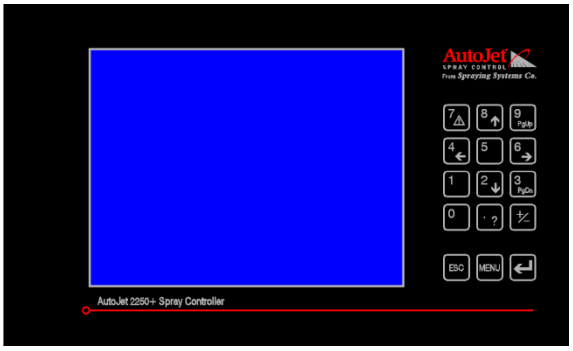
Spraying Systems
Experts in Spray Technology

INSTRUCTION MANUAL



Model 2250+
Spray Controller

CP-CTNAT2250-Px

AutoJet TECHNOLOGIES
From Spraying Systems Co.

Experts in spray technology

ISO 9001 14001 Certified by BVQI

Spray Nozzles — Spray Control — Spray Analysis — Spray Fabrication

Revision Sheet

Release No.	Date	Revision Description
R00		Draft
R01	07/10/2009	Pilot 1 preliminary release (approvals pending)
R02	08/09/2010	Pilot 2 release
R03-E00	18/04/2011	Added statement for indoor use
R04-E00	08/03/2012	Extract too detailed waveform data

INSTRUCTION MANUAL

TABLE OF CONTENTS

Page #

GENERAL INFORMATION

Notes:

1 GENERAL INFORMATION

1.1 Scope

AutoJet instruction manuals cover the following:

- Hardware specifications
- Guidelines for installing, wiring and cabling
- Basic operation

Application related software is described in a separate software manual.

AutoJet instruction manuals do not cover the usage of AutoJet electronic products in an application, nor system setup or other specialized tasks which are part of automated system engineering. System testing and diagnostics are also beyond the scope of this document.

1.2 Disclaimer

The information presented in this document is believed to be accurate and reliable and may change without notice.

1.3 Intended use

AutoJet electronic products shall only be installed and put into operation by qualified personnel. It is designed for installation in an enclosure and is intended for spray applications in an industrial environment. Do not use it in equipment where malfunctioning of the device may cause severe personal injury or threaten human life.

1.4 Markings

AutoJet electronic products are at minimum built according to the essential requirements from the applicable european directives. Compliance with requirements from other continents or countries may also apply.
Compliance verification is done to the appropriate (harmonized) standards and is illustrated in the SAFETY chapter in this document.

PRODUCT INFORMATION

Notes:

2 PRODUCT INFORMATION

2.1 Manufacturer

AutoJet Technologies BVBA
Buchtenstraat 2
B-9051 Belgium
Tel. +32-(0)9/244.65.65
Fax +32-(0)9/244.65.66
E-mail: info@autojet.be
Web page address: www.autojet.com

2.2 Identification

The controller can be identified on the back:

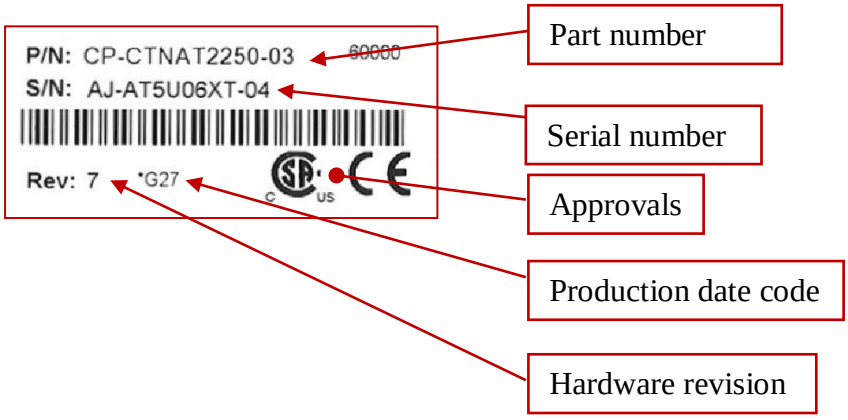


Figure 1 Example product identification label

Name	Model 2250+ Spray Controller
Part number (P/N)	CP-CTNAT2250-Px [1]
Serial number (S/N)	See 12 digit code on product identification label
Hardware Revision	See number on product identification label
Approvals	CE, cCSAus

Table 1 System identification

2.3 General Description

The 2250+ controller is an upgrade of the present 2250 controller with distinct features as faster processor, QVGA color display with touch screen, 48V gun drivers and extra communication possibilities. With the basic software, it remains completely backward compatible (can handle SprayLogic files), although expanded with touch screen operation.

[1] 'x' denotes that at this position, characters relevant to a specific model or version will be in place

2.4 Hardware Features

- Display
  - 5.7" QVGA TFT color screen (320x240xRGB)
  - 256 colors
  - LED backlight
  - Resistive touch panel
- Keyboard: 15-key tactile keypad with smart keys
- Same housing and I/O connectors as predecessor
- Dimensions: 203 x 128 x 87mm, 1325gr.
- Power supplies
  - LOGIC: 24Vdc nominal, 1A (internally fused)
  - GUNS: 24 to 48Vdc nominal, 10A (to be fused externally)
  - LOOP: 24 to 36Vdc nominal, 0.2A (optional; internally powered by 24Vdc)
- Operating range: 0ºC to + 45ºC, 10% to 95% RH (non-condensing)
- Storage range: -40ºC to + 70ºC
- Environmental: altitude up to 2000m, Pollution Degree 2
- Processors:
  - Main controller: 16 bit - 64MHz
  - PWM controller: 8 bit – 40MHz
- Communications:
  - Downlink:
    - 1x RS422 (i.e. WAGO I/O expansion)
    - 1x RS485 (AutoJet proprietary bus for i.e. 2008 controllers)
    - 1x USB 2.0 host (i.e. for flash stick)
  - Uplink
    - 1x RS422 or RS232 (or Modem V92TM or Ethernet 10/100Mbit)
    - 1x USB 2.0 slave (PC side)
- GUN outputs
  - 24 to 48Vdc, 6A
  - Hold-chopping frequency: 10kHz
  - Fully protected
  - 2250+ versions exist with 0, 1 or 2 drivers
- Digital outputs
  - 9x General Purpose, max. 30V/1A
  - Optional General Purpose outputs when GUN driver(s) not present:
    - 2x per GUN channel, max 60V/750mA
  - Fully protected to 30V
- Digital inputs:
  - 24Vdc
  - Optical isolated Type 3 NPN or PNP, group selectable through wiring
    - 13x General Purpose, typical 1kHz
    - 4x Fast, typical 25kHz
  - Fully protected to 30V
- Analog inputs:
  - 12x 0/4 to 20mA, single ended, sinking, 10 bit
  - Fully protected to 30V
  - Sampling rate: 45µsec min

- Analog outputs:
  - 8x 0/4 to 20mA, single ended, sourcing, 12 bit
  - Fully protected to 30V
  - Refreshing rate: 100kHz
- RoHS compliant

2.5 Reset

- Start-up after reset (cold start, hot or warm restart): default 3s (settable in BIOS - Settings)

2.6 Hardware Elements

2.6.1 Front panel

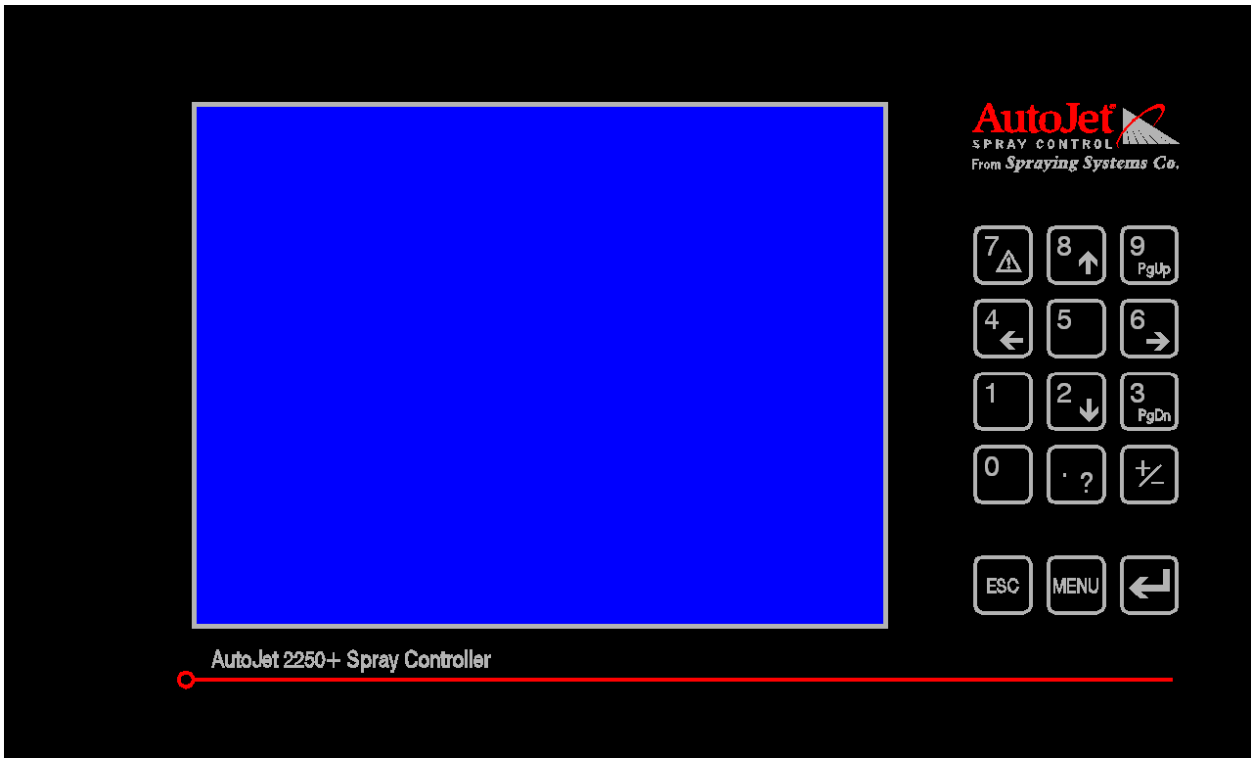


Figure 2 Front panel

2.6.2 Rear connections

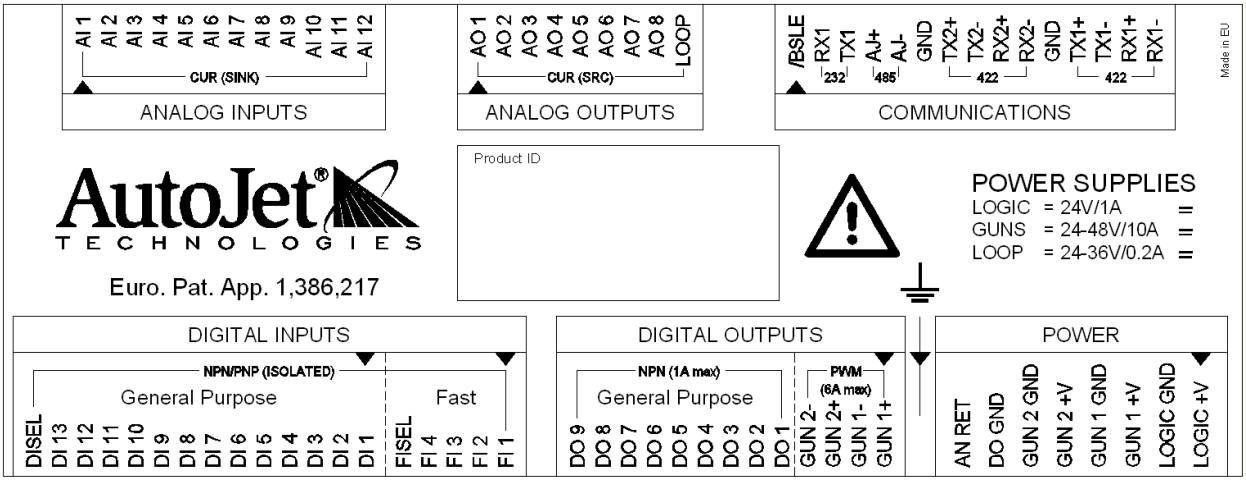


Figure 3 Rear overlay

Element	*Name*	*Characteristics*	*Usage*
ANALOG INPUTS	AI1 to AI12	0/4-20mA sinking	Application specific current inputs
ANALOG OUTPUTS	AO1 to AO8	0/4-20mA sourcing	Application specific current outputs
	LOOP	24 to 35Vdc	Optional AO loop voltage input
DIGITAL INPUTS	DI1 to DI13	PNP or NPN (1), 10kHz	Application specific general purpose inputs
	DISEL	GND or +24Vdc	PNP/NPN selection for DI (1)
	FI1 to FI4	PNP or NPN (1) , 25kHz	Application specific timer/counter inputs
	FISEL	GND or +24Vdc	PNP/NPN selection for DI (1)
DIGITAL OUTPUTS	DO1 to DO9	NPN, 1A	Application specific outputs
	GUN1, 2 +/-	BRIDGE, 6A	GUN drive outputs (2)
	DO10 to DO13	NPN, 750mA	Optional application specific outputs (2)
POWER	LOGIC +V	24Vdc	LOGIC supply input (4)
	LOGIC GND	0Vdc	LOGIC supply ground return
	GUN1,2 +V	24 to 48Vdc	GUN supply inputs (5)
	GUN1,2 GND	0Vdc	GUN supply ground returns
	DO GND	0Vdc	Digital outputs ground return (3)
	ANRET	0Vdc	Optional analog outputs ground return
COMMUNICATIONS	/BSLE	NPN input	FW programming enable input
	RX1,TX1	RS232	Uplink COM for FW programming
	AJ+/-	RS485	Downlink AutoJet proprietary COM
	TX1, RX1+/-	RS422	Uplink COM for OPC a.o.
	TX2, RX2+/-	RS422	Downlink COM for I/O expansion a.o.
	GND's	0Vdc	COM ground returns
	⏚	0Vdc	Protective earth

Table 2 Rear connections

(1) Logic selected in group: D(F)ISEL = +24V → D(F)I's = NPN, D(F)ISEL = GND → D(F)I's = PNP

(2) When a GUN output module is omitted inside the controller, two extra digital outputs become available instead
(3) The power supply for the digital outputs is usually taken from the system's 24V supply(ies) with all 0V's connected to a common system GND
(4) Internally fused, return to factory for fuse replacement
(5) To be fused externally by 10amp fast reacting glass fuses or electronic DC circuit breakers

2.6.3 Bottom side connections

On the bottom side, there are two USB connections available, as well as an optional Modem or Ethernet connection.

2.7 Software features

The BIOS is a part of the firmware that allows basic input/functions, as well as basic configuration of the controller. It allows to:

- Test the I/O of the controller.
- Show the current state of the I/O.
- Set the default values of the gun driver, even those that are not accessible by the application software.
- Update the firmware of the controller and peripheral chips, such as the gun driver.
- Calibrate the touch screen.

SAFETY

Notes:

3 SAFETY

3.1 General

This instruction manual contains information and warnings that need to be followed by the user to ensure safe operation and to retain the device in a safe condition.

The device has been designed for use in a Pollution Degree 2 environment in the temperature range 0ºC to + 45ºC, 10% to 95% RH (non-condensing). Indoor use only.

Use of this device in a manner not specified by these instructions may impair the provided safety protection. Do not operate the device outside its rated supply voltages or environmental range.

Use only double insulated or reinforced limited power supplies. LOGIC power input must be rated at 240VA and GUN power inputs at 240/480VA with a max current of 10A each. Power supplies and fuses/circuit breakers must comply with the relevant Safety Standards (CE, UL, CSA, TUV...).

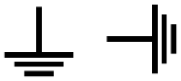
Only mount the module in a protective steel fire enclosure.

A means for disconnection of the power must be provided through a switch or circuit-breaker, as described in the relevant safety standards. It shall be placed in close proximity to the equipment and within easy reach of the operator. It shall be marked as the disconnecting device for the equipment.

Do not hot-plug the device.

Following symbols are used on the device and in the manual:

Caution mark (on the device, this symbol refers to specific instructions in the manual)



Earth (ground) terminal

3.2 CE

3.2.1 Applicable EU directives

The product meets the essential requirements of following EU directives:

- 2004/108/EC Electromagnetic Compatibility
- 2006/95/EC The low voltage directive.

Relevant portions of the harmonized European Standard IEC 61131-2 "Programmable Controllers – Equipment requirements and tests" were used as guidelines for design and compliance verification.

3.2.2 Normal service and functional type tests and verifications

Climatic & mechanical tests, as well as Power Supply and I/O verifications, were performed in accordance to the standards referred by and limits stated in the standard IEC 61131-2.

3.2.3 Electromagnetic compatibility (EMC) requirements

EMC tests were performed in accordance to the standards referred by and limits stated in the standard IEC 61131-2:

- EMC radiated emissions: CISPR 11/EN55011, class A
- EMC radiated immunity:
  - IEC 61000-4-2 Electrostatic discharge, class B
  - IEC 61000-4-3 Immunity to radiated electromagnetic field, class A
- EMC conducted immunity:
  - IEC 61000-4-4 Fast transients & bursts, zone B, class B
  - IEC 61000-4-6 Conducted immunity, zone B, class B

Restrictions on lengths of wires (see 3.4.1):

- DC power input lines: <= 3m
- I/O lines: <= 30m

3.3 CSA

3.3.1 Product Classes

- CLASS 2252 05 – PROCESS CONTROL EQUIPMENT
- CLASS 2252 85 – PROCESS CONTROL EQUIPMENT – Certified to US Standards

Spray Controller, Model 2250+ Spray Controller for building in, Class III, Logic: 24Vdc, 1A; Guns: 24-48Vdc, 10A; Loop: 24-36Vdc, 0,2A..

3.3.2 Applicable requirements

- CAN/CSA-C22.2 No. 61010.1-04 Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use, Part 1: General Requirements
- UL Std. No. 61010.1 (2nd Edition) - Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use, Part 1: General Requirements

3.4 Cautions

3.4.1 EMI

Some precautions should best be taken to ensure proper system performance.

Due to the chopping of the gun output voltages, lots of transients are generated in the PWM output wiring that could, due to crosstalk, induce EMI in adjacently routed signal wires causing a system not to work properly. Also, the limits for Radiated Emission for CE and FCC will easily be crossed. Therefore, outside the enclosure, the PWM output wires must be screened and routed as close as possible to grounded metal surfaces.

Also, abovementioned transients could also be found back at the power entrance; if other sensitive AC powered apparatus would be used, the use of an EMI filter might be recommended. Consult factory in case of doubt.

Be sure that the cabinet and all other relevant mechanical parts are equal-potentially bonded (i.e. scratch away paint at a grounding point) and connected to the protective earth (PE) at the power entrance.

The unit must always be installed as close as possible to its DC power supply. In case of external power inputs as for instance for the selection of the digital input logic selection (galvanic separation) or higher loop voltage for the analog outputs, hence with wiring longer than 3m, extra EMI filtering must be provided at the entrance of the cabinet.

Special care must also be taken when exchanging signals with other machinery or systems; lines longer than 30m should be protected at the entrance of the control cabinet by means of adequate EMI filters and surge arrestors.

3.4.2 Gun Power Dissipation

Since higher than nominal working voltages can be applied to the guns, one must take the maximum allowed power dissipation into account. The applied waveform should hence be carefully determined concerning positive and negative pulse times, holding voltages, etc.

FUNCTIONAL DESCRIPTION

Notes:

4 FUNCTIONAL DESCRIPTION

4.1 Block diagram

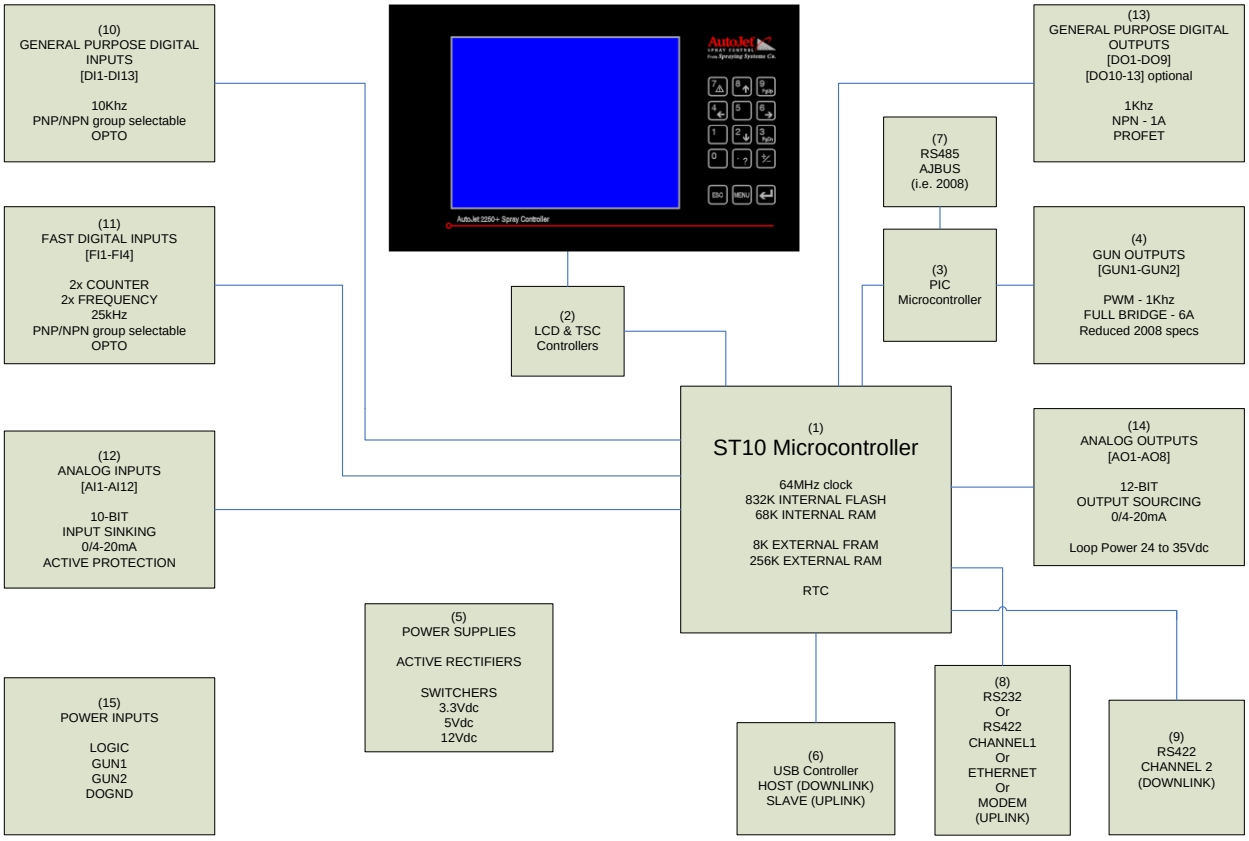


Figure 4 2250+ block diagram

4.2 Operation

The Model 2250+ GUN driver module consists out of following blocks (refer to block diagram above):

(1)

The host microcontroller takes care of virtually all real-time actions, uplink and downlink communication, HMI (Human Machine Interface), and so forth. It reads in a variety of analog and digital control signals and provides the necessary control and output signals.

It is a 16-bit controller running at 64MHz with on-board FLASH and RAM memory and external RAM, FRAM and a RTC.

(2)

A LCD graphics controller with SRAM display buffer and a Touch Screen Controller which also inputs the keypad are the HMI components, controlled by the host controller.

(3)

The PIC microcontroller performs all GUN driving related tasks, reading and providing control signals from and for 2 power bridges with circuitry for error detection, protection, etc.

It is an 8-bit co-controller running at 40MHz with on-board FLASH, RAM and EEPROM memory.

(4)

The actual GUN power drivers are built around a full-bridge circuit that can provide a current up to 6A nominal from a 48Vdc power supply. It is fully protected against overloads, short-circuits between driver outputs and short-circuits to either power supply rail.

Of each driver, the input voltage, high-side and low-side currents and board-temperature are continuously monitored in order to be able to provide adequate protections for the abovementioned power bridge. At an erroneous event, the error-detector will disable the GUN output and enter a so-called "hiccup" mode. In this mode the controller tries to reset the error-detector in a slow regime (approx. every 500ms) until the fault disappears.

A more detailed description of the GUN driver signal can be found in paragraph **Error! Reference source not found.**.

(5)

The necessary voltage converters are present for powering the controller, the bridge drivers, communication transceivers, etc.
In order to keep power losses minimal, active rectifiers are used at the power supply inputs, providing an inverse-polarity protection.

(6)

An USB controller is present that provides uplink communication as a slave, as well as downlink communication as a host. Typical uplink is PC communication, downlink i.e. a Flash disk.

(7)

The PIC microcontroller provides a RS485 channel for the AutoJet proprietary communications bus (AJBUS). This port can be used to augment the number of GUN channels with individual PWM control by hooking up several 2008 modules for instance.

(8)

Serial communication channel 1 is used for uplink communications such as OPC. The port specification is software selectable between RS422 and on-board modem or Ethernet connection – whichever one is physically present. For firmware programming, a RS232 transceiver is also present which overrides the modem/Ethernet when externally activated by the /BSLE input – this way, also serial communication is backward compatible with the "old" 2250.

(9)

Serial communication channel 2 is used for downlink communications, i.e. for implementing WAGO I/O expansion. The port specification is fixed at a RS422 hardware layer.

(10)

Thirteen application specific, optical isolated, general purpose digital inputs are available which can be wired, in group, for either NPN or PNP logic control.

(11)

Four application specific, optical isolated, fast digital inputs are available which can be wired, in group, for either NPN or PNP logic control. They can be used as pulse counter or as frequency counter.

(12)

Twelve application specific, single ended, current sinking, general purpose analog inputs are available at a 10-bit resolution. Two of them can also be read in at 12-bit resolution. They are protected against short-circuits to either 24Vdc power supply rail.

(13)

Nine application specific, NPN logic, fully protected to 30Vdc, general purpose digital outputs are available which can draw up to 1A each. Per module omitted from block (4), two extra outputs are available which can draw nominal 750mA from a 48Vdc power supply. They are also fully protected, but only to 30Vdc.

(14)

Eight application specific, single ended, current sourcing, general purpose analog outputs are available at a 12-bit resolution. They are protected against short-circuits to either Loop power supply rail. The internal Loop power voltage is 24Vdc, but can be externally augmented to 35Vdc in case of higher than 10V compliant analog input circuitry (>500 ohm input impedance).

(15)

As power supply inputs, there is the 24Vdc LOGIC which powers all internal control circuitry, two individual 24 to 48Vdc GUN inputs which power the internal GUN driver modules and a DOGND return for the digital outputs.

CHARACTERISTICS

Notes:

5 CHARACTERISTICS

5.1 Electrical

5.1.1 Absolute maximum values

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability or even damage the controller. The absolute maximum ratings are stress ratings only.

Parameter (per channel)	Tag	Unit	Max
• POWER			
○ Logic input voltage	LOGIC+V	V	30
○ Gun input voltage	GUN[1,2]+V	V	60
○ Digital inputs common	DISEL,FISEL	V	30
○ Analog outputs loop voltage	LOOP	V	35
• OUTPUTS			
○ Power digital out	DO[1..9]	V	30
○ Power digital out	GUN[1,2]+/-	V	60
○ Analog outputs	AO[1..8]	V	30
○ Gun outputs	GUN[1,2]+/-	V	60
• INPUTS			
○ Digital	DI[1..13],FI[1..4]	V	30
○ Analog	AI[1..12]	V	30
• COMMUNICATIONS			
○ Programming enable input	/BSLE	V	30
○ RS232 channel	RX1,TX1	V	30
○ RS422 channels	RX[1,2]+/-,TX[1,2]+/-	V	30
○ AutoJet proprietary bus	AJ+/-	V	30

Table 3 Absolute maximum ratings

5.1.2 Recommended operating values

Conditions for "Typical" values:

- Ambient temperature (TA) = 25ºC
- Power supply input voltage = 24 to 48Vdc
- All measurements done with respect to GND level unless otherwise stated

Parameter (per channel)	Tag	Unit	Min	Typ @ 25ºC	Max
Power Supplies					
• Logic	LOGIC +V/GND				
➢ Input voltage		V	20	24	29
➢ Input voltage rise time		ms		(note 13)	20
➢ Operating current		mA		470	
• Guns	GUN[1,2] +V/GND				
➢ Input voltage		V	12	24/48	57
➢ Load current		A			6
• Digital Outputs Ground	DOGND				
➢ Voltage level		V	---	0	---
➢ Load current		A			9
• Analog Return Ground	DOGND				
➢ Voltage level		V	---	0	---
➢ Load current		mA			200
Analog Inputs	AI[1..12]				
• Input range		mA	0	→	20
• Input impedance		ohm		225	
• Accuracy					
➢ Resolution		bit		10 (note 1)	
➢ Un-calibrated		%	-1		+1
➢ Calibrated		%	-0.2		+0.2
• Temperature stability		ppm/ºC	-250		+250
• Sampling rate		kHz		(note 11)	1.8
Analog Outputs	AO[1..8]				
• Loop power	LOOP				
➢ Input voltage		V		internal	+35
➢ Load current		mA			200
• Output range		mA	0	→	20
• Load resistance					
➢ Internal loop power		Ω		(note2)	650
➢ External loop power		Ω		(note2)	1200
• Output impedance		Ω	10M		
• Accuracy					
➢ Resolution		bit		12	
➢ Un-calibrated		%	-1		+1
➢ Calibrated		%	-0.2		+0.2
• Temperature stability		ppm/ºC	-250		+250

• Refreshing rate		kHz		(note 11)	100
Digital Inputs	DI[1..13]				
• Switching level (note 3)		V	[6.6]		
• ON current		mA	[2.7]		
• Hysteresis		V		0.8	
• Control current		mA		9.6	
• Frequency range		kHz			1
Fast Digital Inputs	FI[1..4]				
• Switching level (note 3)		V	[9]		
• ON current		mA	[2.7]		
• Hysteresis		V		0.4	
• Control current		mA		6.5	
• Frequency range (note 4)		kHz		25	
Digital Input Common	DISEL				
• Voltage level		V	“0”	OR	“24”
• Current		mA			150
• Isolation voltage (note 5)		Vrms		2500	
Fast Digital Input Common	FISEL				
• Voltage level		V	“0”	OR	“24”
• Current		mA			35
• Isolation voltage (note 5)		Vrms		2500	
Digital Outputs					
• General purpose NPN	DO[1..9]				
➢ Drain-Source voltage		V		24	30
➢ Nominal current - ON		A		1	1.4
➢ Nominal resistance - ON		mΩ		200	
➢ Clamping energy (note 6)		mJ			150
➢ Frequency range		Hz	0		2
• General purpose NPN (note 7)	GUN1,2+/-				
➢ Continuous Drain-Source voltage		V			60
➢ Drain-Source voltage for protection		V		24	30
➢ Nominal current - ON		A		0.75	1
➢ RDS on		mΩ		550	
➢ Clamping energy (note 6)		mJ			550
➢ Frequency range		Hz	0		2
• GUN outputs	GUN1,2+/-				
➢ Load current		A	0		6
➢ Total RDS on		mΩ		100	
➢ Output voltage swing		V		(note 8)	
➢ Efficiency in “normal mode” for 24V load (note 9)		%		97	
➢ Efficiency in “enhanced mode” for 24V load (note 10)		%		97	
➢ Chopping frequency		kHz		9.76	
➢ Rise/Fall time		µsec		1.5	
➢ PWM duty-cycle accuracy		%		(note 12)	

➢ Trip temperature on-board thermostat		ºC		105	
➢ 'Hiccup' pulse duration		ms		500	
Communications					
• Program enable	/BSLE				
➢ Control voltage		V	0		6
➢ Control current		mA		10	

Table 4 Electrical characteristics

Note 1:

AI11 and AI12 are also read in with a 12bit resolution – usage application specific

Note 2:

Maximum depends on loop voltage; needed nominal output circuitry voltage is 11Vdc → Max. load resistance = (Loop voltage – 11V) / 20mA

Note 3:

With respect to DISEL potential which is either 0V when used as PNP style inputs or 24V when used as NPN style inputs.

Note 4:

Max allowable frequency of an individual input depends on the sum of frequencies on all present input signals; i.e. a single input may go up to 100kHz when the other inputs are used as low frequency digital inputs. All these inputs are dedicated to pulse or frequency counting.

Note 5:

The digital input circuitry is isolated from the rest of the controller; the common rail can either be taken from the 2250+ controller supply or from an interfacing system which needs to stay galvanic separated and has no floating digital outputs. In latter case, provide EMI filtering!

Note 6:

Always put a diode or transient voltage suppressor directly at the terminals of inductive loads! Depending on the size of the inductor, too much energy (more than specified) could get back into the digital output when switching off and blow up the output driver.

Note 7:

Per omitted GUN driver module, two extra outputs become available.

Note 8:

Typical voltage loss in power circuit = load current * total RDSon. At full load, this is 6A * 100mΩ = 600mV. So voltage swing is then GUN+V – 600mV

Note 9:

Mainly quiescent current + load current * RDSon of different MOSFET switches determine power losses in the module. Given figure is for 24V power supply with 24V/6A load.

Note 10:

In this mode, switching losses become significant – they need to be added to the quiescent and RDSon losses. Given figure is calculated for 24V/6A load, 10KHz chopping frequency with 50% duty cycle at 48V power supply input: with 1.5µsec Rise/Fall time, a loss of 6A load * 48V voltage * 1.5/50µsec = 4.32W is generated and is added to 2W quiescent power and 3.6W RDSon losses giving a total of approx. 10W → for a 144VA load, this represents about 7% loss.

Note 11:

The sampling rate of the Analog input channels and the refreshing rate of the Analog output channels depend on the application software.

Note 12:

Driver PWM duty-cycle accuracy depends on:

- signal accuracy of the PWM controller which is 100 µsec with the standard firmware
- driving frequency

Min PWM duty-cycle accuracy depends on:

- max speed of the gun
- driving frequency

Effective PWM duty-cycle accuracy depends on:

- switching times of the gun
- wear of the gun
- pressure

Example:

PWM duty cycle accuracy

	Duty cycle (%)				
Frequency (Hz)	2	5	8	11	50
6	1.55%	0.63%	0.41%	0.30%	0.09%
15	(1)	1.60%	1.02%	0.76%	0.23%
25	(1)	(1)	1.71%	1.28%	0.38%
35	(1)	(1)	(1)	1.79%	0.53%

(1) Duty cycle not possible for a 10000 cycles/min gun

Table 5 PWM duty cycle accuracy example

Note 13:

Only for pilot batches (PCB revisions 01)

5.2 Mechanical

5.2.1 Specifications

- Front panel: all plastic keyboard with internal metal domes adhered to aluminum front plate
- Back cover: firezinked steel
- Front side protection degree: depends on used bezel
- Rear side protection degree: IP20

5.2.2 Overall dimensions

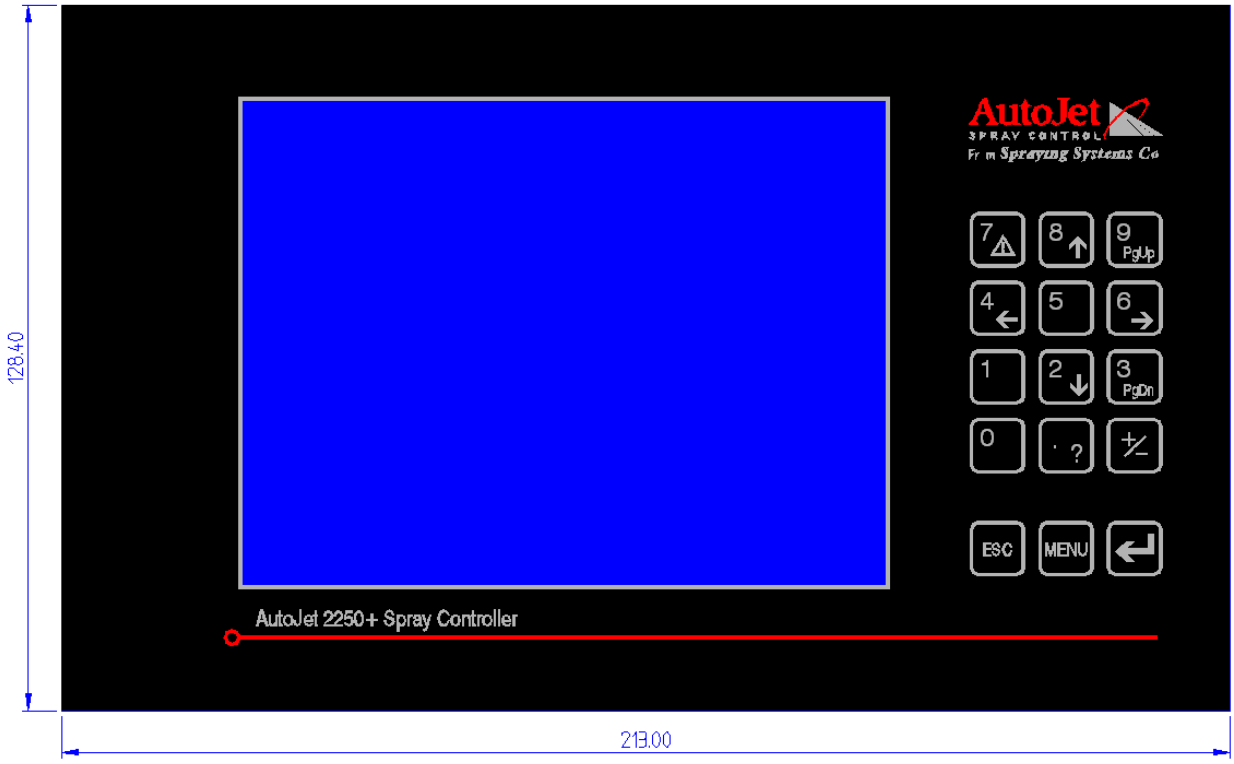


Figure 5 Front view

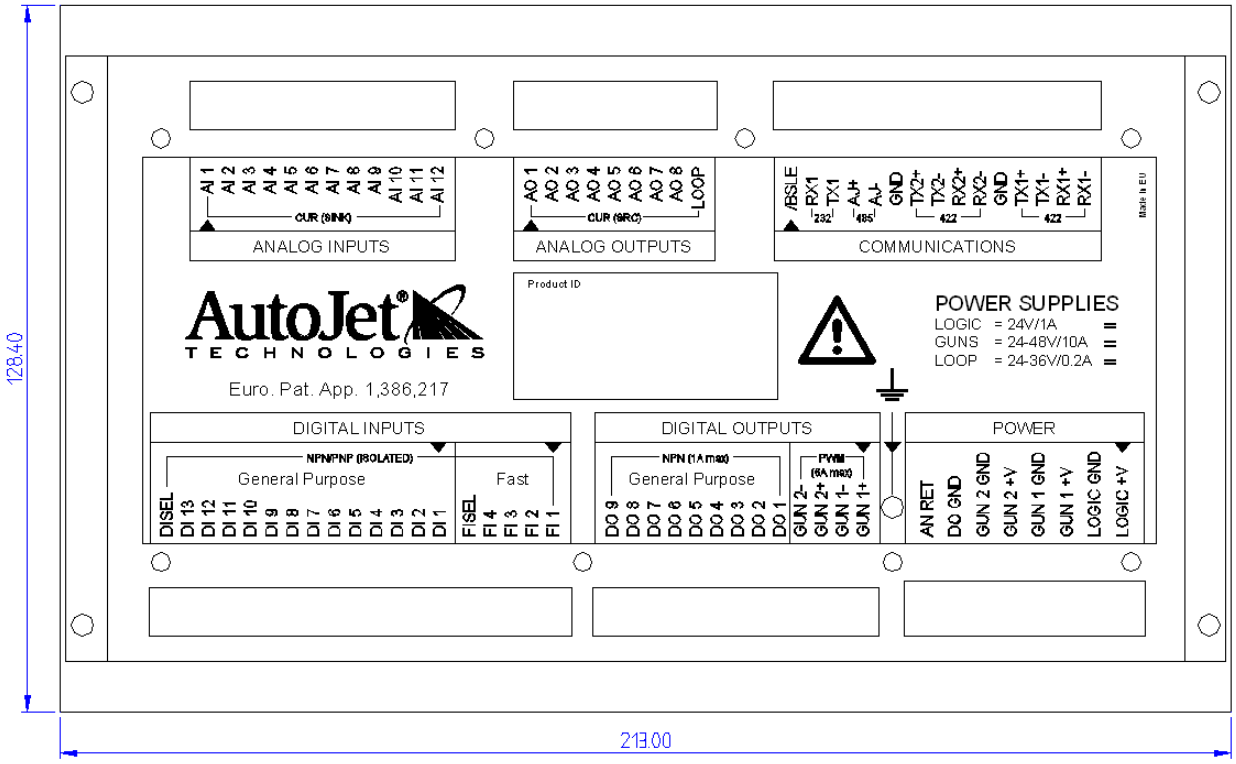


Figure 6 Rear view

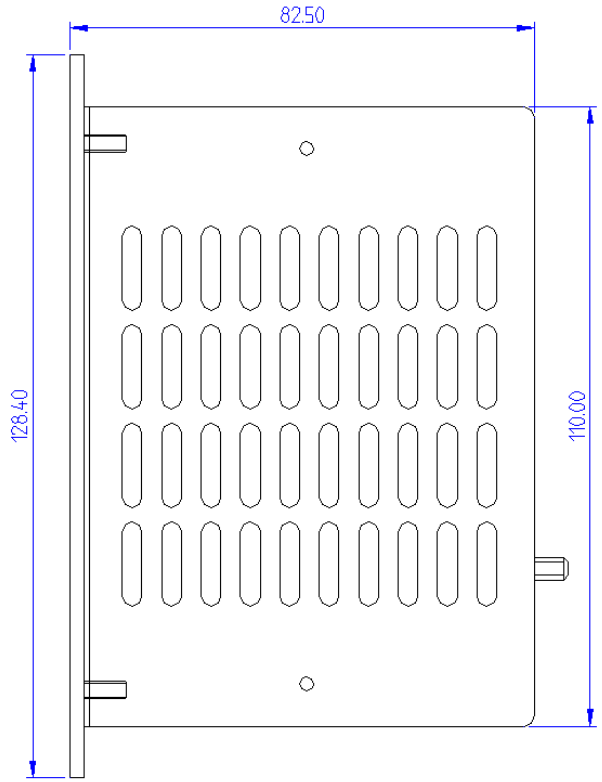


Figure 7 Side view (both sides)

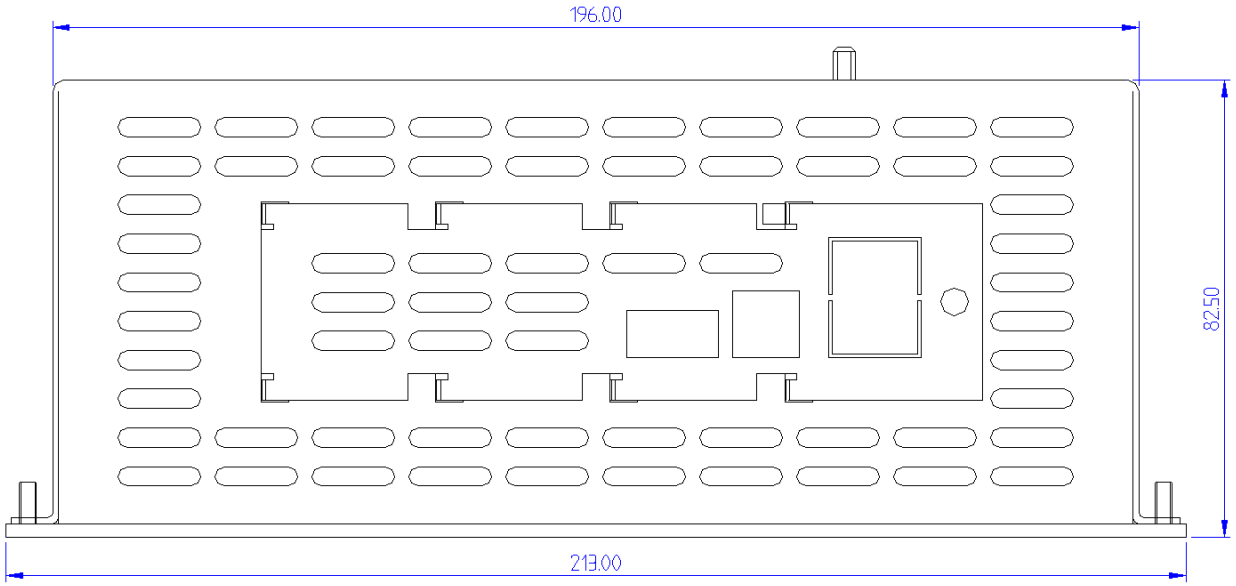


Figure 8 Bottom view (top is the same, but without insert panel)

FRONT SIDE & USER ELEMENTS

Notes:

6 FRONT SIDE & USER ELEMENTS

6.1 User interface

6.1.1 Front panel

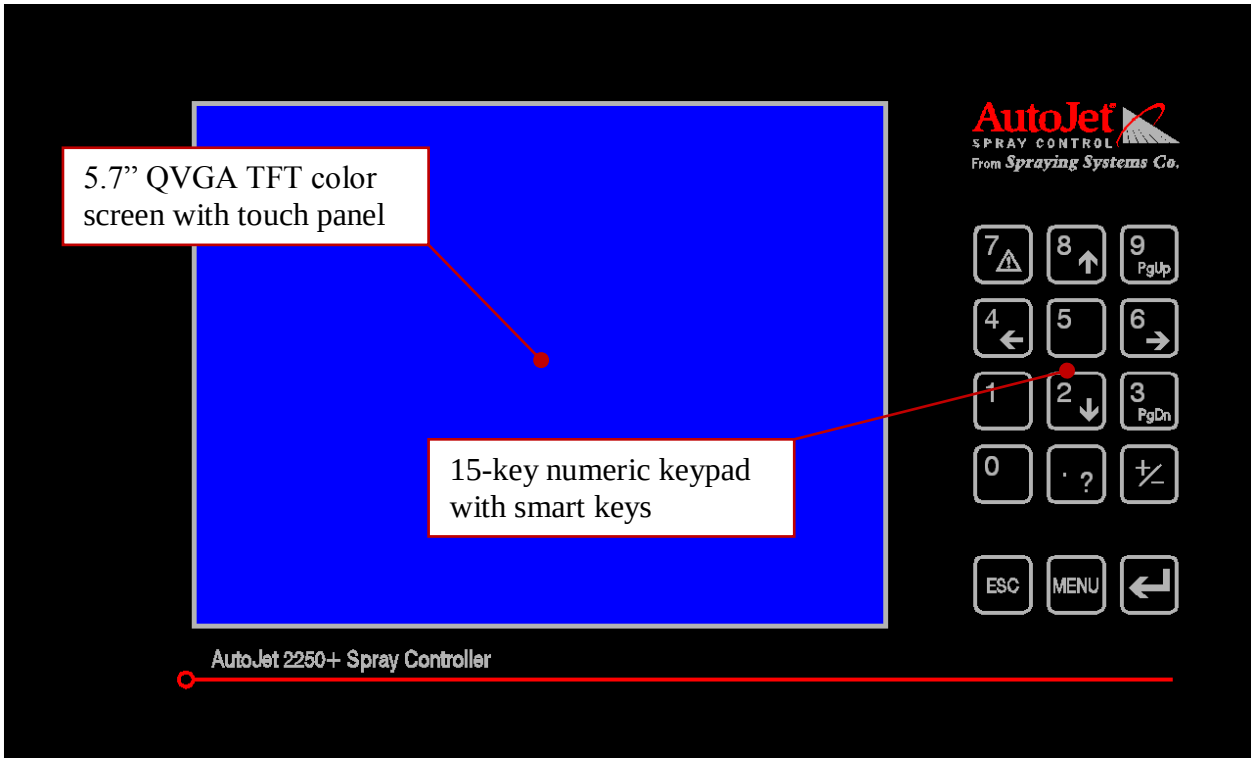


Figure 9 Front panel

6.1.2 Touch buttons and keys

Navigating through the menus can either be done directly with the touch buttons on the screen or via the keys (or combinations) of the keypad. Numeric values can only be entered with the keys of the keypad.

6.1.3 Quick key guide

In addition to its numeric function, the tactile keypad with smart keys can be used to perform the following tasks:

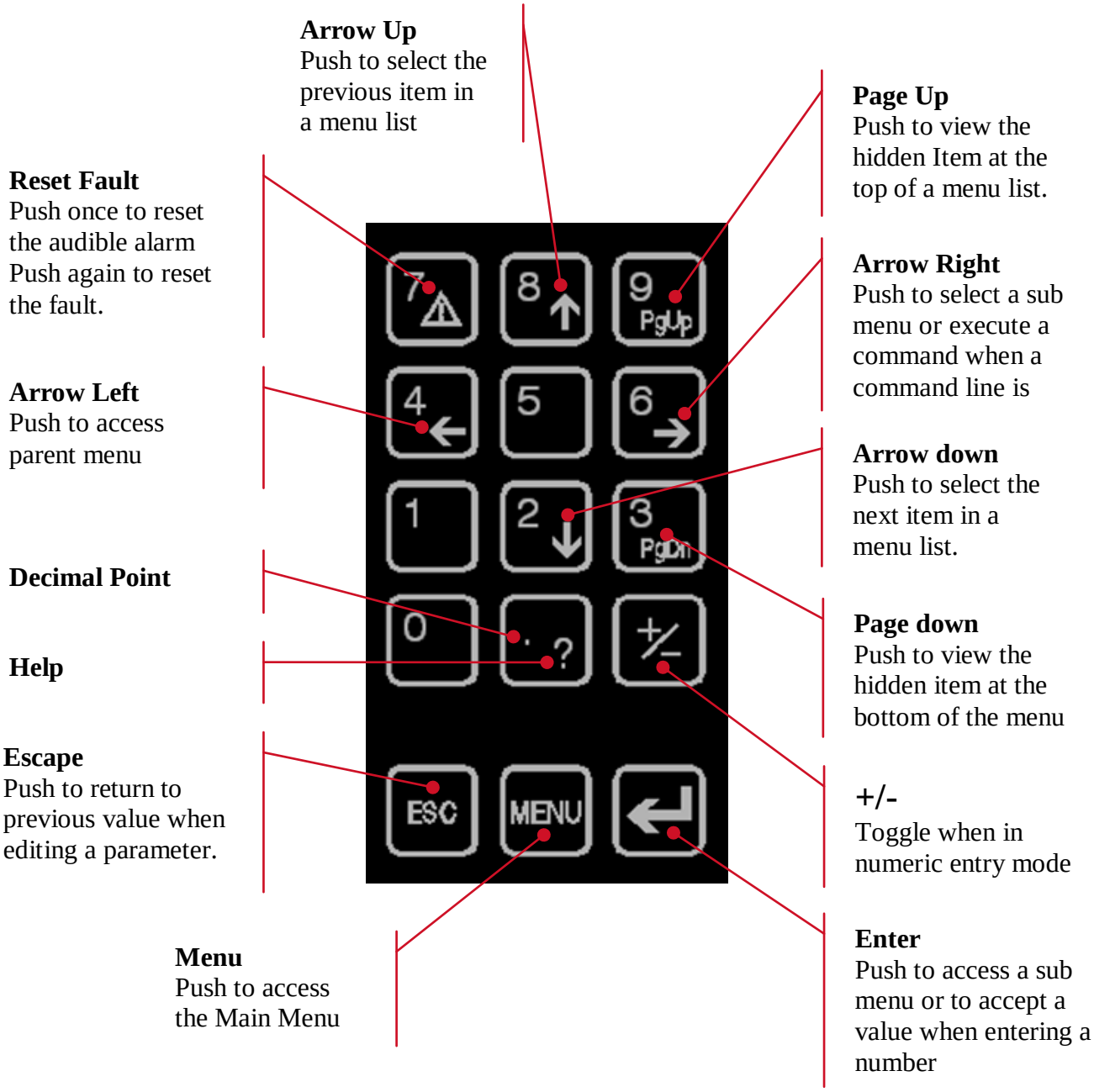
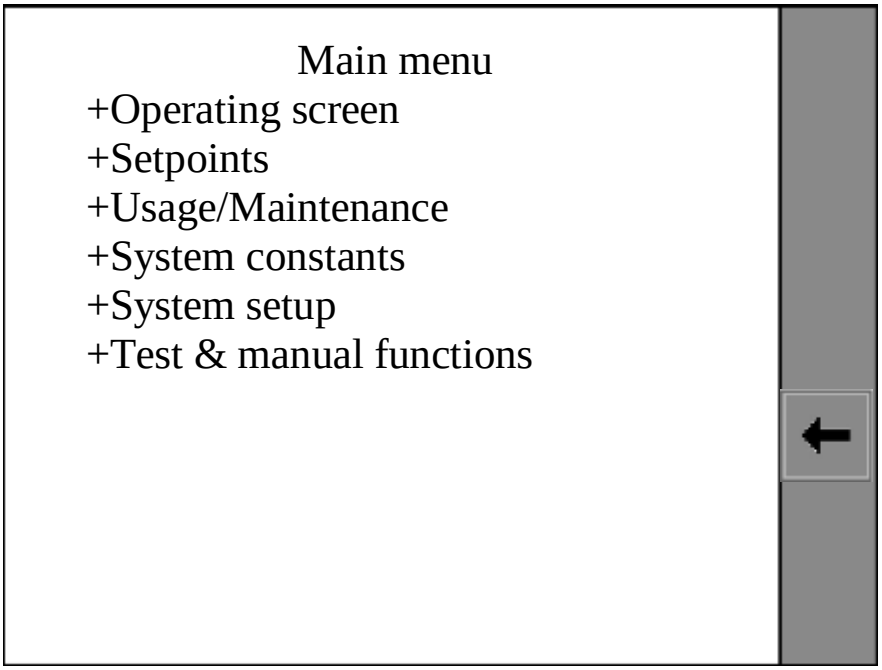


Figure 10 Keypad smart keys

Key(s)	*Function*
ESC	Return to previous value when editing a parameter (holding this key for at least 2 seconds makes the controller jump to the operating screen), or returns to the parent menu
MENU	Jump to the main menu
↵	Accept a value or enter a sub menu
· ?	Enter decimal point / Help
+/-	Toggle +/- when in numerical entry mode
0	Enter numerical value “0”
1	Enter numerical value “1”
2 ↓	Enter numerical value “2” / Move to the next line in the menu list
3 PgDn	Enter numerical value “3” / Move to the next page in the menu list
4 ←	Enter numerical value “4” / Return to the parent menu
5	Enter numerical value “5”
6 →	Enter numerical value “6” / Enter sub menu
7 ⚠	Enter numerical value “7” / First press = reset the audible alarm, second press = reset faults
8 ↑	Enter numerical value “8” / Back to the previous line in the menu
9 PgUp	Enter numerical value “9” / Back to the previous page in the menu
MENU 8 ↑	Quickly increase the value on the current line without going to numerical entry mode
MENU 2 ↓	Quickly increase the value on the current line without going to numerical entry mode
MENU 5	Indicates current software version and serial number as long as the key combination is pressed
MENU 4 ←	Sets the current parameter to its default value

Table 6 Quick key guide

6.1.4 Screen Symbols Guide



In a typical application program screen, there is a status bar on the right hand side of the display area where (system) status symbols and touch keys are displayed to guide the user through the user interface.

Figure 11 Example Main Menu screen

Symbol	*Function*
	*Touch Key:* use this key to go to the main **menu**.
	*Touch Key:* indicates that you can use the **page down** key to go to the next page in the menu list.
	*Touch Key:* indicates that you can use the **page up** key to go to the previous page in the menu list.
	*Touch Key:* indicates that you can jump to the parent menu by pressing the key **arrow left**.
	*Touch Key:* indicates that you can enter a sub menu by pressing the key **arrow right**.
	*System Status symbol:* indicates that the system is working in **manual mode**. This is a test mode to control the outputs manually while the automatic program is disabled.
	*System Status symbol:* the system is in **RUN** mode but gun no.1 is not spraying. When no symbol is shown then the system is in **stand-by.**
	*System Status symbol:* the system is in **RUN** mode and the gun no.1 is **spraying**.

Enter number and ↵ orESC	*Status:* indicates that you can enter a decimal number with the keypad (numerical entry mode).

Table 7 Status bar symbols guide

6.2 Start-up screen

Figure 12 Start-up screen

6.3 Configuration and test screens

When the key combination ESC + MENU, or the touch button 

on the screen is pressed at start-up (before the application is loaded), the BIOS is entered.

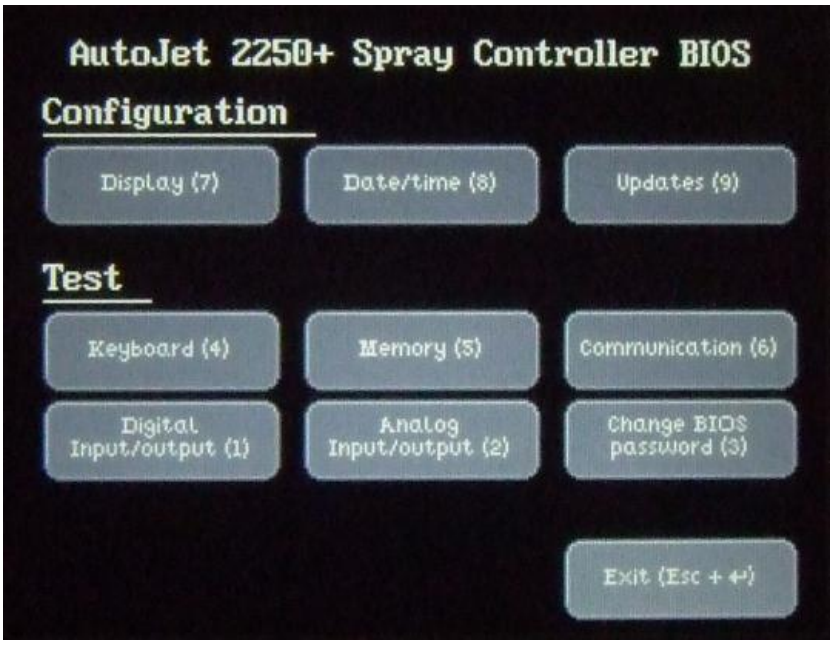


Figure 13 Configuration and test screen (note 2)

Notes:

1. The keypad can also be used to enter submenus (key and key-combinations stated between parentheses)
2. BIOS screens are subject to changes without prior notice; extra tabs or screens may be added in future firmware versions for i.e. setting passwords, configuring start-up behavior, etc.

6.3.1 Display screens

In this screen, the display backlight intensity for non-entry mode is set and the touch panel can be calibrated.

Figure 14 Display configuration screen

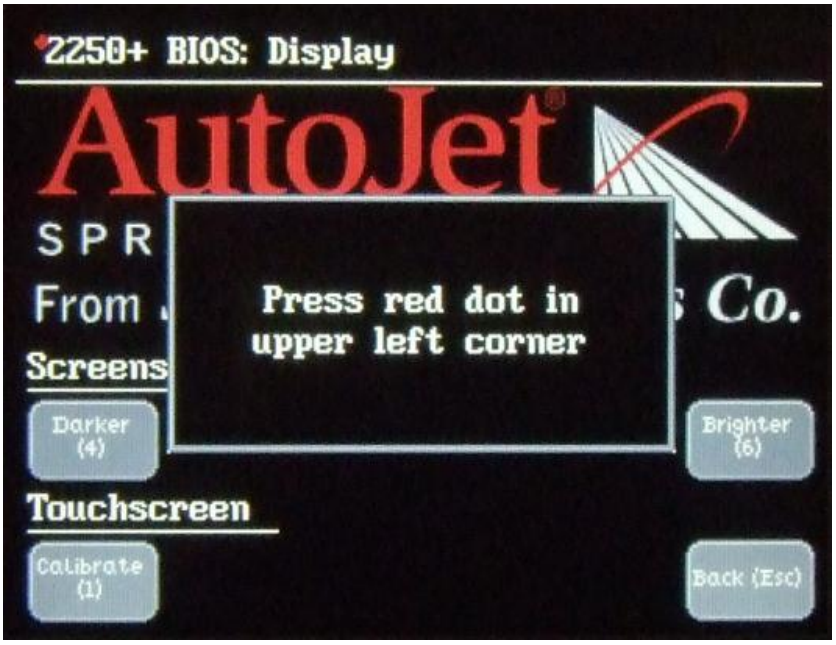


Figure 15 Touch screen calibration screen 1

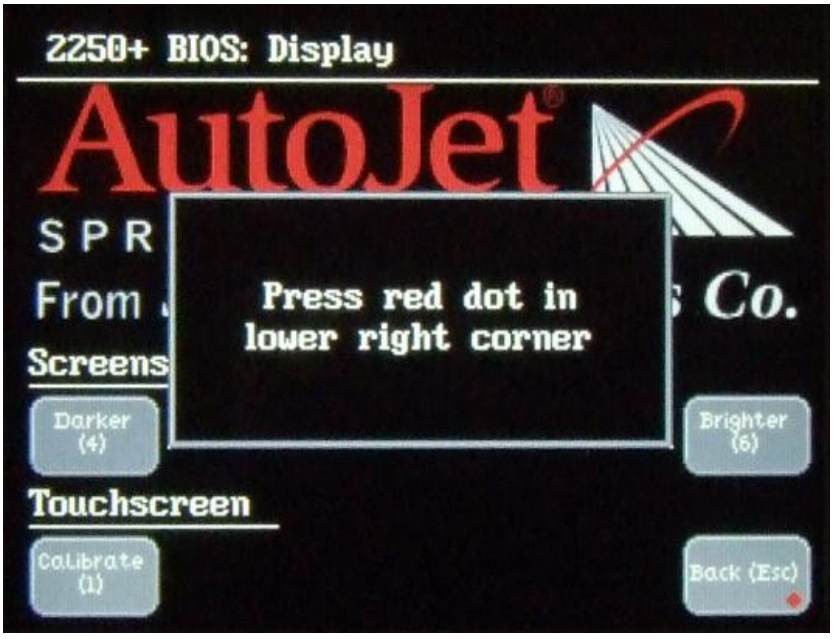


Figure 16 Touch screen calibration screen 2

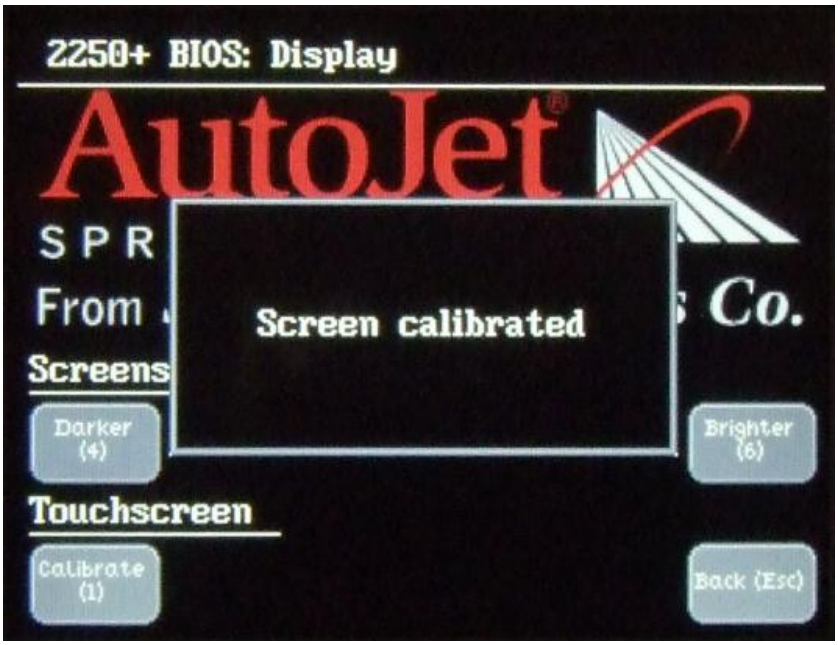


Figure 17 Touch screen calibration screen 3

6.3.2 Date/time screen

In this screen, the back-up battery condition can be monitored. Date and time is set in the application software.

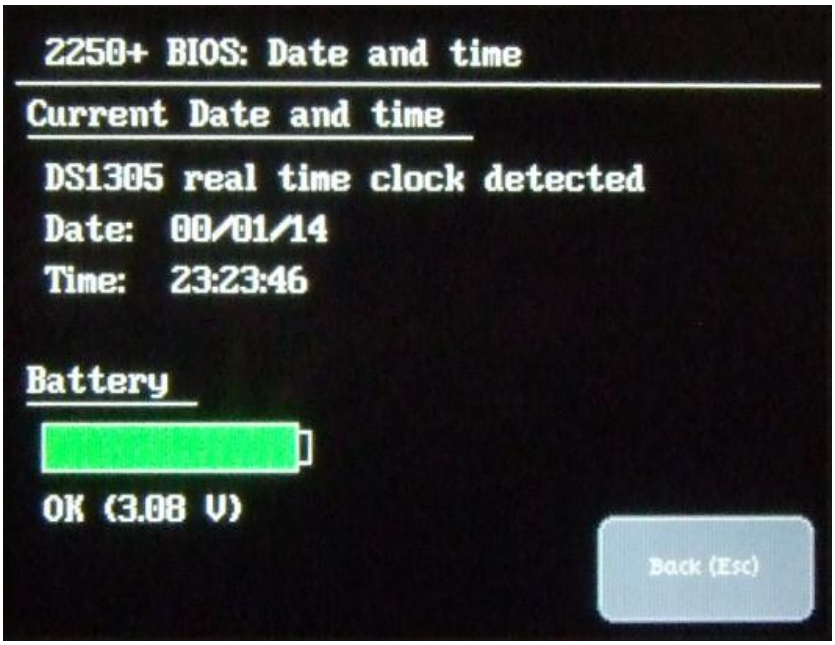


Figure 18 Date and time screen

6.3.3 Updates screens

In this menu, all current firmware versions are shown. Here from, the Gun driver firmware can be updated from PC through the AutoJet Firmware Programming Tool.

Figure 19 Updates screen

Figure 20 Gun driver details

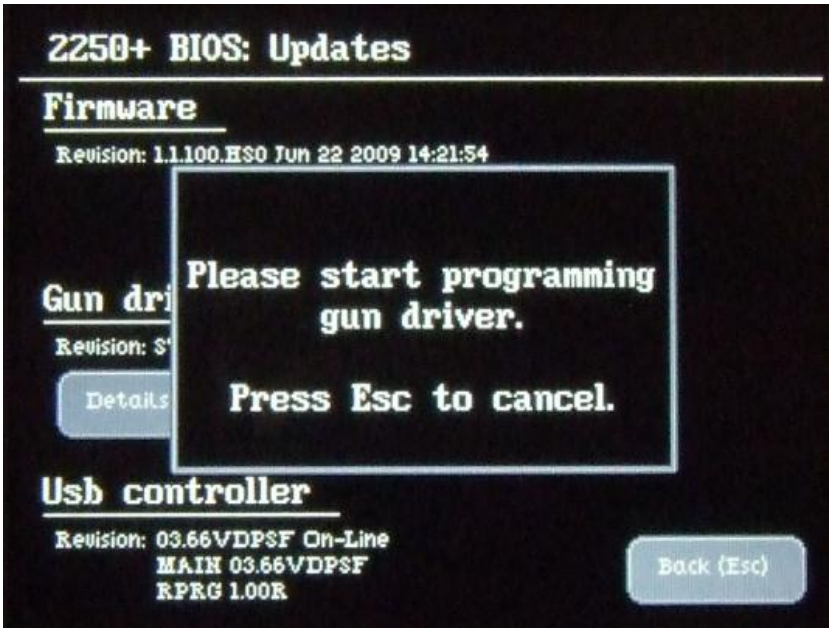


Figure 21 Update from PC

6.3.4 Keyboard screen

In this screen, the keypad can be tested.

Figure 22 Keyboard test screen

6.3.5 Memory screens

From this screen, the internal memory can be tested and the current application software can be, after entering a password, erased.

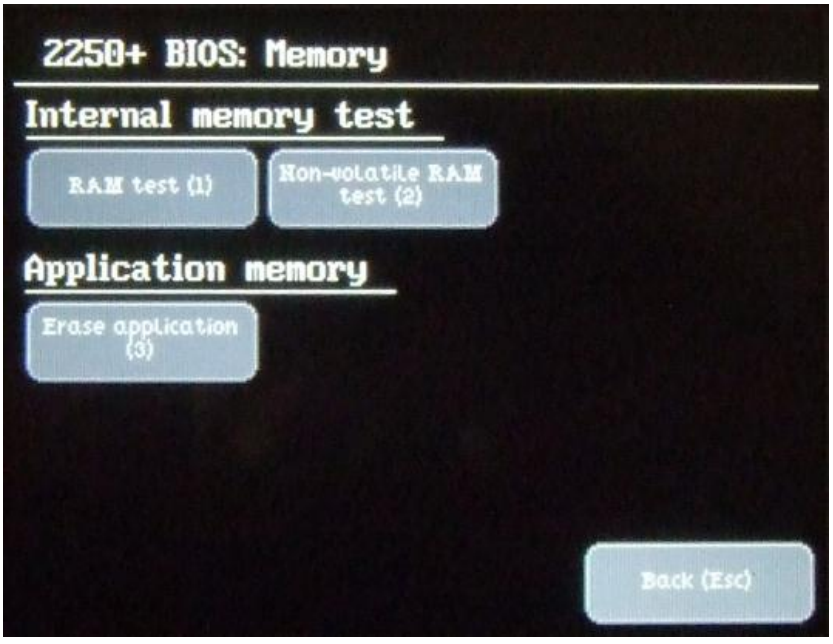


Figure 23 Memory test screen

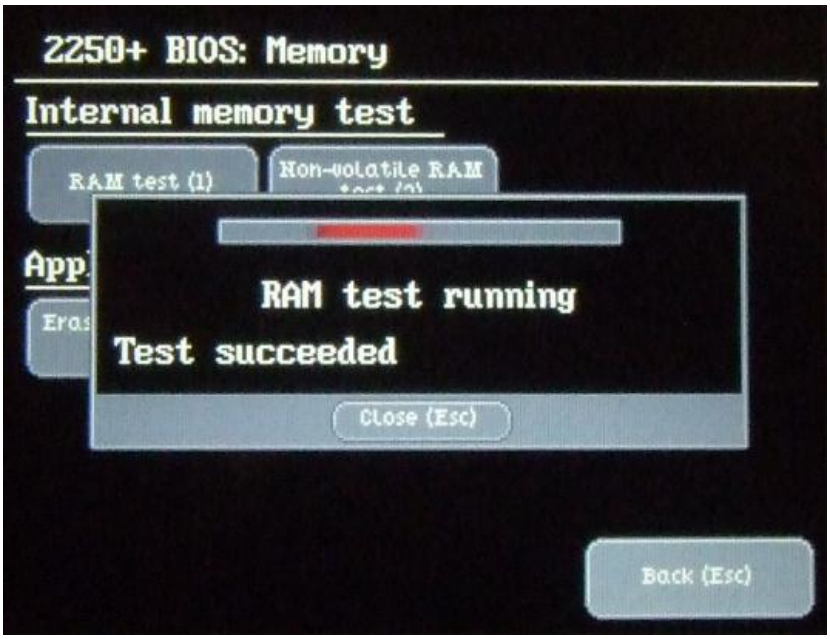


Figure 24 RAM test screen

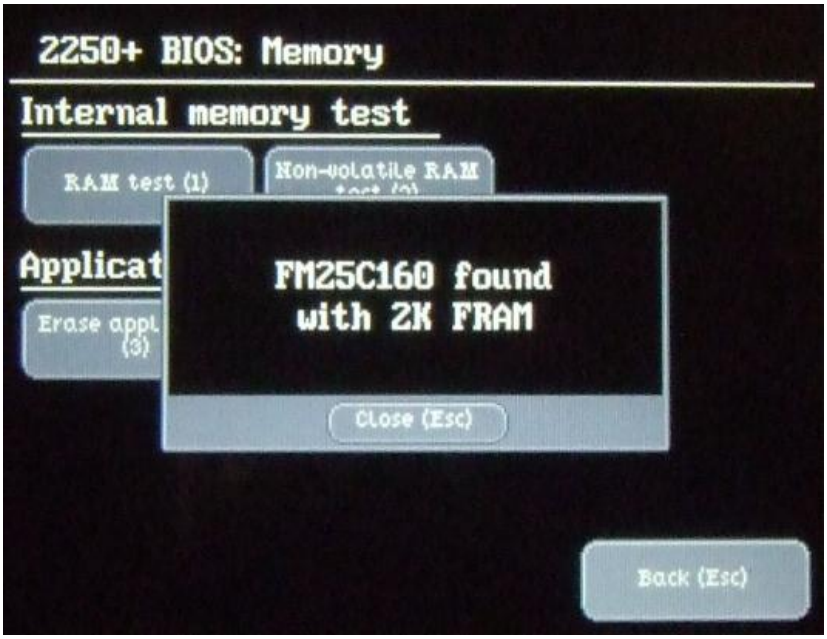


Figure 25 Non-volatile RAM test screen

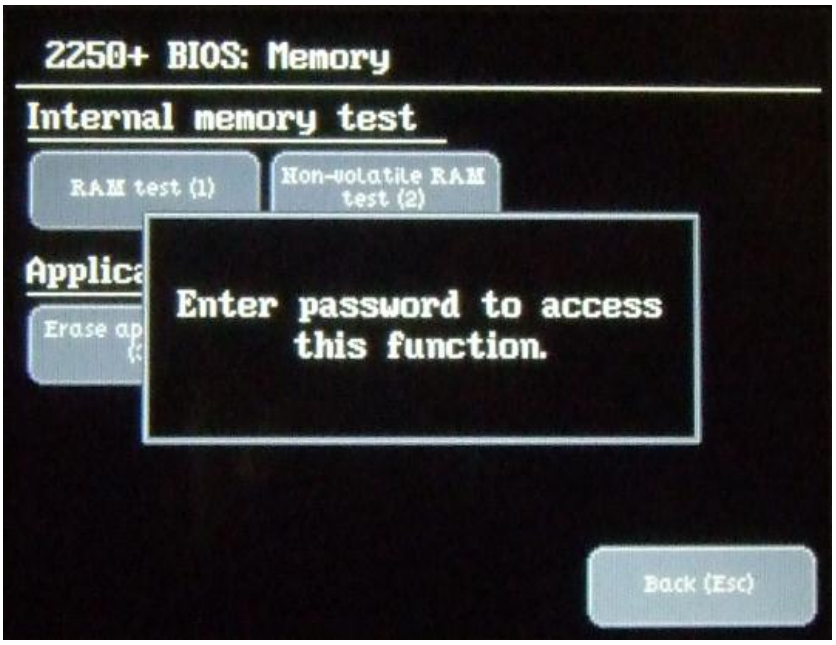


Figure 26 Erase application screen

6.3.6 Communication screens

From this menu, the serial ports can be tested (with a loop-back test connector). Presence of other communication channels is shown.

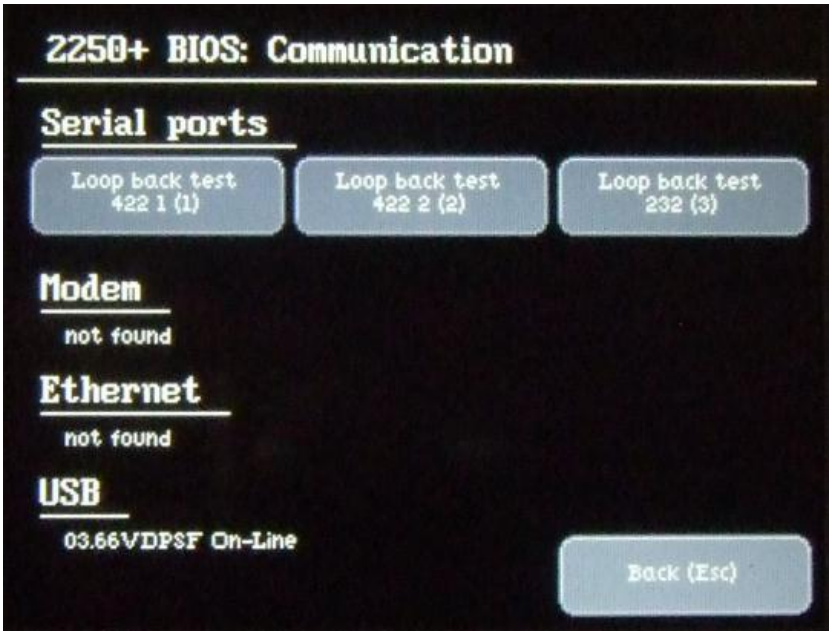


Figure 27 Communication test screen

Wire bridges loop-back test connector:

- 232: RX1 to TX1
- 422: RX1- to TX1-, RX1+ to TX1+
- 422: RX2- to TX2-, RX2+ to TX2+

Remark: 485 AJ-BUS cannot be tested

6.3.7 Digital I/O screens

In this screen, the status of the digital inputs can be monitored; as well can the digital outputs be set after a password is (or was previously) entered.

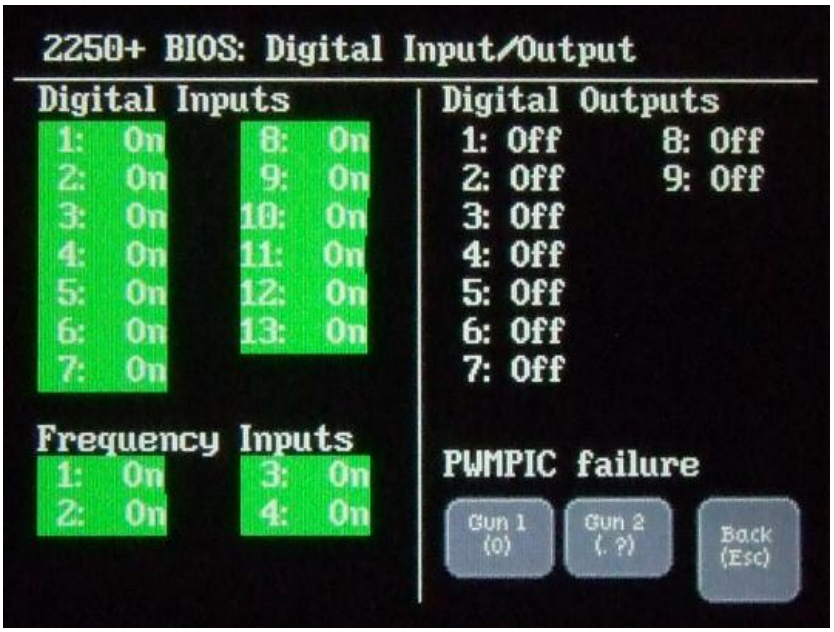


Figure 28 Digital I/O test screen – DI monitoring

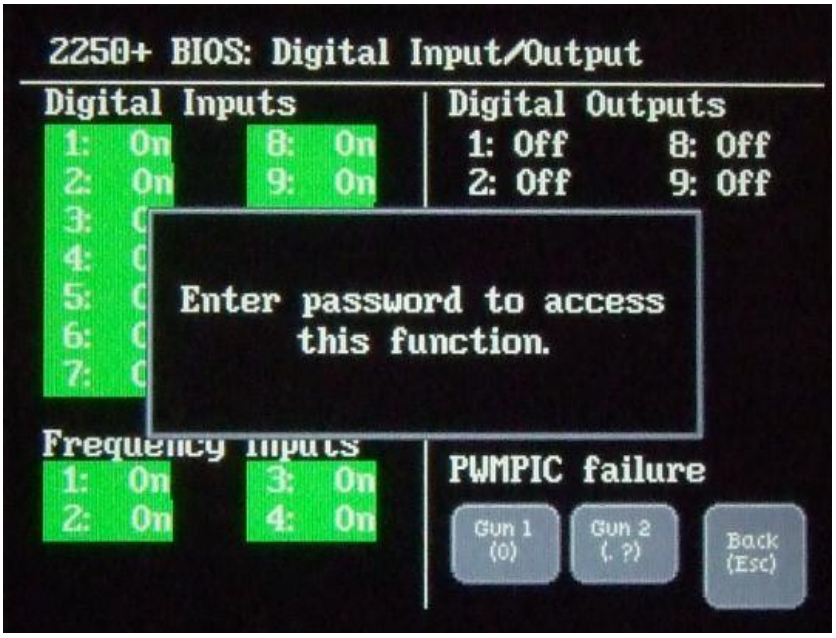


Figure 29 Digital I/O test screen – enter password

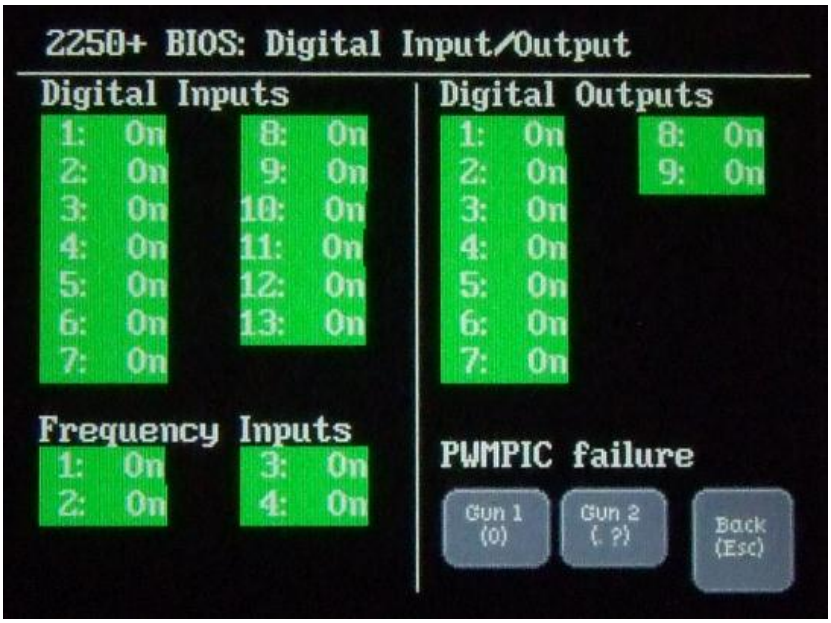


Figure 30 Digital I/O test screen – outputs

The outputs can be set by either pressing the corresponding numerical key or by touching the number on the screen.

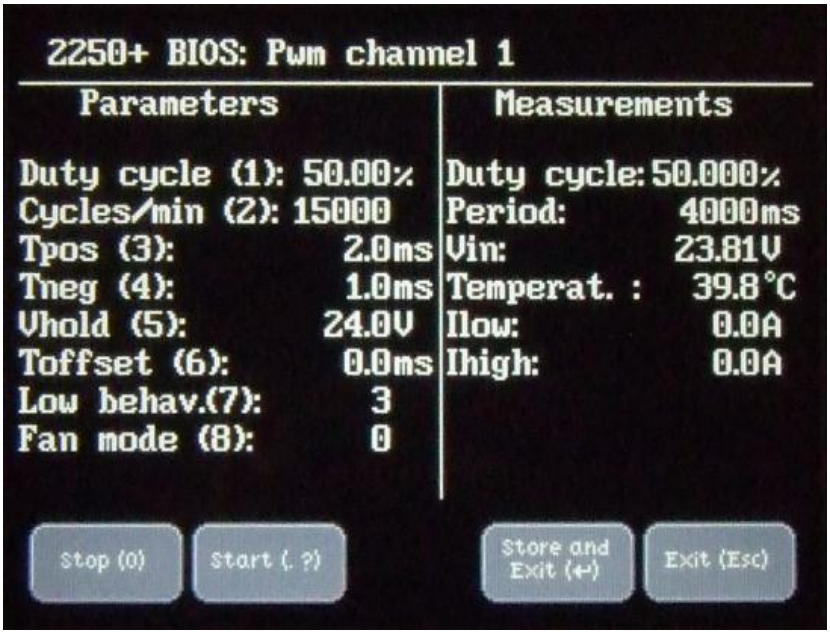


Figure 31 Digital I/O test screen – Gun 1 parameters

The Gun parameters can be set by pressing the corresponding numerical key (shown between parentheses) and then enter the value with the keypad.

Through this BIOS screen, the driver signal can hence be optimized for the gun used in a particular application for which software is written with SprayLogic (cfr. backward compatibility). With SprayLogic.net, one will be able to set these parameters through the application program.

The parameters with corresponding key numbers 1 to 5 are directly related to the generated waveform as described in chapter **Error! Reference source not found.**.

The parameters with corresponding key numbers 6 to 8 have following meaning:

- Toffset (6): corrects the difference in the opening and closing time of an electrical gun. The default value is 0.0 ms.
- Low behav.(7): determines the way striping/sprayed quantity is handled – see graph below.

.

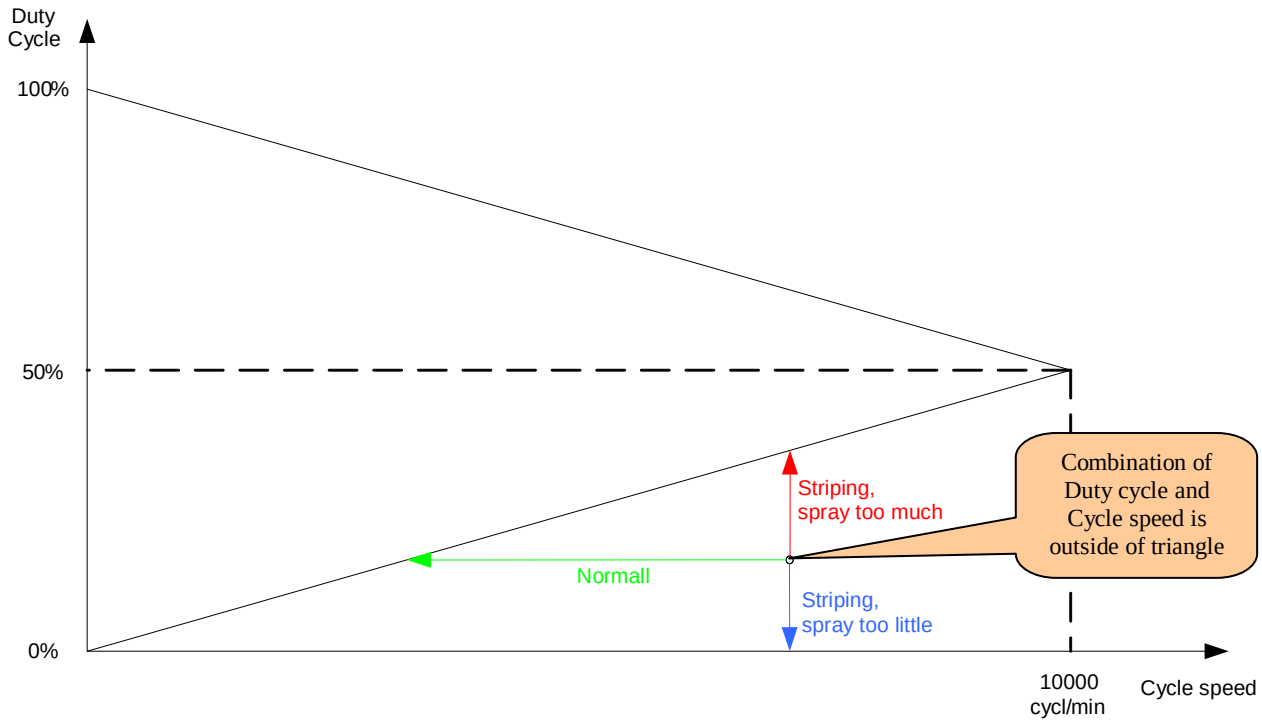


Figure 32 triangle graph of a gun

Settings:

- 1: *normal* → duty cycle stays the same, but cycle speed is reduced to get the working point inside the triangle.
- 2: *no striping spray too much* → cycle speed stays the same, but duty cycle is increased to get the working point inside the triangle.
- 3: *no striping, spray too little* → gun stops spraying.

- Fan mode (8): this is only for testing purposes and is common to both PWM channels. Settings are:
  - 0: automatic fan control (default value after reset)
  - 1: fan ON
  - 2: fan OFF

6.3.8 Analog I/O screens

In this screen, the status of the analog inputs can be monitored; as well can the analog outputs be set after a password is (or was previously) entered.

Figure 33 Analog I/O test screen – AI monitoring

Figure 34 Analog I/O test screen – outputs set

The outputs can be set by either pressing the corresponding numerical key and then enter the value with the keypad or by touching the screen at the vertical line, at the height of the channel number, and then drag the bar towards the right hand side and back (preferable by touch pen).

INSTALLATION GUIDELINES

Notes:

7 INSTALLATION GUIDELINES

7.1 General

Hereafter, an example of wiring and cabling is given with some explanations which covers some possible critical issues with regard to safety, functionality and EMC. Thermal considerations are also addressed.

7.2 Basic wiring

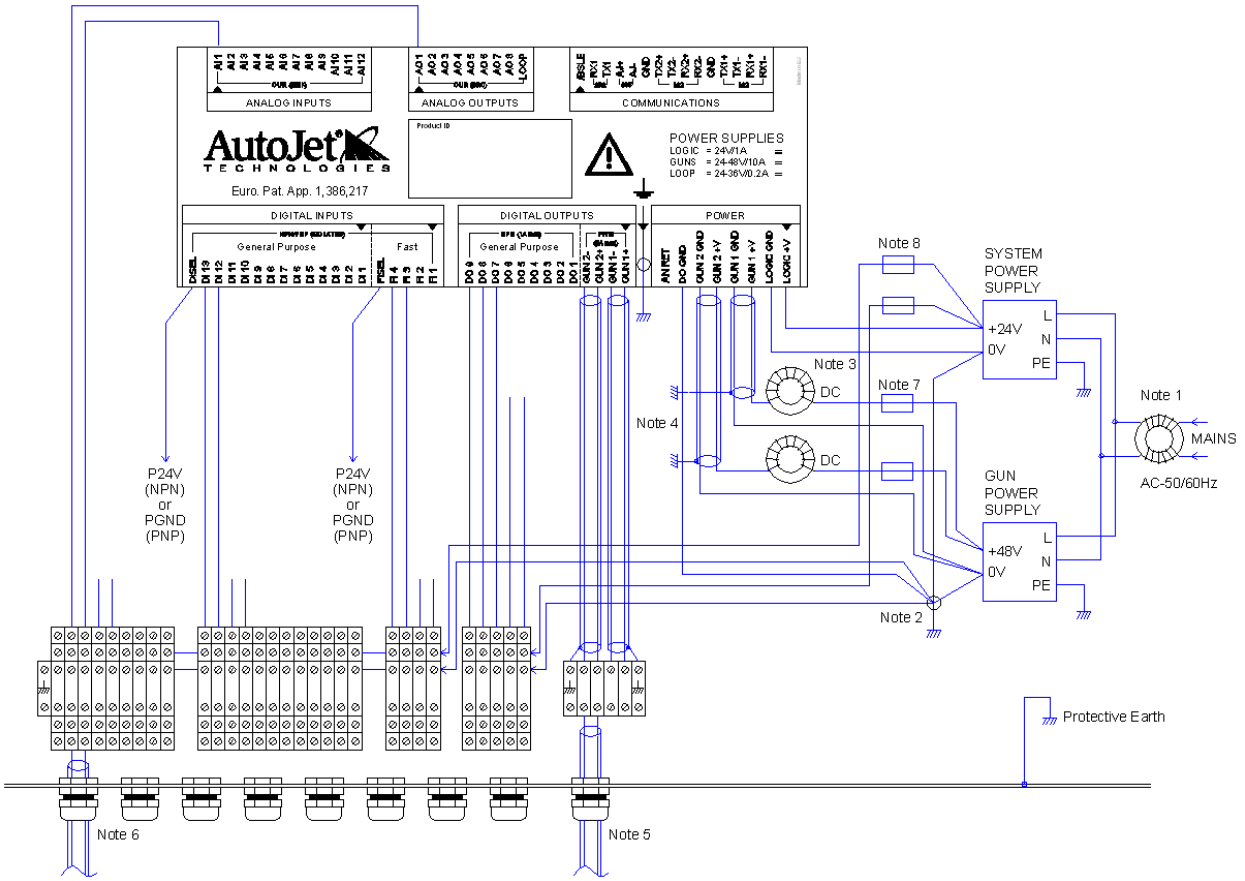


Figure 35 basic wiring example

Note 1:

Depending on the type and brand of used power supplies, it might be necessary to place a common-mode filter at the mains power input in order to comply with the EMC directives. Tests have shown that some switch-mode power supplies, even though they carry the CE mark, still generate disturbances on the mains power lines (conducted emission).

Note 2:

Always provide a “ground star point” at the “Gun power supply” (or as close as possible) in order not to have power return currents flowing through signal return wires. Use separate ground return wires for individual PWM channels, power I/O terminal blocks, signal I/O terminal blocks, digital outputs common ground and connection to the ground

of the system power supply. Provide a connection to the Protective Earth (PE) at this point.

Note 3:

When using the controller to drive electric guns or other inductive loads with PWM, and certainly with high-frequency chopping in the enhanced gun driving mode, a lot of spikes appear evidently on the signal lines but also the power lines, so it might be necessary to provide extra EMI filters at the used GUN power supply inputs. These filters must be suitable for DC use – either differential or common-mode, but in latter case, care must be taken that due to the filter part in the GND line, the proper performance of the output drivers is not disturbed under dynamic conditions.

Note 4:

Following the above note, the GUN driver lines are preferably screened in order not to induce spikes in adjacently routed wires in the cable trunks. Connect the screen to the protective earth (PE) at least at one side. When the in note 3 mentioned filters cannot be mounted directly next to the controller, also use screened power wires between the controller's valve power inputs and the filters.

Note 5:

It is necessary to use shielded cables to connect the guns, or a possible header, with. Connect cable shields directly to the enclosure bottom plate and header with an as short as possible wire, or preferably use EMC cable glands which is by far the best solution for grounding screens.

Note 6:

Special care must be taken with signal lines that are longer than 30m (i.e. in case of exchanging signals with other machinery or systems); these should be protected at the control cabinet entrance by means of EMI filters and surge arrestors.

Notes 7, 8:

Keep the wiring between the controller and the power supplies as short as possible (<3m).

The power supply line to the LOGIC power input must only be fused in case of working with a 24Vdc power supply that can deliver more than 240W (max. current that the power connector of the 2250+ can carry is 12A). In a system where the enhanced gun driving method with 48V is used, the 24V power supply may likely be rated to < 240W where the 48V power supply can be a 960W type.

The power supply lines to the GUNx +V terminals must individually be protected by a 10Amp fast reacting glass fuse.

The power supply lines to the connection terminal blocks must also adequately be protected by glass fuses or preferably by DC electronic circuit breakers like for instance the ESX10-T series from E-T-A (i.e. ESX10-TA100-DC24V-10A for 10A version).

Circuit breaking values depend on used wire sections. Note that the wires going to the fuses or circuit breakers must be able to carry the short-circuit current of the used power supply and will hence inherently be bigger than the wires leaving the fuses towards the powered components (see wire sizes for power distribution in section 7.3.1).

General Notes:

- To comply with the EMC and Machinery directives, guard for an equipotential design of the electric cabinet and safety issues according to the 60204-1 standard (beyond the scope of this manual; consult the relevant standards).
- Concerning the layout of the electric cabinet, try to group different types of I/O and wire them physically away from each other. This way you can prevent that signal lines are routed directly next to power lines.

CAUTION:

In order to prevent damage to the controller and/or wiring, take the following into account **before switching the power on!**

- **Make sure that the 48Vdc power supply is NOT wired to the I/O terminal blocks!**

  In case 48Vdc is needed for external 2008 modules, provide a separate terminal block which is clearly marked so that none of the control I/O lines can be abusively connected to this high voltage.

- **Guard carefully the polarity of the power lines wired to the GUN + and GUN GND terminals.**
- **Make sure that, in case of working with different power supplies, their negative terminals (GND) are properly connected to the dedicated ground terminals.**
- **Check the wiring of the DO outputs: no power line (+24V or 0V) must be directly connected to either one of those.**

  In a situation that a current could inversely flow from the GND terminal to a DO-output, the respective internal driver chip could blow.

7.3 Wires & cables

7.3.1 Internal wiring:

- Use 0.25mm^2 (24AWG) or 0.34mm^2 (22AWG) for signal wiring (Analog I/O, Digital Inputs, Communication, etc.)
- Sizes for power distribution (24V and GND) and power driver lines (Digital Outputs, PWM outputs, etc.) depend on the I^2t rating of the wires, ambient temperature, length of the wires, bundled or not, etc, but in general, following "safe" values can be used :
  - 0.50mm^2 (20AWG) for currents up to 5 Amps
  - 0.75mm^2 (18AWG) for currents up to 6.5 Amps
  - 1.00mm^2 (16AWG) for currents up to 7.5 Amps
  - 1.50mm^2 (14AWG) for currents up to 10 Amps
- Use bootlace ferrules for stranded conductors, or connectors which can handle them (i.e. spring-clamp contacts)

7.3.2 External cabling:

- Refer to above summarized wire sizes for conductor dimensions
- Avoid "pig-tails" when providing extra cable lengths at sensors and actuators for servicing purposes. A "pig-tail" is formed when the wire or cable is wound up like a solenoid; creating an inductor which on its turn becomes an antenna for Radiated Frequencies (even with shielded cables)! "Back-and-forth" folding is recommended.

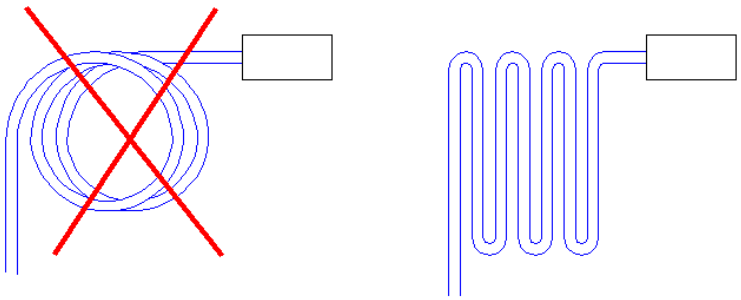


Figure 36 "pig-tail" winding versus "back-and-forth" folding

7.4 Mechanical

7.4.1 Cut-out dimensions

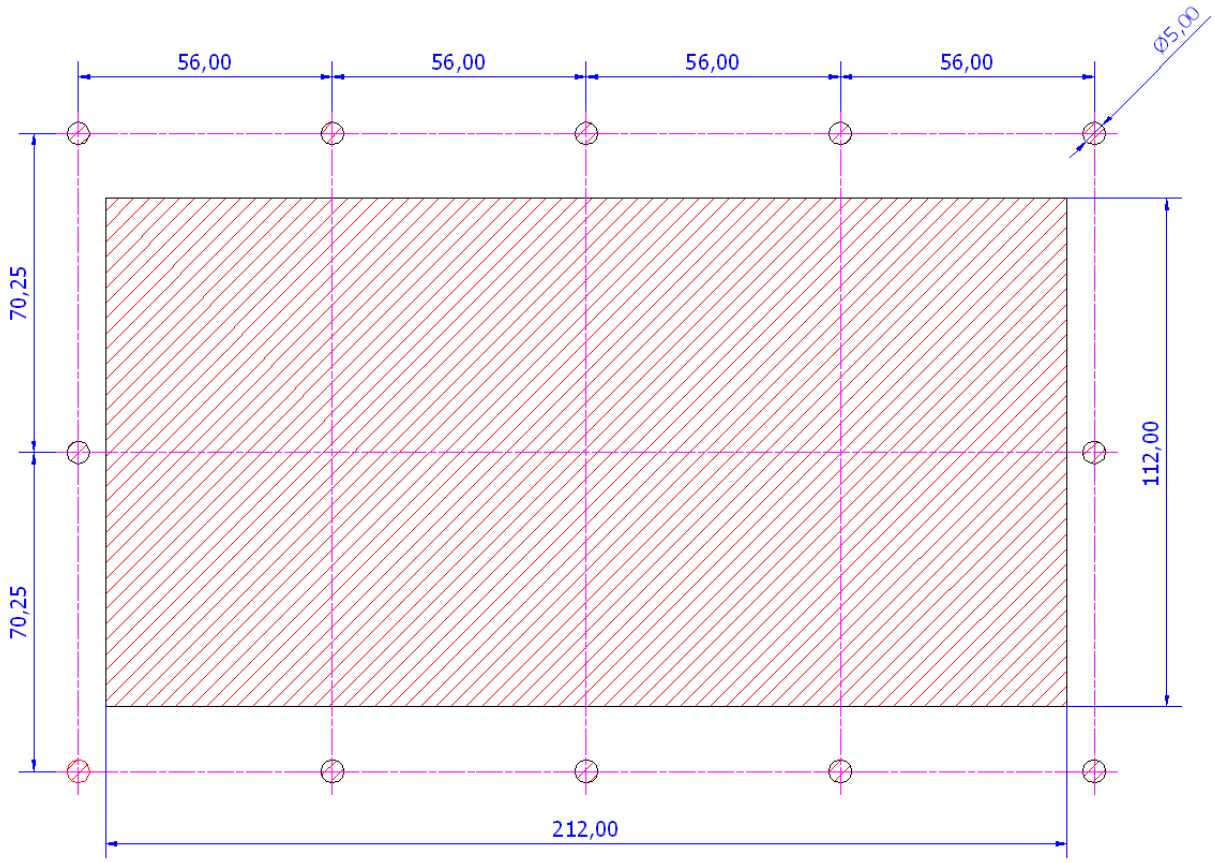


Figure 37 Cut-out dimensions

Above cut-out diagram is used for mounting with the standard AutoJet 2250 bezels.

7.4.2 Keep-out areas

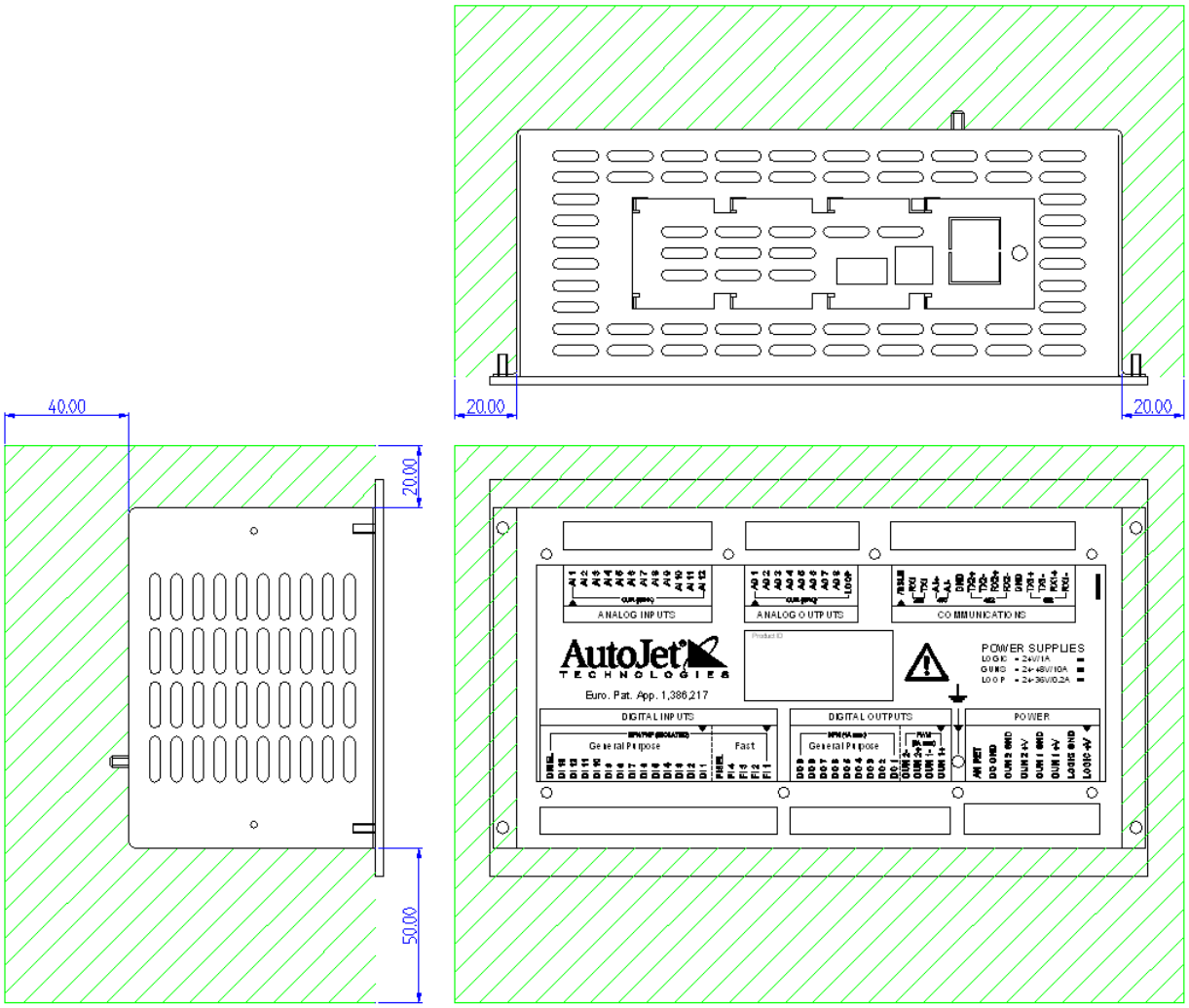


Figure 38 Keep-out areas

The green colored hatches areas in figure above must be kept free for cabling and cooling purposes.

7.5 Thermal considerations

7.5.1 General

When driving guns at higher voltages where a hold voltage/current is generated by means of chopping the signal, switching losses become significant making thermal management a very important issue. Depending on various parameters as size of the cabinet, the layout, internal power consumption, environmental temperature, requested protection degree and even the type of cabinet material, different cooling methods may be considered such as fan-filter combination, air conditioning, vortex-cooler, etc.
Very important to be aware of is that in closed boxes, and certainly small ones, heat can easily remain static and accumulate to levels way above the specified limits of certain devices, making the system unreliable.

7.5.2 The 2250+ in AutoJet systems

The backward compatible 2250+ can certainly directly replace the 2250 in existing systems and controls. In case of future software upgrades where the holding current/voltage feature is used, even at the normal working voltage of 24Vdc, one must check whether the temperature in the control cabinet remains at a safe level.

Tests has been performed on an existing Spray Cart control cabinet equipped with a 2250+ and in this case, no extra cooling was needed with the holding voltage/current feature in use, even with two GUN channels at full load. Only one GUN channel can be used though at an environmental temperature of 35ºC when powered with 48Vdc.

A 2250+ cabinet can be subjected to severe negative temperatures by mounting a protection window/door above the controller, insulate the cabinet and provide heating inside for regulating the internal temperature to a level that is sufficient for keeping the temperature at the controller window to a min of -10ºC but yet not too high for the normal operating temperature of the controller. For example, a 2250+ controller mounted in a Spray Cart cabinet can be put in an environment of -40ºC when a protection window/door is mounted above the controller, the box is insulated with 2cm PU and the temperature inside the cabinet is held at approx. 30ºC by means of dissipating 40 to 50W inside.

APPENDICES

Notes:

8 APPENDICES

8.1 TERMINOLOGY & ACRONYMS

P/N	Product Number
S/N	Serial Number
AC	Alternating Current
DC	Direct Current
NPN	Control logic - switches to the "ground" of the DC power supply
PNP	Control logic - switches to the "plus" of the DC power supply
PPE	Personal Protective Equipment
MSDS	Material Safety Data Sheets
WEEE	Waste of Electronic and Electronic Equipment
RoHS	Restriction of Hazardous Substances
TDC	Technical Documentation set for Customer
P&ID	Piping & Instrumentation Diagram
BIOS	Basic Input Output System
Wired-OR	ORring several PNP or NPN outputs by connecting them together
RAM	Random Access Memory
FRAM	Ferro electric RAM
RTC	Real Time Clock

8.2 PARTS LIST

8.2.1 Controller

The lower-case "x" in part ID's below denotes that at these positions, characters relevant to specific models or versions will be in place.

- *Controller:*
  - CP-CTxxT2050-Px: Standard Model 2250+ Spray Controller with application software (consult factory for available models and versions)
    - OR -
- *Manuals:*
  - ML00CTNAT2250E2-Rxx: this hardware manual
  - ML00CTxxT2250-x-Rxx: software manual per version

8.2.2 Connectors

- Use following Phoenix socket terminal blocks (or variant from the same series with the same approvals):
  - MCVW 1.5/xx-G-3.81 for I/O ("xx": 12, 9, 14, 5, 13)
  - MCVW 1.5/15-G-3.81 for COMMUNICATIONS
  - MVSTBR 2.5/8-ST-5.08 for POWER

8.2.3 Available options

- *Communication:*
  - CP-LECMS0001-00: 2250 programming cable
  - CP-LECMS0002-00: 2250 communication cable - RS232 (PC)
  - CP-LECMS0002-01: 2250 communication cable - RS232 (MODEM)
  - CP-LECMS0003-00: 2250 OPC communication cable - RS422 <=> USB
  - CP-LECMS0003-01: 2250 OPC communication cable - RS422 <=> RS232
  - CP-LECMS0006-00: 2250 Modem communication link
  - CP-LECMS0007-00: 2250 Ethernet communication link
  - CP-LECMS0008-00: 2250 Anybus Communicator link, Ethernet/IP & Modbus TCP, 2m
  - CP-LECMS0009-00: 2250 Anybus Communicator link, Profibus, 2m
  - CP-LEPWS0001-00: 2250 power cable
  - CP-LENAT2250-00: 2250 extension cable set

- *Bezels:*

  - HOPCBT2250BZxxx: (consult factory for available models)

8.3 TROUBLESHOOTING

8.3.1 General

A troubleshooting guide should be applied with the application where this controller is used in.

However, on controller level, following steps can be taken in case functional failure is expected:

- Check all power supplies at the POWER connector.
- Check the internal fuse.
- With the BIOS test screens (refer to 6.3), check the status of the different I/O.

8.3.2 Faults list

Fault messages depend on the loaded application software and are therefore out of the scope of this instruction manual.

8.3.3 Replacing battery

When the battery is empty, replace it with a CR1216 or compatible model – make sure it complies with the local safety regulations (i.e. UL mark).

Procedure:

1. Remove the bottom lid (with the USB ports) from the back-cover by removing the screw and shifting the lid into the direction of the screw until it can be removed.
2. Remove battery with the help of a small screwdriver and dispose of it properly.
3. Place new battery (+ terminal on top).
4. Position the bottom lid again into the housing, shift it into the opposite direction of 1) and fix it with the screw.

Go to the BIOS date/time screen (see chapter 6.3.2) to check the battery level.

WARNING:
Battery may explode if mistreated. Do not recharge, disassemble or dispose of in fire.

8.4 MAINTENANCE

8.4.1 General directions

No specific maintenance is required.

8.4.2 Periodic maintenance & cleaning

The front keyboard can be cleaned with non-aggressive cleaning agents like i.e. isopropyl alcohol.

8.5 TRANSPORTATION & STORAGE

8.5.1 Transportation

To avoid damage, the controller must be transported in its original package.

8.5.2 Storage

To avoid corrosion, the controller must be stored in its original package, best in a dry place.

8.6 END-OF-LIFE

Refer to the national law transposing the WEEE directive and/or contractual agreements. Consult local sales office for further inquiries.