# 1 Hardware reference

1.1 GRT1-ML2 overview

The GRT1-ML2 SmartSlice Communication Unit controls data exchange between a TJ1-MC__ Motion Controller Unit (via a connected TJ1-ML__ MECHATROLINK-II Master Unit) and SmartSlice I/O Units over a MECHATROLINK-II network. For more information on SmartSlice I/O Units, refer to the GRT1 Series SmartSlice I/O Units Operation Manual (W455).
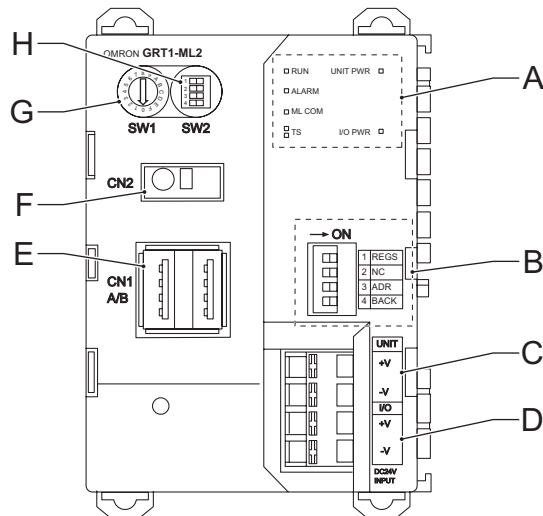
Label	Description
A	LED indicators
B	Unit dipswitches
C	Unit power supply terminals
D	I/O power supply terminals
E	MECHATROLINK-II connectors
F	Shielding terminal

Label	Description
G	Rotary switch
H	Communication dipswitches

1.1.1 Unit dipswitches
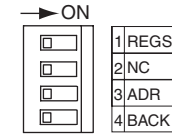
Dipswitch	Function	Setting	Description
REGS	Create/enable registration table	ON	Registered table is enabled
		OFF	Registered table is disabled
		OFF to ON[1]	Register I/O unit table
		ON to OFF[1]	Clear registered I/O unit table
NC	N/A	OFF	Not used, always set to OFF
ADR	Automatic restore	OFF to ON	When the SmartSlice I/O Units are replaced, the parameter data that was backed up with the BACK dipswitch is automatically restored[2]
		OFF	Automatic restore disabled
BACK	Backup trigger	ON to OFF to ON in 3 s[3]	Parameter data of all connected SmartSlice I/O Units is backed up[2]

1. When the unit power is on.
2. When dipswitch 1 is set to ON.

3. The setting of dipswitch 4 (BACK) is given in the figure below.
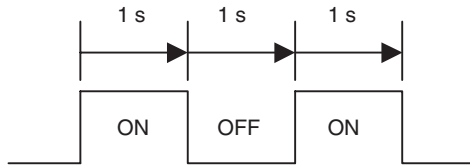
The backup operation starts after DIP switch 4 is turned from ON to OFF to ON within 3 seconds.

⚠️ The Backup and Restore functionality is available in the GRT1-ML2. However, the backed up and restored parameters cannot be accessed via MECHATROLINK-II communication.

ℹ️
- It is recommended to do a registration of the SmartSlice I/O Units (see section 2.2.1).
- It is recommended to set dipswitches 1, 3 and 4 on after this registration.

The factory setting of all dipswitches is OFF.

1.1.2 LED indicators
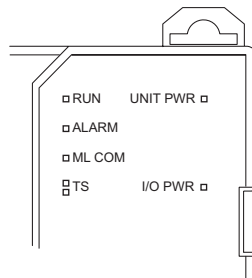
LED	Description	Color	Status	Meaning
RUN	Unit status	Green	Not lit	• Startup test failed, unit not operational • Operation stopped due to a fatal error
			Lit	Initialization successful, unit is in normal operation
ALARM	Unit error	Red	Not lit	Unit is in normal operation
			Flashing	A startup error has occurred
			Lit	Unit is in alarm state, or a fatal error has occurred
ML COM	MECHATRO-LINK-II communication	Green	Not lit	No MECHATROLINK-II communication
			Lit	MECHATROLINK-II communication active

LED	Description	Color	Status	Meaning
TS	SmartSlice I/O system communication status	N/A	Not Lit	• No power supply • Communication with SmartSlice I/O Unit has not started • Overcurrent detected
		Green	Flashing (every second)	SmartSlice I/O Unit added to the system
			Flashing (every 0.5 second)	Backup/Restore function operating: • Restoring settings to SmartSlice I/O Unit, backup function operating • Downloading SmartSlice I/O Unit settings
			Lit	Communication with SmartSlice I/O Unit established
		Red	Flashing	Non-fatal communication error occurred. • Communication timeout • Verification error occurred with registered table • Different model unit detected after SmartSlice I/O Unit replacement
			Lit	Fatal communication error occurred.
			Lit for 2 s	Failure occurred while restoring settings to I/O unit or downloading I/O unit settings
UNIT PWR		Green	Not Lit	No power supply to the unit (All LEDs are off)
			Lit	Power supply to the unit
I/O PWR		Green	Not Lit	No power supply to the SmartSlice I/O (No output from the SmartSlice I/O Units, even when they are in operation)
			Lit	Power supply to the SmartSlice I/O

• When the power of the Trajexia system is turned on, the TJ1-MC__ executes its startup sequence before it initializes the MECHATROLINK-II bus. During this startup sequence, the ML COM LED is off.
• When the TJ1-MC__ initalizes the MECHATROLINK-II bus with the command **MECHATROLINK(unit,0)**, the ML COM LED goes on.
• When the GRT1-ML2 loses the MECHATROLINK-II communication with the master, or when the command **MECHATROLINK(unit,1)** is executed, the ML COM LED goes off.

1.1.3 Communication dipswitches

Dipswitch	Function	Setting	Description
1	MECHATROLINK-II address range	ON	70 hex – 7F hex
		OFF	60 hex – 6F hex
2	MECHATROLINK-II bus speed	OFF	10 Mbps[1]
3	Frame size	OFF	32 bytes[2]
4	HOLD/CLEAR	ON	HOLD: All outputs hold their values when communication is lost
		OFF	CLEAR: All outputs become 0 when communication is lost

1. Trajexia only supports 10 Mbps bus speed. Therefore always set dipswitch 2 to OFF.
2. Trajexia only supports 32-byte communication. Therefore always set dipswitch 3 to OFF.

1.1.4 Rotary switch

The rotary switch (SW1) sets the MECHATROLINK-II address that identifies the GRT1-ML2 in the MECHATROLINK-II network. The settings range is from 0 hex to F hex.

To set the MECHATROLINK-II address of the GRT1-ML2, do these steps:
1. Turn off the Unit power supply of the GRT1-ML2.

> **i** The address of the GRT1-ML2 is read only at power on. Setting the new address when the power is on has no effect.

2. To set the address of the unit, set communication dipswitch 1 and the rotary switch as given in the table below.

Dipswitch 1	Rotary switch	Address	Dipswitch 1	Rotary switch	Address
OFF	0	60 hex	ON	0	70
OFF	1	61 hex	ON	1	71
OFF	2	62 hex	ON	2	72
OFF	3	63 hex	ON	3	73
OFF	4	64 hex	ON	4	74
OFF	5	65 hex	ON	5	75
OFF	6	66 hex	ON	6	76
OFF	7	67 hex	ON	7	77
OFF	8	68 hex	ON	8	78
OFF	9	69 hex	ON	9	79
OFF	A	6A hex	ON	A	7A
OFF	B	6B hex	ON	B	7B
OFF	C	6C hex	ON	C	7C
OFF	D	6D hex	ON	D	7D
OFF	E	6E hex	ON	E	7E
OFF	F	6F hex	ON	F	7F

> **i** Make sure that the address is unique in the MECHATROLINK-II network. If two or more units have the same MECHATROLINK-II address, they cannot be initialized properly.
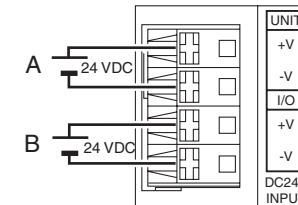
3. Turn the power on.

> **i** To make the MECHATROLINK-II address of the unit valid, do one of these steps:
> - Restart the TJ1-MC__.
> - Execute the command **MECHATROLINK(unit,0)**.

1.1.5 Power supply connector

The GRT1-ML2 has 2 24 VDC power supply terminals:

Label	Power supply terminal	Description
A	Unit power supply terminal	Power supply to the internal circuits of the GRT1-ML2 and to the internal circuits of the connected SmartSlice I/O Units (through the SmartSlice bus)
B	External I/O power supply terminal	Power supply to the external I/Os connected to the SmartSlice I/O Units

ℹ️ The unit power supply and the external I/O power supply are not transferred through the GCN2-100 Turnback cable. The GRT1-TBR units have the same power supply terminals as the GRT1-ML2.

1.2 Specifications

Item		Specification
Installation	Unit type	SmartSlice GRT1 series
	Model	GRT1-ML2
	Installation position	On a DIN rail
	Power supply	24 VDC +10% −15% (20.4 to 26.4 VDC)
	Current consumption	110 mA typical at 24 VDC
	Dimensions (W × H × D)	58 × 80 × 70 mm
	Weight	130 g
Environment	Ambient operating temperature	−10 to 55°C (no icing or condensation)
	Ambient operating humidity	25% to 85% Relative humidity
	Storage temperature	−20 to 65°C (no icing or condensation)
	Vibration resistance	10 to 57 Hz, 0.7 mm amplitude 57 to 150 Hz, acceleration: 49 m/s^2
	Shock resistance	150 m/s^2
	Dielectric strength	500 VAC (between isolated circuits)
	Conformance to EMC and electrical safety standards	EN61131-2:2003
	Enclosure rating	IP20

Item		Specification
SmartSlice I/O	Number of connectable SmartSlice I/O Units	64 Units max. Connected directly to the GRT1-ML2 or via Turnback extension units
	Baud rate	3 Mbps
	Communication signal level	RS485
	Communication distance	SmartSlice I/O Units: 64 Units coupled (about 2 m max.) Turnback cable: 2 m max. (2 cables, 1 m each)
	Turnback cable	Length 1 m max., up to 2 cables can be connected
	SmartSlice I/O Unit connections	Building-block style configuration with slide connectors (Units connect with Turnback cables).
	Baseblock power supply	Voltage: 24 VDC Current: 4 A max.
	Event messaging	Supported
MECHATROLINK-II	Baud rate	10 Mbps (MECHATROLINK-II)
	Data length	17-byte and 32-byte data transmission

1.2.1 Supported SmartSlice I/O Units

The GRT1-ML2, in combination with the Trajexia system, supports these SmartSlice I/O Units.

Function	Specification	Model
4 NPN inputs	24 VDC, 6 mA, 3-wire connection	GRT1-ID4
4 PNP inputs	24 VDC, 6 mA, 3-wire connection	GRT1-ID4-1
8 NPN inputs	24 VDC, 4 mA, 1-wire connection + 4xG	GRT1-ID8
8 PNP inputs	24 VDC, 4 mA, 1-wire connection + 4xV	GRT1-ID8-1

Function	Specification	Model
4 NPN outputs	24 VDC, 500 mA, 2-wire connection	GRT1-OD4
4 PNP outputs	24 VDC, 500 mA, 2-wire connection	GRT1-OD4-1
4 PNP outputs with short-circuit protection	24 VDC, 500 mA, 3-wire connection	GRT1-OD4G-1
8 NPN outputs	24 VDC, 500 mA, 1-wire connection + 4xV	GRT1-OD8
8 PNP outputs	24 VDC, 500 mA, 1-wire connection + 4xG	GRT1-OD8-1
8 PNP outputs with short-circuit protection	24 VDC, 500 mA, 1-wire connection + 4xG	GRT1-OD8G-1
2 relay outputs	240 VAC, 2A, normally-open contacts	GRT1-ROS2
2 analog inputs, current/voltage	10 V, 0-10 V, 0-5 V, 1-5 V, 0-20 mA, 4-20 mA	GRT1-AD2
2 analog outputs, voltage	10 V, 0-10 V, 0-5 V, 1-5 V	GRT1-DA2V
2 analog outputs, current	0-20 mA, 4-20 mA	GRT1-DA2C

1.2.2 Dimensions

The external dimensions are in mm.
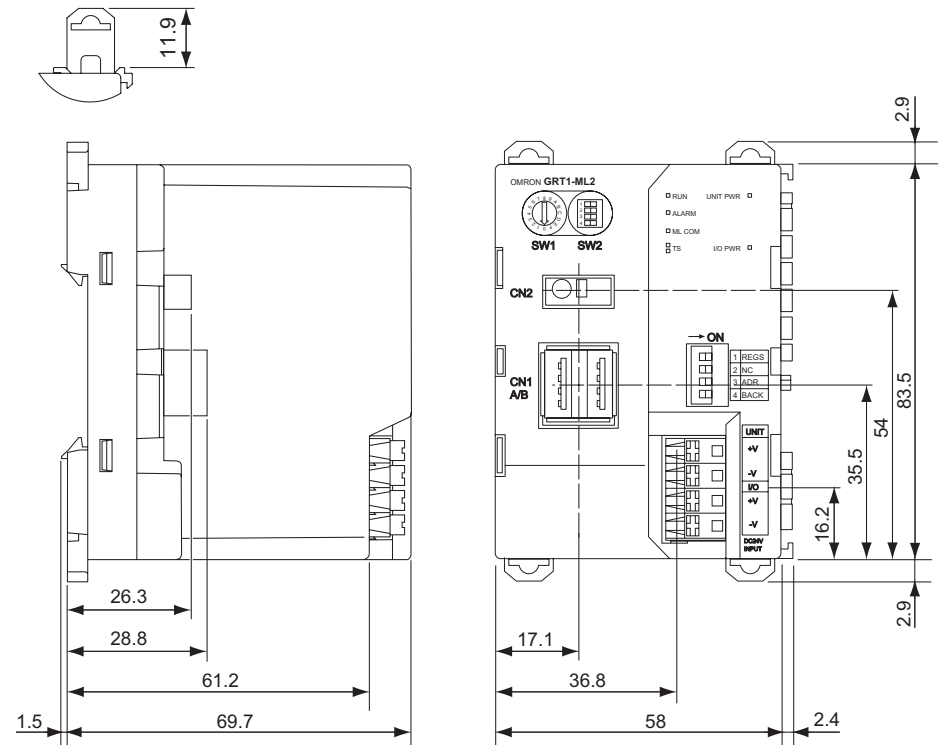
1.3 Installation

Follow these rules when installing the GRT1-ML2:
- Before installing the GRT1-ML2 or connect or disconnect cables, switch off the power of the Trajexia system, the SmartSlice I/O Units and the external I/Os.
- Make sure that the power supplies of the GRT1-ML2, the SmartSlice I/O Units and the external I/Os are correctly connected.
- Provide separate conduits or ducts for the I/O lines to prevent noise from high-tension lines or power lines.
- It is possible to connect up to 64 SmartSlice I/O Units to 1 GRT1-ML2.
- Install the GRT1-ML2 and the SmartSlice I/O Units on a DIN rail. To install a GRT1-ML2 on the DIN rail, press it onto the DIN track from the front, and press the unit firmly until it clicks. Check that all DIN rail sliders of the unit are locked onto the DIN rail.
- To remove the GRT1-ML2 from the DIN rail, release the sliders from the DIN rail with a screwdriver, and pull the unit straight from the DIN rail.

1.3.1 Connections
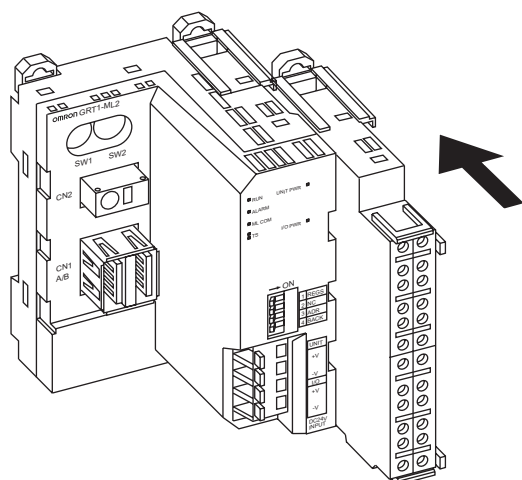
Connect the first SmartSlice I/O Unit to the GRT1-ML2:
- Align the sides of the GRT1-ML2 and the SmartSlice I/O Unit.
- Slide the SmartSlice I/O Unit to the rear until it clicks onto the DIN rail.

⚠️ Do not touch the connectors on the side of GRT1-ML2 and the SmartSlice I/O Units.

See the GRT1 Series SmartSlice I/O Units Operation Manual for more information on connecting additional SmartSlice I/O Units, Turnback Units, End Units and end plates.

1.3.2 Wiring

The GRT1-ML2 has 2 power supply terminals. Both power supply terminals have screwless clamping-type connections.
To determine the power supply requirements, do the steps below.

Unit power supply requirements
The maximum power consumption for SmartSlice I/O Units is 80 W per block.
1. Calculate the power consumption of all SmartSlice I/O Units connected to the GRT1-ML2. Refer to the GRT1 Series SmartSlice I/O Units Operation Manual (W455) for the power value for each SmartSlice I/O Unit.
2. If the power consumption exceeds 80 W, mount a Right Turnback Unit (GRT1-TBR) on the SmartSlice I/O Unit at the point where the power consumption is less than 80 W.
3. Connect the 24 VDC unit power supply to the Left Turnback Unit (GRT1-TBL).

I/O power supply
The maximum I/O current consumption is 4 A.

1. Calculate the total current consumption used by all external I/Os of the connected SmartSlice I/O Units (including other units like Turnback Units). Refer to the GRT1 Series SmartSlice I/O Units Operation Manual (W455) for the current value for each SmartSlice I/O Unit.
2. If the current consumption exceeds 4 A or if you want to provide separate systems for inputs and outputs, divide the SmartSlice I/O Units at the desired point with a GRT1-PD_(-1) I/O Power Supply Unit and provide a separate external I/O power supply.

It is also possible to provide a separate external I/O power supply at a Left Turnback Unit (GRT1-TBL).

Make sure the power supply is isolated.

The GCN2-100 Turnback cable does not supply power.

The figure gives a wiring example.
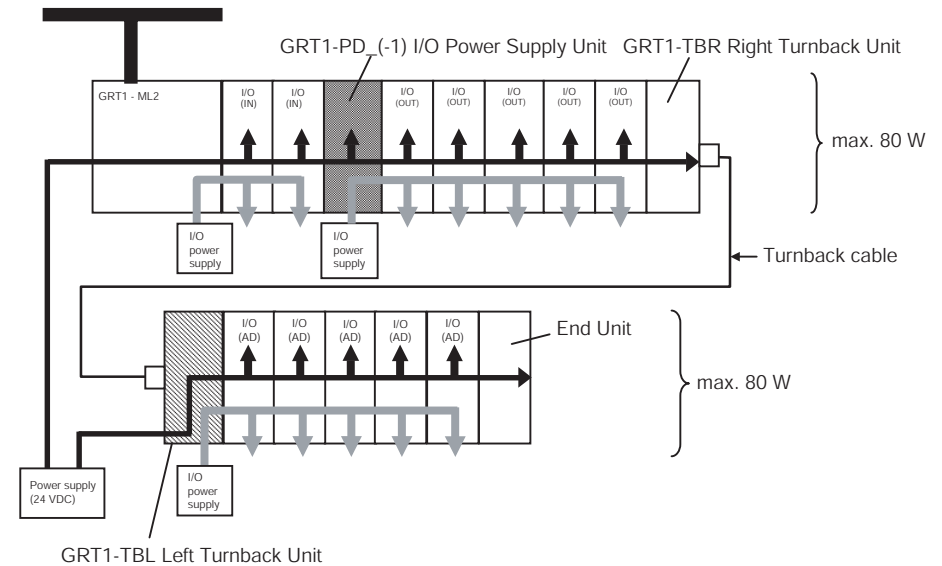
Connect and remove wires
To supply power to the units and the I/O devices, connect the power supply wires to the power supply terminals of the GRT1-ML2. If the wire ends have pin terminals, just insert the pin terminals in the power supply terminals.
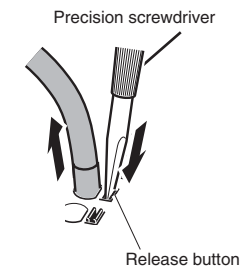
To remove the wires, press the release button above the terminal hole with a precision screwdriver, and pull out the wire.

Recommended power supplies

It is recommended to use a SELV (Safety Extra Low Voltage) power supply with over-current protection. A SELV power supply has redundant or increased insulation between the I/O, an output voltage of 30 V rms and a 42.4 V peak or maximum of 60 VDC.

Recommended power supplies are:
- S82K-01524 (OMRON)
- S8TS-06024 (OMRON).

Recommended wires

It is recommended to use wires with a gauge of 20 AWG to 16 AWG (0.5 to 1.25 mm^2).

Strip the wire between 7 and 10 mm of insulation at the ends of the wires (stranded or solid wire), or use pin terminals with a pin (conductor) length of 8 to 10 mm.

1.3.3   Replace

The GRT1-ML2 is a unit that is part of a network. If the GRT1-ML2 is damaged, it effects the whole network. Make sure that a damaged GRT1-ML2 is repaired immediately.

To replace the unit, follow these rules:
- Turn off the power before replacing the unit. This includes the power to all master and slave units in the network.
- Make sure that the new unit is not damaged.
- If a poor connection is the probable cause of any malfunctioning, do these steps:
    - Clean the connectors with a clean, soft cloth and industrial-grade alcohol.
    - Remove any lint or threads left from the cloth.
    - Install the unit again.
- When returning a damaged unit to the OMRON dealer, include a detailed damage report with the unit.
- Before reconnecting the new unit, do these steps:
    - Set the MECHATROLINK-II station address to the same address as the old unit.
    - If the table registration function was used for the old unit, create a new registration table for the new unit. See section 2.2.1.

2 Setup and usage

2.1 MECHATROLINK-II I/O mapping

2.1.1 Unit numbers

The GRT1-ML2 must have a MECHATROLINK-II address to be identified on the MECHATROLINK-II network. With this address, the TJ1-MC__ connected to the TJ1-ML__ can exchange I/O data with the GRT1-ML2.

2.1.2 SmartSlice I/O mapping

The I/O data of the SmartSlice I/O Units is transferred to the TJ1-MC__ controller. Then the data is automatically mapped in the I/O memory of the TJ1-MC__. The mapping is determined by:
- The type of the SmartSlice I/O Unit
- The order of the SmartSlice I/O Units

The I/O data from GRT1-ML2 units is mapped in the TJ1-MC__ in order of the GRT1-ML2 addresses. For example, the I/O data of a GRT1-ML2 unit with address 67 hex is mapped before the I/O data of a GRT1-ML2 unit with address 68 hex.

The TJ1-MC__ allocates digital I/O points in blocks of 32 points.

> ℹ The GRT1-ML2 does not support the on-line configuration of SmartSlice I/O Units. However, other communications units can change the parameters of a SmartSlice I/O Unit and store this configuration in the SmartSlice I/O Unit.

> ⚠ Use of a SmartSlice I/O Unit with a non-default configuration can lead to SmartSlice I/O allocation errors.

> ℹ The automatic I/O mapping of SmartSlice I/O Units in the examples given below assumes that each SmartSlice I/O Unit has the default I/O memory settings.

I/O mapping example 1
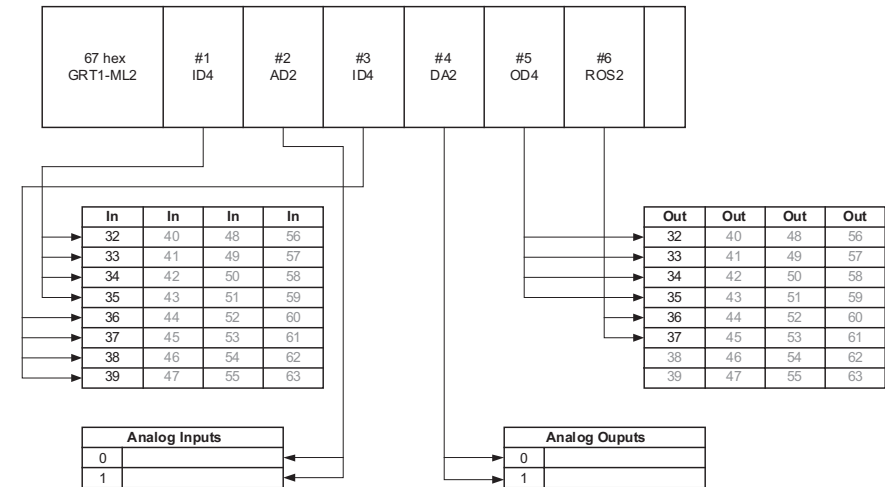
With a MECHATROLINK-II network as shown in the figure, the response of the system when the network is initialized[1] is:

GRT1-ML2: 67(32/8/6/0/2/0/2)

where:
- 67 is the GRT1-ML2 address (hexadecimal)
- 32 is the start address of the digital I/O

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1. To initialize the network, execute the command **MECHATROLINK(unit,0)**, reset the system, or turn the power on.

- 8 is the number of digital inputs
- 6 is the number of digital outputs
- 0 is the start address of the analog inputs
- 2 is the number of analog inputs
- 0 is the start address of the analog outputs
- 2 is the number of analog outputs

I/O mapping example 2

63 hex GRT1-ML2	#1 ID4	#2 ID4	#3 DA2	#4 DA2	#5 DA2	

67 hex GRT1-ML2	#1 OD8	#2 OD8	#3 AD2	#4 DA2	#5 DA2	

69 hex GRT1-ML2	#1 ID8	#2 ID4	#3 OD4	#4 ROS2	#5 ROS2	#6 AD2	#7 AD2	

The configuration of the GRT1-ML2 units in the example above is:

GRT1-ML2: 63(32/8/0/0/0/0/6)

where:
- 63 is the GRT1-ML2 address (hexadecimal)
- 32 is the start address of the digital I/O
- 8 is the number of digital inputs
- 0 is the number of digital outputs
- 0 is the start address of the analog inputs

- 0 is the number of analog inputs
- 0 is the start address of the analog outputs
- 6 is the number of analog outputs

GRT1-ML2: 67(64/0/16/0/2/6/4)

where:
- 67 is the GRT1-ML2 address (hexadecimal)
- 64 is the start address of the digital I/O
- 0 is the number of digital inputs
- 16 is the number of digital outputs
- 0 is the start address of the analog inputs
- 2 is the number of analog inputs
- 6 is the start address of the analog outputs
- 4 is the number of analog outputs

GRT1-ML2: 69(96/12/8/2/4/10/0)

where:
- 69 is the GRT1-ML2 address (hexadecimal)
- 96 is the start address of the digital I/O
- 12 is the number of digital inputs
- 8 is the number of digital outputs
- 2 is the start address of the analog inputs
- 4 is the number of analog inputs
- 10 is the start address of the analog outputs
- 0 is the number of analog outputs

Depending on the actual GRT1-ML2 configurations, gaps are introduced in the available digital I/O ranges. In the example above, the range of distributed digital inputs and outputs is [32–127], but there are gaps in the digital inputs in the ranges [40–95] and [108–127], and there are gaps in the digital outputs in the ranges [32–63], [80–95] and [104–127]. These digital inputs and outputs are virtual. Virtual digital inputs always have value 0 (OFF). Virtual outputs can be set ON or OFF and they can be used in programming, but they do not have a physical representation and cannot activate a device.

2.1.3 GRT1-ML2 status word

The GRT1-ML2 status flags give the status of the connection between the GRT1-ML2 and the SmartSlice I/O Units, and the status of the SmartSlice I/O Units. The status flags are 1 word in size. Their information is transferred to the TJ1-MC__ as part of the input data.
The table below gives the meaning of the bits in the status word.

Bit	Flag	Description
0	SmartSlice I/O Bus Communication Error	Monitors the status of SmartSlice I/O communication
1	–	Reserved
2	SmartSlice I/O Unit Warning 0: Normal 1: Error detected	Indicates a minor SmartSlice I/O Unit error. This flag goes ON when there is an error in any one of the connected SmartSlice I/O Units.
3	–	Reserved
4	SmartSlice I/O Unit Alarm 0: Normal 1: Error detected	Indicates a major SmartSlice I/O Unit error. This flag goes ON when there is an error in one of the connected SmartSlice I/O Units.
5–11	–	Reserved
12	Unit Maintenance 0: Normal 1: Error (monitor value reached)	Monitors the operating time threshold that is set with the Unit power ON time monitor function
13	Automatic Restore Monitor 0: Restore successful 1: Restore failed	Indicates whether or not the automatic parameter restore to the SmartSlice I/O Units was completed successfully
14	Communication Unit Error 0: Normal 1: Error occurred	This flag is ON if one of the other flags (bits 0 to 13) is ON
15	I/O Refreshing 0: I/O communication stopped 1: I/O communication normal	Indicates whether I/O data is exchanged normally

To read the status word, use the command

MECHATROLINK(unit,36,station,vr)

where:
- **unit** is the number of the MECHATROLINK-II Master Unit in the Motion Controller system
- **station** is the station address of the GRT1-ML2 set with the rotary switches
- **vr** is the VR memory address where the read status word is put. Use -1 to print the status word to the Command Line Terminal interface.

Every servo cycle the status word is checked and a bitwise AND is performed with the status word and the status error mask. If the result of this AND operation is not 0, the WDOG is switched off. This can be used to detect particular errors in GRT1-ML2 and stop the controller operation if they occur.

To set the status error mask, use the command

MECHATROLINK(unit,37,station,value)

where:
- **unit** is the number of the MECHATROLINK-II Master Unit in the Motion Controller system
- **station** is the station address of the GRT1-ML2 set with the rotary switches
- **vr** is the value of the status error mask that must be set.

The status error mask value can be read back by means of the command

MECHATROLINK(unit,39,station,vr)

where the arguments of the command are the same as for the command **MECHATROLINK(unit,36,station,vr)**. The default value of the status error mask after the controller is turned on or reset is 4000 hex. This triggers the

WDOG when an error occurs in the GRT1-ML2. 4000 hex equals 0100 0000 0000 0000 binary. Bit 14 is the overall error bit, which is set to 1 when an error occurs.

2.2   GRT1-ML2 functions

2.2.1   Table registration

The table registration function registers the configuration of the SmartSlice I/O Units that are connected to the GRT1-ML2 in a table in the GRT1-ML2. This allows for a comparison of the acutal configuration when the power is turned on with the registered configuration.
• To enable the registered table, make sure that unit dipswitch 1 (REGS) is set to ON before the power is turned on.
• To disable the registered table, make sure that unit dipswitch 1 (REGS) is set to OFF before the power is turned on. In this case, the GRT1-ML2 automatically detects the actual I/O configuration and starts the communication.

Create a new registration table
To register the table, make sure the power of the GRT1-ML2 and the SmartSlice I/O Units is on, and set unit dipswitch 1 (REGS) on the GRT1-ML2 from OFF to ON. If the registration table is refreshed, the old registration table is erased.

> ℹ️ It is recommended to register the I/O configuration table when all SmartSlice I/O Units are communicating, that is, when the TS LED is lit green.

The configuration information that is registered contains these items:
• The order of the SmartSlice I/O Units connected to the GRT1-ML2.
• The I/O size (input or output, number of bits) of each SmartSlice I/O Unit.

The configuration information does not contain the model numbers of the SmartSlice I/O Units.

Comparison of the actual configuration and the registered table
When unit dipswitch 1 is set to ON, an I/O configuration table is registered in the GRT1-ML2, and the GRT1-ML2 is turned on, the GRT1-ML2 automatically compares the actual I/O configuration and the registered table. If a registered SmartSlice I/O Unit cannot participate in he I/O communication, or if the GRT1-ML2 detects an unregistered SmartSlice I/O Unit, a verification error occurs. In this case, the concerned SmartSlice I/O Units do not participate in the I/O communication. The I/O communication starts with the other SmartSlice I/O Units.

From left	I/O	Bits		From left	I/O	Bits
#1	Input	4		#1	Input	4
#2	Input	4		#2	Input	4
#3	Output	4	← Mismatch →	#3	Output	2
#4	Output	2		#4	Output	2

Registered table   Actual configuration

The tables above give an example of a mismatch between the registered table and the actual configuration. The I/O data sizes of the third unit do not match. Therefore, a verification error occurs and the third unit does not participate in the communication.
The TS LED flashes red when a verification error occurs.

2.2.2   Online replacement

It is possible to replace SmartSlice I/O Units connected to a GRT1-ML2 when the power is on. The I/O communication continues while a SmartSlice I/O Unit is removed and replaced.
To replace a SmartSlice I/O Unit online, do these steps:
1. Turn off all power supplies of the SmartSlice I/O Unit. This is the I/O power supply, plus possible external power supplies to the terminal block (for example, a Relay Output Unit).
2. Release the locks on the front of the unit and remove the terminal block. Do not remove the wiring.
3. Remove the main block of the unit. Replace it with a new SmartSlice I/O Unit of the same type.

4. Attach the new unit to the system. Close the locks on the front of the unit.
5. Turn on the power supplies to the unit.

When replacing a SmartSlice I/O Unit online, note the following things:
- When a unit is removed from the I/O communication, the withdrawn flag of the unit is set on and the TS LED on the GRT1-ML2 flashes red.
- If I/O power supply of the unit is not turned off, there can be false output signals, false input signals and electrical schocks.
- Only replace one SmartSlice I/O Unit at a time.
- If a unit is replaced with a different type of unit, there can be unexpected outputs and the restore operation can be incomplete.
- If the base block has faults or damage, turn off the power supply and replace the entire unit.

When an online replacement is performed, the status word of the GRT1-ML2 reports an error (missing I/O Unit). When the I/O Unit is replaced or put back, the status word changes to 8000 hex, but the error has already been detected by the TJ1-MC__. To avoid this, it is necessary to mask the errors before the online replacement is performed. To perform the online replacement do the following:
1. Execute **MECHATROLINK(unit,37,station_addr, 0)**. This masks all bits, including errors, in the GRT1-ML2 status word.
2. Replace the I/O Unit.
3. Execute **MECHATROLINK(unit,37,station_addr, $4000)**. This sets the error mask to its default value.

3 Troubleshooting

Some analog I/O Units initialize slower after power on than others. If such an I/O Unit reports its correct status too late to the GRT1-ML2, the status word of the GRT1-ML2 has bit 13 set, which means that there is an error or a warning in the SmartSlice system. The default value of the error mask is set to detect if this bit is on, and thus an error is detected and reported by the TJ1-MC__. After a short time, the I/O Unit reports its (real) correct status and the status word becomes 8000 hex, but the MC__ has already detected the error, even though there was no real error. Masking this particular bit of the status word with the command **MECHATROLINK(unit,37,station,value)** is not an option, because no command can be sent before the start-up sequence, during which the error is detected, is complete.
The solution to the problem is to use the command

MECHATROLINK(unit,5,station,vr)

where:
- **unit** is the number of the MECHATROLINK-II Master Unit in the Motion Controller system.
- **station** is the station address of the GRT1-ML2 unit set with the rotary switches.
- **vr** is the VR memory address where the read code is put. Use value -1 to print the status word to the Command Line Terminal interface.

This command clears the error of the unit, and enables turning on the WDOG.
If this error and the problem of I/O Units that initialize slower occur, put the command **MECHATROLINK(unit,5,station,vr)** in the start-up program.

3.1 Unit power supply errors

The UNIT PWR LED shows if the power supply to the GRT1-ML2 and to the SmartSlice I/O system is enough to start-up and operate correctly.

UNIT PWR	Probable cause	Correction
Not lit	No power supply or not enough power supply to the units[1]	• Check whether power is supplied to the unit power supply terminal • Check that the supplied power is in the required range, that is 24 VDC +10% −15% (20.4 to 26.4 VDC)
Flashing	The unit power supply capacity is insufficient	Check the power supply requirement of the entire Smart-Slice I/O System and replace the power supply with one that has enough capacity
Lit	No error, the correct power is supplied to the system	

1. The GRT1-ML2 can start with less power than specified. In this case, the UNIT PWR LED can be off, although other LEDs can indicate normal operation. However, in this case the correct operation of the whole SmartSlice I/O system is not guaranteed.

3.2 I/O power supply errors

The I/O PWR LED shows if the power supply to the external I/O connected to the SmartSlice I/O Units is enough to drive the external outputs on the individual units.

I/O PWR	Probable cause	Correction
Not lit	No power or not enough power supply to the external I/O of the SmartSlice I/O Units	• Check whether power is supplied to the I/O power supply terminal • Check that the supplied power is in the required range, that is 24 VDC +10% −15% (20.4 to 26.4 VDC)
Lit	No I/O power error, the correct power is supplied to the external I/O system	

3.3 Unit errors

The GRT1-ML2 starts the initialization when the power is turned on. During the initialization, the RUN LED and the ALARM LED are off. When the initialization completes, the RUN LED goes on.

Possible errors during the initialization are in the table below.

RUN	ALARM	Probable cause	Correction
Not Lit	Not lit	Initialization in progress	N/A
	Flashing	Fatal system error during initialization	Replace the unit
	Lit	Fatal error during operation	Restart the unit. If the problem persists, replace the unit.
Lit	Not Lit	No error	N/A
	Lit	One of these MECHATROLINK-II protocol violations: • Parameter out of range • Communication lost	• Restart the TJ1-MC__ • Execute the command **MECHATROLINK(unit,0)**

3.4   SmartSlice I/O errors

TS	Color	Probable cause	Correction
Not Lit	N/A	No power supply	Refer to section 3.1

TS	Color	Probable cause	Correction
Flashing (every second)	Green	Adding SmartSlice I/O Units to the network	Wait until the SmartSlice I/O Units are added to the network
		There can be a break in the connection between individual slices, or one of the SmartSlice sockets is not connected properly to its left neighboring connector. The TS LED on all correctly connected slices are flashing, but the TS LED on the not correctly connected units are off.	Check the connection between slices at the point where the first unit is located with its TS LED off. Make sure that all slices are connected correctly to each other.
		The last unit is not or not properly connected. The SmartSlice communication does not start up. The TS LED on all SmartSlice I/O Units are flashing.	Check the connection of the last unit and make sure that it is correctly connected to the SmartSlice system
	Red	SmartSlice bus communication error	Make sure that the base block of the SmartSlice I/O System is connected properly
		When the registration table function is enabled, the actual configuration does not match the registered configuration	Correct the configuration and turn the power on again
		The total number of I/O points in the SmartSlice I/O systems is greater than the maximum	Correct the unit configuration and number of I/O points and turn the power on again
Flashing (every 0.5 seconds)	Green	Restore operation in progress	Wait until the restore operation is complete
		Backup operation in progress	Wait until the backup operation is complete

| TS	Color	Probable cause	Correction
Lit	Red	Backup operation failed[1]	Do the backup of the data again
		Restore operation failed[1]	Reinstall the unit in which the restore operation was in progress and turn the power on again
		SmartSlice I/O Unit configuration error	Check these items: • Are more than 64 I/O units connected? • Are more than 128 bytes of I/O data used? • Has the I/O configuration changed since the I/O configuration table was registered?
	Green	The Slice bus operates normally	N/A

1. The TS LED is lit for 2 seconds.

A   Timing

This appendix describes the I/O timing issues for the communication between the TJ1-MC__, the GRT1-ML2 and the SmartSlice I/O Units. The information in this section is useful for planning operations that require strict control of the I/O timing.

In this section, the following is assumed:

- All required slaves participate in the communication.
- The TJ1-MC__ and the GRT-ML2 have no error indications.
- The I/O configuration is properly registered.
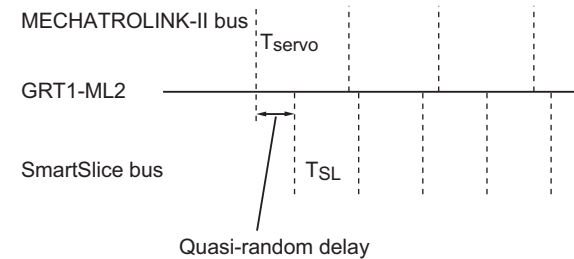
> **i** To register the I/O configuration, use the REGS dipswitch. See section 1.1.1.

> **i** If the I/O configuration is not properly registered, the system can operate, but the data exchange is delayed.

- All filter functions in the SmartSlice I/O Units are disabled.

A.1   Timing concepts

A.1.1   Refresh cycles

There are two refresh cycles involved in the timing issues:

- The refresh cycle between the TJ1-MC__ and the GRT1-ML2
- The refresh cycle between the GRT1-ML2 and the SmartSlice I/O Units.

These refresh cycles are independent, they are not synchronized. Therefore a small delay in the communication between the TJ1-MC__ and the SmartSlice I/O Units occurs. The maximum duration of this delay is the longest refresh cycle time. This delay is "quasi-random", and it is not possible to compensate it. Applications that require more precisely timed I/O must use the onboard I/O of the TJ1-MC__.

A.1.2   Paging

The maximum amount of data that can be transferred in one servo period with the MECHATROLINK-II protocol is 27 bytes. This is called a page. If the GRT1-ML2 transfers more than 27 bytes of input and/or output data, the data is divided into multiple pages. These pages are transferred in multiple servo periods. The transferred I/O data is only used when all pages are transferred.

The contribution of the individual slices to the I/O data size is described in section 2-2-2 of the GRT1 Series SmartSlice I/O Units Operation Manual (W455).

> **i** If the number of input pages and the number of output pages are different, the refresh cycle of the input data and the refresh cycle of the output data are also different.

To display the number of pages used, execute the command
MECHATROLINK(unit,38,station,vr). This command reads the paging data
and stores it in the VR array: first the number of input pages, and then the
number of output pages. If **vr** equals -1, the paging data is printed to the
Command Line Terminal interface.

ℹ️ A system with at most 6 slices typically produces less
than 27 bytes of I/O data, in which case the number of
pages is 1.

A.2   Examples

The following time variable and other variable definitions are used:

Variable	Definition
T_{ON} T_{OFF} $T_{ON/OFF}$	The ON or OFF delay of the SmartSlice I/O Unit. See the GRT1 Series SmartSlice I/O Units Operation Manual (W455) for more information on input delay times of input units and output delay times of output units. Note: T_{ON} is the ON delay, T_{OFF} is the OFF delay, $T_{ON/OFF}$ is both the ON delay and the OFF delay.
T_{SERVO}	The Trajexia servo period Typically 1ms See the BASIC command **SERVO_PERIOD** in the Trajexia Programming Manual (I52E).
T_{SL}	The refresh cycle of the SmartSlice I/O Units, which is the communication time of the SmartSlice bus. T_{SL} = 0.66 + number of input words of SmartSlice Input Units that use words $\times$ 0.022 + number of input bits of SmartSlice Input Units that use bits $\times$ 0.009 + number of output words of SmartSlice Output Units that use words $\times$ 0.008 + number of output bits of SmartSlice Output Units that use bits $\times$ 0.001 ms
T_{CU}	The data processing and synchronisation time of the SmartSlice I/O Units.
PDsize	The Process Data size in bytes, which is the number of bytes needed to transfer all input or output data.
Pages	The number of pages used to transfer all data. The minimum is 1.

Variable	Definition
T_{ML}	The total MECHATROLINK-II communication time for all data. T_{ML} equals Pages $\times$ T_{SERVO}.
T_{SYNC}	The servo interval synchronisation time of the Trajexia program.
T_{in}	The input response time: the time between these 2 events: • The SmartSlice Input Unit receives an input signal. • This signal is available to the TJ1-MC__ for processing. $T_{in} = T_{ON/OFF} + T_{SL} + T_{CUin} + T_{MLin} + T_{SERVO}$, where: • 0.1 ms $\leq T_{CUin} \leq 0.1 + MAX(T_{SL}, T_{MLin})$ ms • $T_{MLin} = Pages_{in} \times T_{SERVO}$ • $Pages_{in} = (PDsize_{in} + 2) / 27$ [1], rounded up to the nearest integer
T_{out}	The output response time: the time between these events: • The TJ1-MC__ sets an output signal. • This signal is available to the SmartSlice Output Unit. $T_{out} = T_{SYNC} + T_{MLout} + T_{CUout} + T_{SL} + T_{ON/OFF}$, where: • $\pm0 \leq T_{SYNC} \leq T_{SERVO}$ • $T_{MLout} = Pages_{out} \times T_{SERVO}$ • $Pages_{out} = PDsize_{out} / 27$, rounded up to the nearest integer • 0.1 ms $\leq T_{CUout} \leq 0.1 + T_{SL}$ ms

1. 2 is added to PDsize$_{in}$ because the GRT1-ML2 produces 2 bytes of input
   data (the GRT1-ML2 status word).
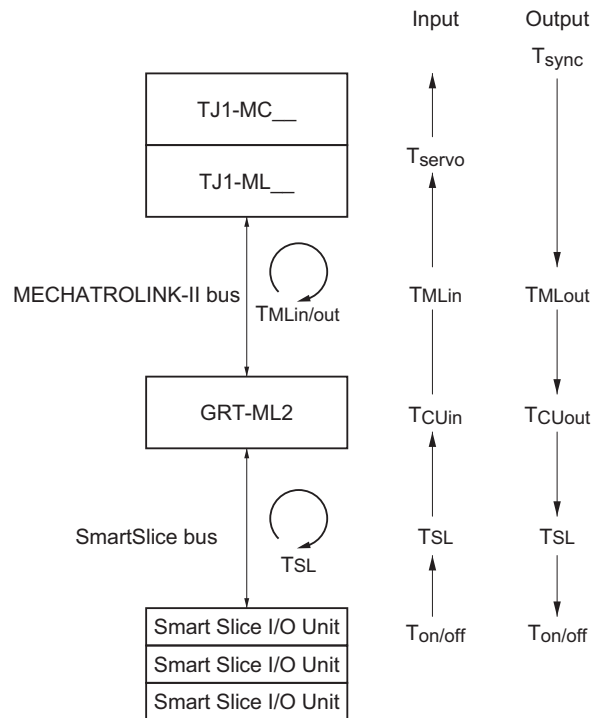
The following SmartSlice I/O Units, which are used in the examples, have the following ON/OFF delays:

SmartSlice I/O Unit	$T_{ON/OFF}$
GRT1-ID4	$0 \text{ ms} \leq T_{ON/OFF} \leq 1.5 \text{ ms}$
GRT1-OD4	$0 \text{ ms} \leq T_{ON} \leq 0.5 \text{ ms}$
	$0 \text{ ms} \leq T_{OFF} \leq 1.5 \text{ ms}$
GRT1-AD2	$0 \text{ ms} \leq T_{ON/OFF} \leq 2 \text{ ms}$
GRT1-DA2	$0 \text{ ms} \leq T_{ON/OFF} \leq 2 \text{ ms}$

Furthermore, $T_{SERVO} = 1 \text{ ms}$.

A.2.1   Example 1

Setup of the SmartSlice I/O system: GRT1-ID4 − GRT1-OD4.

$T_{SL} = 0.66 + 4 \times 0.009 + 4 \times 0.001 = 0.7 \text{ ms}$

GRT1-ID4 input response time
$(T_{in} = T_{ON/OFF} + T_{SL} + T_{CUin} + T_{MLin} + T_{SERVO})$

$0 + 0.7 + 0.1 + 1 + 1 = 2.8 \text{ ms} \leq T_{in} \leq 1.5 + 0.7 + 1.1 + 1 + 1 = 5.3 \text{ ms}$

GRT1-OD4 output response time
$T_{out} = T_{SYNC} + T_{MLout} + T_{CU} + T_{SL} + T_{ON/OFF}$

$0 + 1 + 0.1 + 0.7 + 0 = 1.8 \text{ ms} \leq T_{out} \leq 1 + 1 + 0.8 + 0.7 + 1.5 = 5.0 \text{ ms}$

A.2.2   Example 2

Setup of the SmartSlice I/O system: GRT1-OD4 − GRT1-ID4 − GRT1-OD8 − GRT1-ID8 − GRT1-OD8 − GRT1-ID8 − GRT1-OD8 − GRT1-ID8 − GRT1-OD8 − GRT1-ID8 − GRT1-OD4 − GRT1-DA2 − GRT1-AD2 − GRT1-DA2 − GRT1-DA2 − GRT1-DA2 − GRT1-DA2 − GRT1-ID4 − GRT1-ID4

Inputs	Bits	Words	Data size[1]
$4 \times$ ID4	4		2 Bytes (Filled up to 1 word)
$4 \times$ ID8		4	8 Bytes
$1 \times$ AD2		2	4 Bytes
$2 \times$ ID4	8		1 Byte
TOTAL	12	6	15 Bytes (15 + 2) / 27, rounded up = 1 Page

1. For the contribution of the individual slices to the I/O data size, see section 2-2-2 of the GRT1 Series SmartSlice I/O Units Operation Manual (W455).

Outputs	Bits	Words	Data size
1 × OD4	4		2 Bytes (Filled up to 1 word)
4 × OD8		4	8 Bytes
1 × OD4	4		2 Bytes (Filled up to 1 word)
4 × DA2		8	16 Byte
TOTAL	8	12	28 Bytes 28 / 27, rounded up = 2 Pages

$T_{SL} = 0.66 + 6 \times 0.022 + 12 \times 0.009 + 12 \times 0.008 + 8 \times 0.001 = 1.004$ ms

GRT1-ID4 input response time
$(T_{in} = T_{ON/OFF} + T_{SL} + T_{CUin} + T_{MLin} + T_{SERVO})$

$0 + 1.004 + 0.1 + 1 + 1 = 3.104$ ms $\leq T_{in} \leq 1.5 + 1.004 + 1.104 + 1 + 1 = 5.608$ ms

GRT1-AD2 input response time
$(T_{in} = T_{ON/OFF} + T_{SL} + T_{CUin} + T_{MLin} + T_{SERVO})$

$0 + 1.004 + 0.1 + 1 + 1 = 3.104$ ms $\leq T_{in} \leq 2.0 + 1.004 + 1.104 + 1 + 1 = 6.108$ ms

GRT1-OD4 output response time
$(T_{out} = T_{SYNC} + T_{MLout} + T_{CU} + T_{SL} + T_{ON/OFF})$

$0 + 2.0 + 0.1 + 1.004 + 0 = 3.104$ ms $\leq T_{out} \leq 1.0 + 2.0 + 1.104 + 1.004 + 1.5 = 6.608$ ms

GRT1-DA2 output response time
$(T_{out} = T_{SYNC} + T_{MLout} + T_{CU} + T_{SL} + T_{ON/OFF})$

$0 + 2.0 + 0.1 + 1.004 + 2 = 5.104$ ms $\leq T_{out} \leq 1.0 + 2.0 + 1.104 + 1.004 + 2 = 7.108$ ms