of the returned data byte.
0B	Get Serial Number	Returns the Serial number string, for example "GMX2307240001"

15.3 Error codes

Error code byte value	Description	Comments
0	No error	
1	Unrecognized command	
2	Invalid data size	This error code is returned if a command that requires data bytes contains an incorrect number of data bytes as required by that command.
3	Invalid string size	This error code is returned if a command that requests a string returns an incorrect string size as required by that command.

15.4 Examples of Command exchanges

15.4.1 Command "Get Goneco Technologies Identifier":

Command sent: 0x01 (Command), 0x00 (Error status = No error), 0x00 (no data bytes)

Command response: 0x01 (Command), 0x00 (Error status = No error), 0x0B (11 data bytes), "Goneco Tech" (11 bytes)

15.4.2 Command "Set MUX address":

Command sent: 0x09 (Command), 0x00 (Error status = No error), 0x01 (1 data byte), 0x05 (set MUX position to position 5)

Command response: 0x09 (Command), 0x00 (Error status = No error), 0x00 (no data bytes)

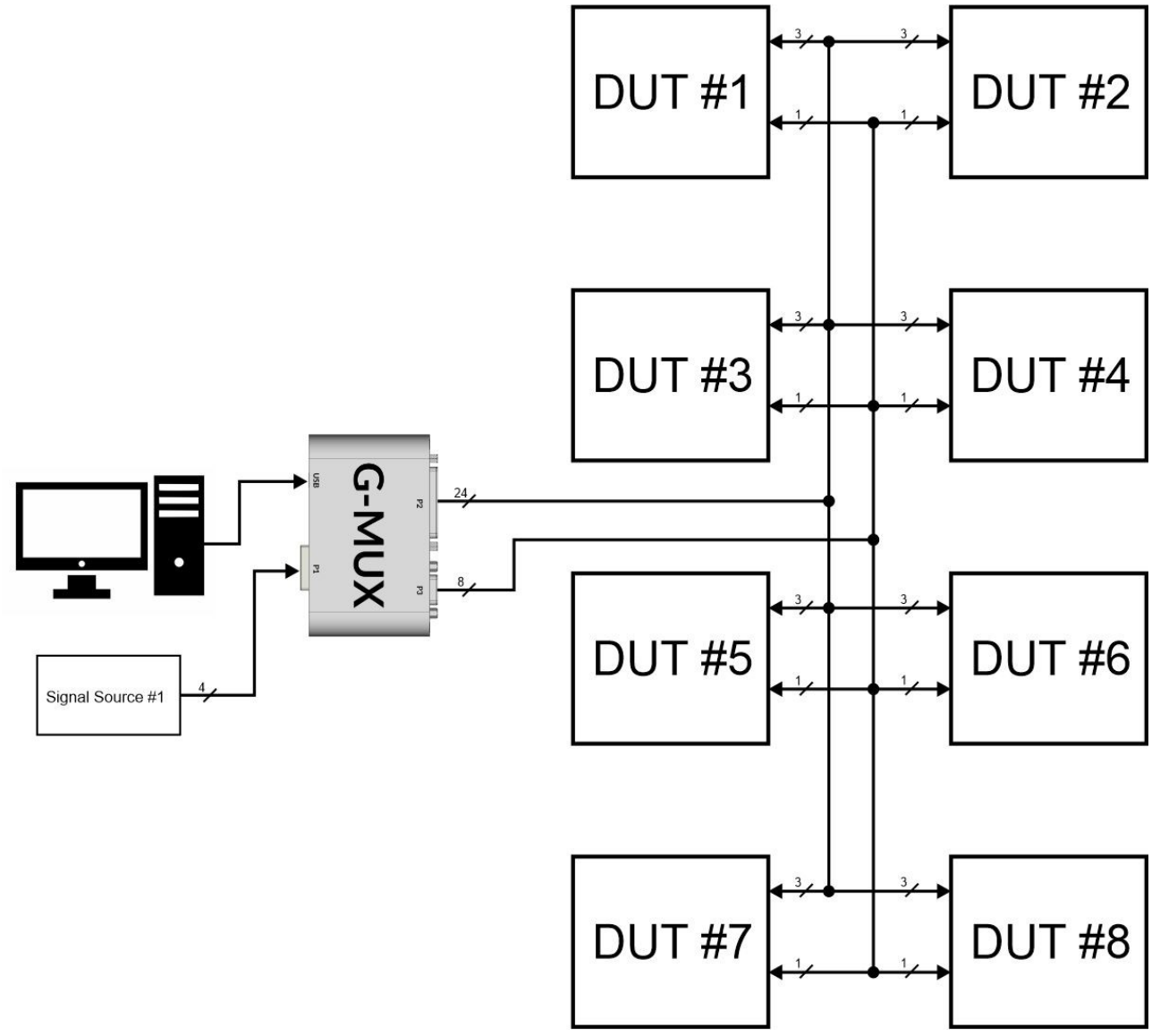
15.4.3 Sending an invalid command:

Command sent: 0x0C (Invalid Command), 0x00 (Error status = No error), 0x00 (no data bytes)

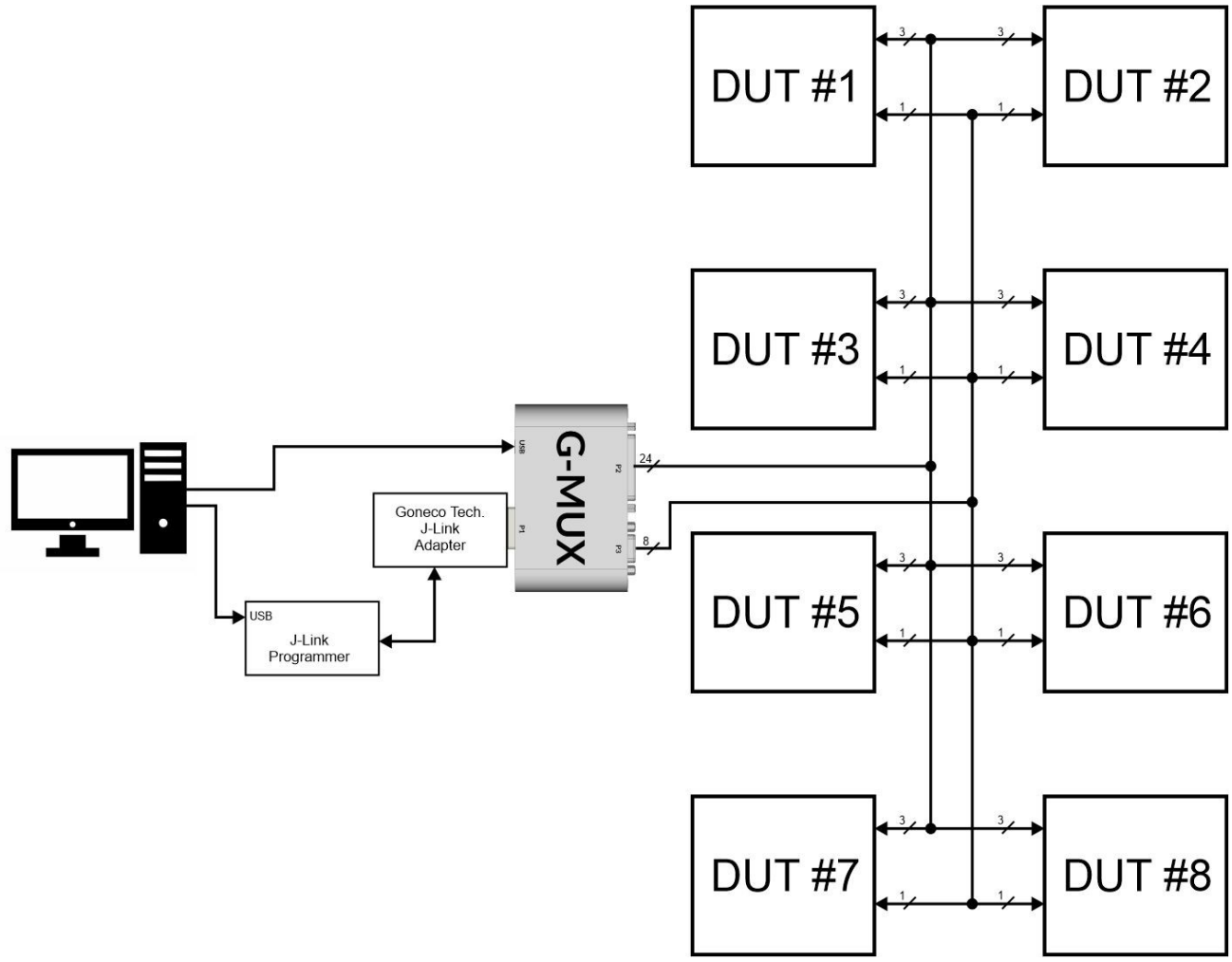
Command response: 0x0C (Command), 0x01 (Error status = unrecognized command), 0x00 (no data bytes)

16 G-MUX usage examples

16.1 Basic setup

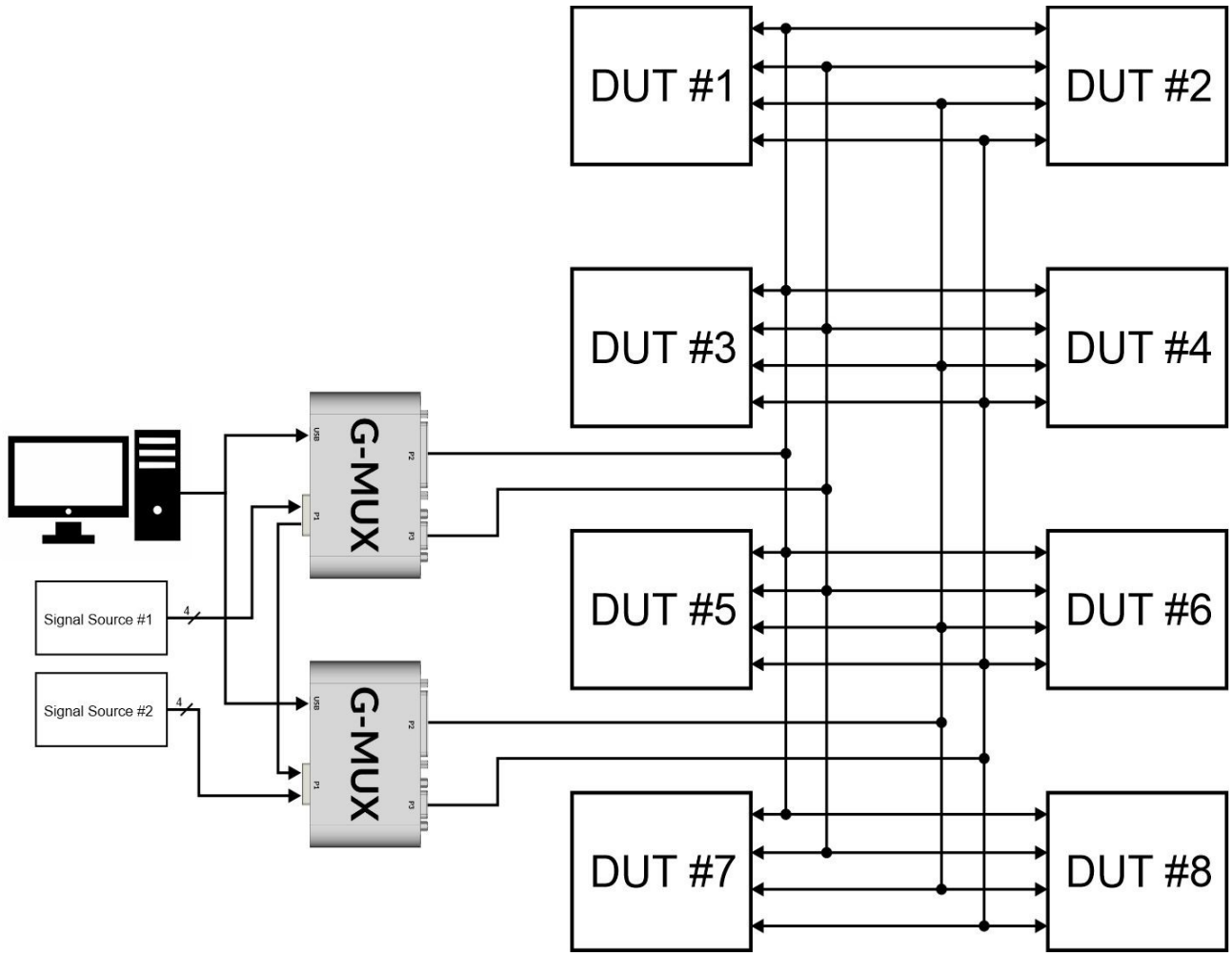


16.2 G-MUX with J-Link In-System Programmer



Note: The Goneco Technologies J-Link Adapter (Model Number JLA-2402) provides a 10 pin header which allows the connection of a standard 10 pin connector J-Link ribbon cable to the G-MUX I/Os. Click here for a detailed description of this adapter.

16.3 Using two G-MUX devices to expand the I/O group width to eight I/Os



17 Programming examples

Goneco Technologies has developed software libraries that can easily be integrated into the main code base. These software libraries have been created in C++, Delphi Pascal and Python. In addition Goneco Technologies has developed an example application in all three languages in order to demonstrate how simple it is to drive one or more G-MUX devices using these software libraries. Full project code examples are freely available here for download from the Goneco Technologies website.