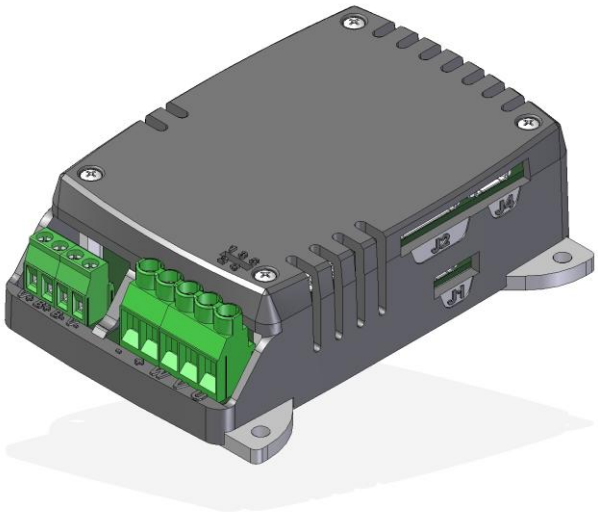
SMARTRIS COMPACT USER GUIDE



Rel.	Date	Description
1.0	24/01/2024	User Guide for COMPACT Smartris Drive - first release - DRAFT
1.0a	03/07/2024	User Guide for COMPACT Smartris Drive - Errata corrige in SinCos cable
1.1	11/11/2024	User Guide for COMPACT Smartris Drive – Updated STO Safety validation
1.2	16/05/2025	Upgrade for new FW 2.4.2

Release 1.2
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This User Guide refers to FW 2.4.2

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Tables and Figures:

REFERENCE DOCUMENTS:

- *Lafert CANOpen Manual rel. 1.11*
- *CiA 301 (310_1v01010005_cor.pdf)*
- *CiA 402 (CiA® 402 Draft Standard Proposal.pdf)*

1 | PURPOSE OF MANUAL

1.1 Purpose of the Manual

This operating guide provides information for safe installation and commissioning of the *Smartris Compact Drive*.

Read and follow the instructions to use the Lafert Smartris Compact Drive safely and professionally and pay attention to the safety instructions and general warnings.
Always keep this operating guide available with the Smartris Compact Drive.

This operating guide provides information for safe installation and commissioning of the *Lafert Smartris Compact Drive*: read carefully the entire guide before installing and using the equipment.

Caution
The operating guide is intended for use by qualified personnel.

Attention
Ce mode d'emploi est prévu pour servir à du personnel qualifié.

A qualified person has the knowledge and authorization to perform tasks such as transporting, assembling, installing, commissioning and operating motors.

This manual is regularly reviewed and updated. All suggestions for improvement are welcome.

1.2 Trademarks

Any product names in this document may be registered trademarks. The sole purpose of any trademarks in this document is the identification of the corresponding products.

1.3 Warning Safety Information

In order to achieve the optimum, safe operation of the Smartris Compact Drive, it is imperative that you implement the safety procedures included in this installation guide. This information is provided to protect you and to keep your work area safe when operating the Smartris Compact Drive and accompanying equipment.

Caution

- The Systems that are electrically connected must be properly secured so they cannot be switched back on and warnings signs must be put up.
- Before startup, it must be checked that the wiring is correct and is free of mechanical damages. Only drive with wiring in perfect condition may be enabled to operation.
- Incorrect voltage, reverse polarity and defective wiring can damage the drive.
- Do not connect or disconnect electric cables while the equipment is powered or running.
- The operator is responsible for keeping the safety installations in perfect working order, conforming to prevailing laws and standards.

Please read this chapter carefully before you begin the installation process.

Attention

- Les systèmes qui sont connectés électriquement doivent être correctement sécurisés afin qu'ils ne puissent pas être rallumés et des signaux d'avertissement doivent être mis en place.
- Avant la mise en service, il faut vérifier que le câblage est correct et exempt de dommages mécaniques. Seul le variateur dont le câblage est en parfait état peut être autorisé à fonctionner.
- Une tension incorrecte, une polarité inversée et un câblage défectueux peuvent endommager le variateur.
- Ne pas brancher ni débrancher les câbles électriques lorsque l'équipement est sous tension ou en marche.
- L'opérateur est responsable du maintien en parfait état de fonctionnement des installations de sécurité, conformément aux lois et normes en vigueur.

The Lafert Compact Smartris Drive contains electrostatic-sensitive components that can be damaged if handled incorrectly. To prevent any electrostatic damage, avoid contact with highly insulating materials, such as plastic film and synthetic fabrics. Place the product on a conductive surface and ground yourself in order to discharge any possible static electricity build-up.
To avoid any potential hazards that may cause severe personal injury or damage to the product during operation, keep all covers and cabinet doors shut.

Warning

Safety Instructions: for the electrical installation, the ESD instructions must be observed. To maximize ESD protection you may connect the metallic heatsink of the controller to -VBus.

The following safety symbols are used in this manual:

Hot Surface Warning

To alert against surfaces that may reach high temperatures. The heatsink and wires may reach high temperatures.

Warning

This information is needed to avoid a safety hazard, which might cause bodily injury or death as a result of incorrect operation:

- To avoid electric arcing and hazards to personnel and electrical contacts, never connect/disconnect the servo drive while the power source is on.
- Power cables can carry a high voltage, even when the motor is not in motion. Disconnect the Lafert Smartris Compact Drive from all voltage sources before servicing.
- After shutting off the power and removing the power source from your equipment, wait at least 1 minute before touching or disconnecting parts of the equipment that are normally loaded with electrical charges (such as capacitors or contacts). Measuring the electrical contact points with a meter, before touching the equipment, is recommended.

Caution

This information is necessary to prevent bodily injury, damage to the product or to other equipment:

- The maximum DC power supply connected to the instrument must comply with the parameters outlined in this guide.
- When connecting the Lafert Smartris Compact Drive to an approved control supply, connect it through a line that is separated from hazardous live voltages using reinforced or double insulation in accordance with approved safety standards.
- Before switching on the Smartris Compact Drive, verify that all safety precautions have been observed and that the installation procedures in this manual have been followed.
- Make sure that the Safe Torque Off is operational.
- If a fire breaks out, do not direct the water extinguishers near the equipment to put out the flames.

Important

Identifies information that is critical for successful application and understanding of the product.

Safety measures must be taken both for people and machines, in compliance with Standards and local conditions.

Les symboles de sécurité suivants sont utilisés dans le manuel :

Mise en garde pour surface chaude

Avertissement concernant les surfaces qui peuvent atteindre des températures élevées. Le dissipateur thermique et les fils peuvent atteindre des températures élevées.

Mise en garde

Ces informations sont nécessaires pour éviter un danger pour la sécurité, qui pourrait causer des blessures corporelles ou la mort à la suite d'un fonctionnement incorrect :

- Pour éviter les arcs électriques et les risques pour le personnel et les contacts électriques, ne jamais connecter/déconnecter le servomoteur lorsque la source d'alimentation est allumée.
- Les câbles d'alimentation peuvent véhiculer une haute tension, même lorsque le moteur n'est pas en mouvement. Débrancher le variateur Lafert Smartris de toutes les sources de tension avant de procéder à l'entretien.
- Après avoir coupé l'alimentation et retiré la source d'alimentation de l'équipement, attendre au moins une minute avant de toucher ou de déconnecter des parties de l'équipement qui ont normalement des charges électriques (comme les condensateurs ou les contacts). Il est recommandé de mesurer les points de contact électrique avec un compteur, avant de toucher l'équipement.

Attention

Ces informations sont nécessaires pour éviter des blessures corporelles, des dommages au produit ou à d'autres équipements :

- L'alimentation maximale en courant continu, connectée à l'instrument, doit être conforme aux paramètres décrits dans ce guide.
- Lors de la connexion du variateur Lafert Smartris à une alimentation de contrôle autorisée, le brancher via une ligne séparée des tensions dangereuses à l'aide d'une isolation renforcée ou double, conformément aux normes de sécurité approuvées.
- Avant d'allumer le Smartris Compact Drive, vérifier que toutes les précautions de sécurité ont été respectées et que les procédures d'installation décrites dans ce manuel ont été suivies.
- S'assurer que la fonction Safe Torque Off est opérationnelle.
- Si un incendie se déclare, ne pas diriger les extincteurs à eau à proximité de l'équipement pour éteindre les flammes.

1.4 Warranty Information

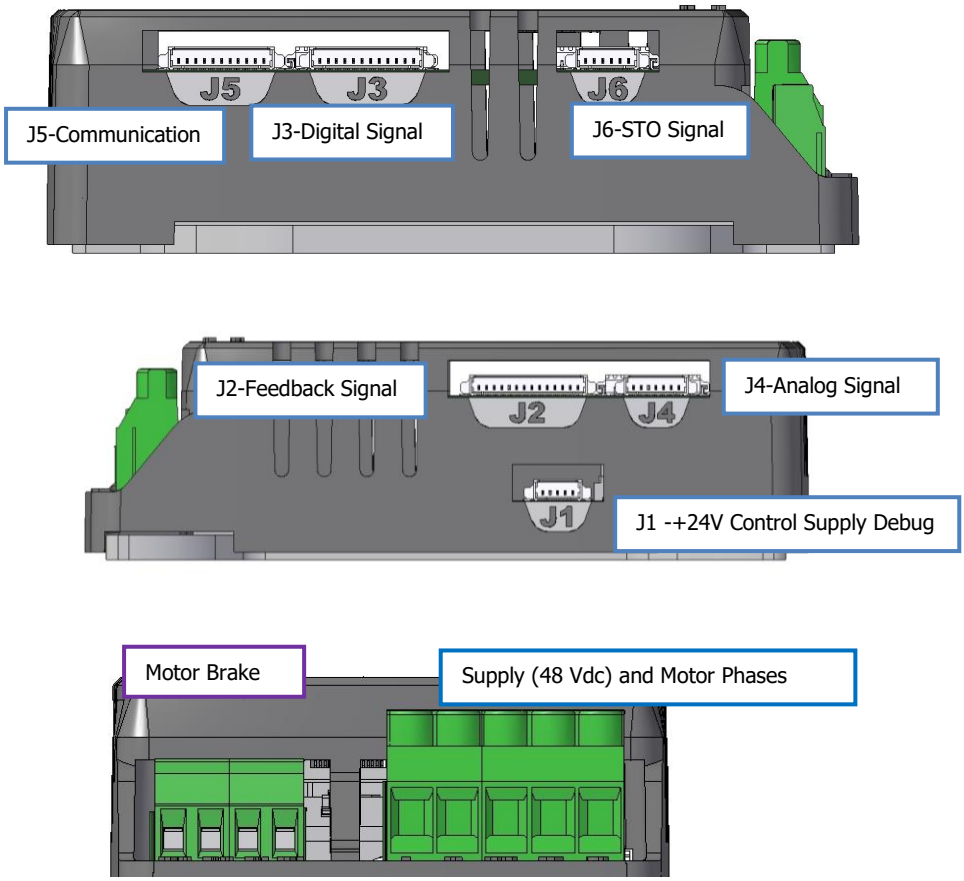
The products covered in this manual are warranted to be free of defects in material and workmanship and conform to the specifications stated either within this document or in the product catalogue description.

Do not remove any cover.
Interventions or modifications made to the equipment, or parts of it, and/to the standard fittings, which are not authorized by us, will void the warranty.
Any faults caused by failure to comply with instructions will NOT be covered by the warranty. Electrical Specifications

1.5 Electrical Specifications

Main power supply	
Supply Voltage*	Typical 48 Vdc (20 Vdc Min/60Vdc Max)
Brake Supply Voltage*	Typical 48 Vdc (20 Vdc Min/60Vdc Max)
STO Supply	24 Vdc (Dedicated Connection)

*to supply 24Vdc contact the manufacturer



Picture 1 - Smartris Wiring

Do not connect power supply voltages if higher than the admissible voltage range. If excessive voltages are applied to the drive, its internal components will be damaged.

1.6 Electrical Installation, Terminal Wirings

Screw driver 0,6x3,5 mm² – 0,6 Nm / Wire 0,2 ÷ 6 mm² rigid – 4 mm² flex

SUPPLY/MOTOR CONNECTOR			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
1	- VBUS	Connection to - Vbus	
2	+ VBUS	Connection to + Vbus (+24/48 Vdc)	
3	W	Motor Phase W	
4	V	Motor Phase V	
5	U	Motor Phase U	

Table 1 – Supply/Motor Wiring

Screw driver 0,4x2,5 mm²– 0,6 Nm / Wire 0,2 ÷ 6 mm² rigid – 4 mm² flex

Brake connector			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
1	V+	+V Supply for brake (24/48V) – **it is possible to connect to "+"**	
2	B+	Motor Brake +	
3	B-	Motor Brake -	
4	V-	-V Supply for brake (24/48V) – **it is possible to connect to "-"**	

Table 2 - Brake Wiring

J2 - Feedback SIGNAL			
PIN	**RESOLVER**	**INC ENC+HALL**	**SINCOS ENCODER**
1	SIN+	A+	SIN

2	SIN-	A-	REFSIN
3	COS+	B+	COS
4	COS-	B-	REFCOS
5	R1	Z+	DATA+
6	R2	Z-	DATA-
7	-	HX	-
8	-	HY	-
9	-	HZ	-
10	-	+5V	+8V
11	-	GND	GND
12	SCH	SCH	SCH
13	NTC1a	NTC1a	NTC1a
14	NTC1b	NTC1b	NTC1b

Table 3 – Feedback Wiring

J3 – Digital I/O SIGNAL			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
1	DIN1	Digital Input 1	Red
2	DIN2	Digital Input 2	Black
3	DIN3	Digital Input 3	Black
4	DIN4	Digital Input 4	Black
5	DIN COMMON	Common Input	Black
6	NC	-	Black
7	NC	-	Black
8	DOUT COMMON	Common Output	Black
9	DOUT 1	Digital Output 1 – DRIVE OK	Black
10	DOUT 2	Digital Output 2 - Open Drain - Programmable	Black
11	DOUT 3	Digital Output 3 - Open Drain - Programmable	Black
12	DOUT 4	Digital Output 4 – Brake Energized	Black

Table 4 – Digital I/O Wiring

J4 – Analog I/O SIGNAL			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
1	VinAN1 Pos	Analog Input Pos	Red
2	VinAN1 Neg	Analog Input Neg	Black
3	+10V	10 Vdc Output	Black
4	Analog GND	GND Analog Reference	Black
5	NC		Black
6	VoutAN1 GND	GND Analog Output	Black
7	VoutAN1	Analog Output	Black

Table 5 - Analog I/O Wiring

J5 - Communication SIGNAL			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
1	CAN_H	CAN_H Connection	Red
2	CAN_L	CAN_L Connection	Black
3	CAN_T	120 Ω Termination resistance CAN (connect to CAN H)	Black
4	CAN_GND	GND reference for CAN/RS485	Black
5	485_A	ModBus RS485+	Black
6	485_B	ModBus RS485-	Black
7	485_T	120 Ω Termination resistance Modbus (connect to 485_A)	Black
8	485_GND	GND reference for RS485	Black
9	TX232_PC	Tx232 Signal	Black
10	RX232_PC	Rx232 Signal	Black
11	GND_232	GND RS232 Serial Communication	Black

Table 6 - Communication Wiring

J6 – Safety STO SIGNAL			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
1	STO IN 1	Safety Input STO1	Red
2	STO IN 2	Safety Input STO2	Black
3	STO IN COM	Common STO1 / STO2	Black
4	NC	-	Black
5	STO OUT COM	STO Out Common	Black
6	STO OUT	STO Out	Black

Table 7 – Safety STO Wiring

J1 – 24V Control Board Supply – Only for Debug			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
1	24V-48V [range 20-60Vdc]	Switching Power Supply for Logic Board; consumption=3.5W / At 24V 150mA of absorption. It is used to switch ON the logic board in absence of 48V power supply.	Red
2			Black
3	NC		Black
4	0V	0V for Logic Board – only for Upgrade/Debug	Black
5			Black

Table 8 – +24V Logic Board

DIGITAL INPUT/OUTPUT	
Digital Input	24 V +/- 20%
Impedance Input	3 kΩ, 7 mA - NPN/PNP type
Digital Output	24 V +/- 20%
Current Output	100 mA - NPN/PNP type

All cables and components used for connecting the equipment must comply with prevailing Standards. When assembling the equipment, be sure it cannot be damaged in any way by the moving components.

Warning

This information is needed to avoid a safety hazard, which might cause bodily injury or death as a result of incorrect operation:

Avoid Ground loops when connecting I/O devices

- When connecting a PC, encoder, switch or actuators on the I/O connector, be very careful that you do not create a path of current that flow from the ground signal (GND) pins on the I/O connector to the –V Main Power Supply terminal. If the –V Mains Ground wires (thick black) or -V terminals are disconnected while the +V Power Supply wires (thick red) or +V terminals are connected, a high current would flow from the ground (GND) pins, potentially causing serious damage to the controller and/or your external devices.
- Do not connect a wire between the I/O connector ground and the battery minus terminal. Look for hidden connection and eliminate them. Note that ground signals GND of I/O connector pin N.1,10,13,18,19, are internally connected to –V Main Power terminal of the drive.
- Have a very firm and secure connection and don't use switches for wiring from the –Main supply (- Battery) and -V terminals of the drive.
- Do not use connectors or switches on the power ground cables.
- It is suggested that the external I/O signals are insulated from –Vmain Power Supply to prevent ground loop and damages.
- Do not allow water to seep into the equipment.

Installation électrique, câblages de bornes

Mise en garde

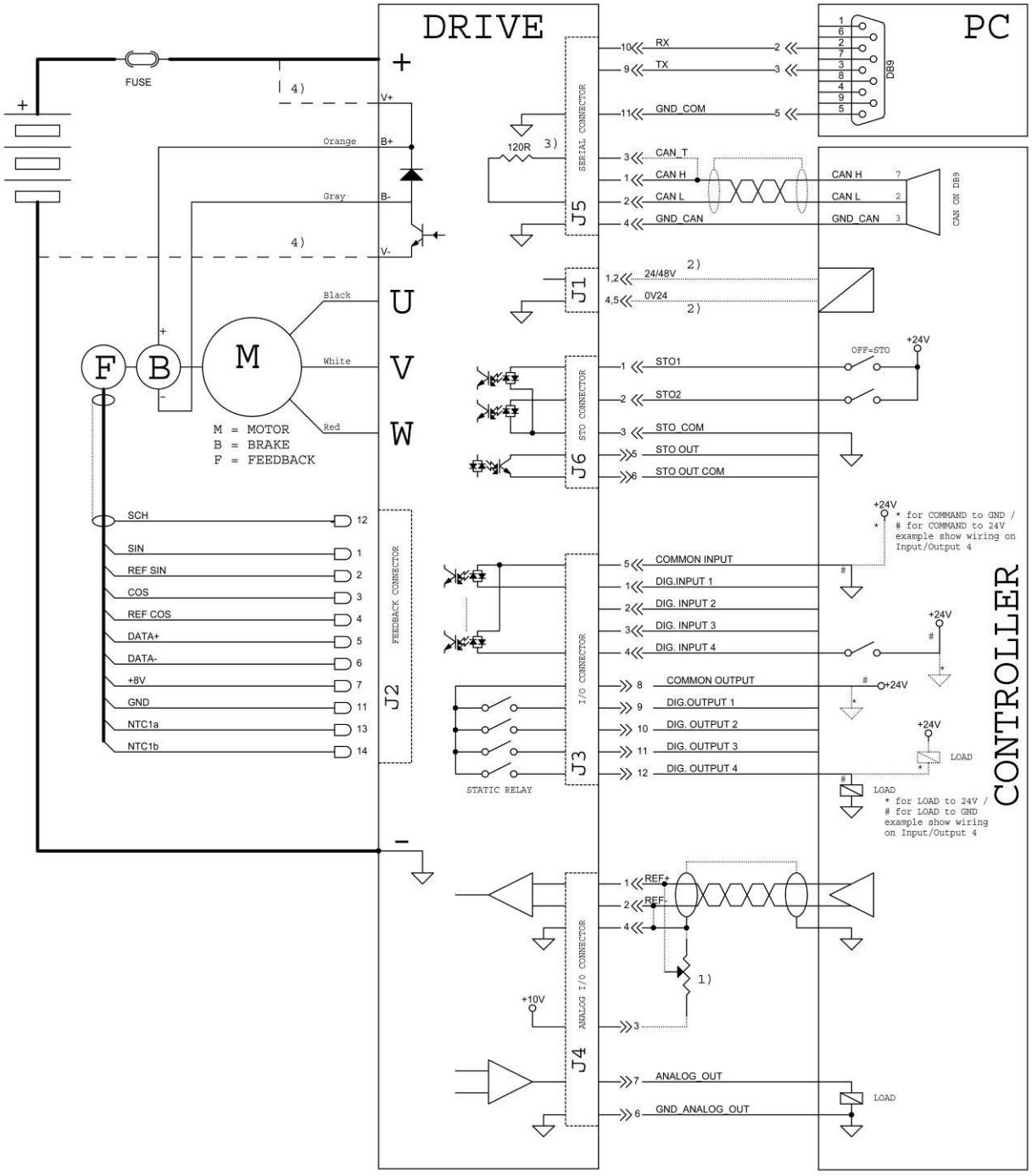
Ces informations sont nécessaires pour éviter un danger pour la sécurité, qui pourrait causer des blessures corporelles ou la mort à la suite d'un fonctionnement incorrect :

Éviter les boucles de masse lors de la connexion de périphériques d'E/S

- Lors de la connexion d'un ordinateur, d'un encodeur, d'un commutateur ou d'actionneurs sur le connecteur d'E/S, veiller à ne pas créer de chemin de courant provenant des broches de terre du connecteur d'E/S et de la borne d'alimentation principale –V. Si les principaux fils de terre du contrôleur (noirs épais) ou les bornes sont déconnectés alors que les fils d'alimentation +V (rouges épais) ou les bornes sont connectés, le courant élevé s'écoulerait des broches de terre, causant potentiellement de graves dommages au contrôleur et/ou aux périphériques externes.

- Ne pas brancher de fil entre la masse du connecteur d'E/S et la borne négative de la batterie. Rechercher les connexions cachées et les éliminer. Il convient de remarquer que les signaux GND des broches N.1,10,13,18,19 du connecteur E/S sont connectés à la borne d'alimentation principale –V du variateur.
- La connexion du fil de terre du contrôleur et de la borne négative de la batterie doit être très ferme et sûre.
- Ne pas utiliser de connecteurs ou d'interrupteurs sur les câbles de mise à la terre.
- Il est suggéré que les signaux d'E/S externes soient isolés de l'alimentation principale –V pour éviter les dommages.
- Ne pas laisser l'eau s'infiltrer dans l'équipement.

Wiring Example:



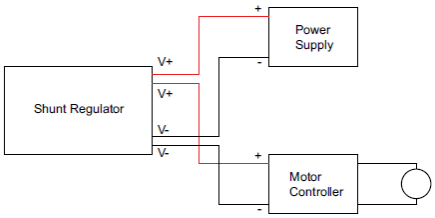
1) Optional wiring for a potentiometer or a throttle pedal. In case of Single-Ended signal, connect pin 13 to pin14.
2) Optional wiring for power supply for logic board (used for Upgrade/Debug)
3) For CAN termination connect pin 3 to CAN H signal (pin1)

Warning

This information is needed to avoid a safety hazard, which might cause bodily injury or death as a result of incorrect operation:

1) **Connection for Safe Operation with Discharged Supply Voltage**
2) **Protection against Damage due to Regeneration** The voltage generated by motors rotating while not powered by the drive can cause serious damage even if the controller is Off or disconnected. If the supply is not able to absorb and dissipate regenerated current, the voltage will increase until the over-voltage protection circuit cuts off the motors. While this process should not be harmful to the controller, it may be to the power supply, unless one or more of the protective steps below is taken:

- use a power supply that will not suffer damage in case a voltage is applied at its output that is higher than its own output voltage. This information is seldom published in commercial power supplies, so it is not always possible to obtain positive reassurance that the supply will survive such a condition.
- Place a battery in parallel with the power supply output.
- Place a shunt regulator such in picture below.

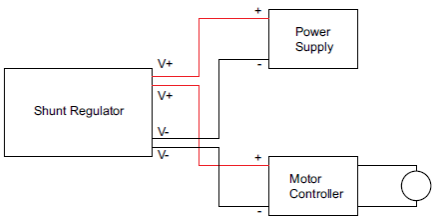


Mise en garde

Ces informations sont nécessaires pour éviter un danger pour la sécurité, qui pourrait causer des blessures corporelles ou la mort à la suite d'un fonctionnement incorrect :

1) **Connexion pour un fonctionnement sûr avec une tension d'alimentation déchargée**
2) **Protection contre les dommages dus à la régénération** La tension générée par les moteurs tournant alors qu'ils ne sont pas alimentés par le variateur peut provoquer de graves dommages même si le contrôleur est éteint ou déconnecté. Si l'alimentation n'est pas en mesure d'absorber et de dissiper le courant régénéré, la tension augmentera jusqu'à ce que le circuit de protection contre les surtensions coupe les moteurs. Bien que ce processus ne devrait pas être nocif pour le contrôleur, il peut l'être pour l'alimentation électrique, à moins qu'une ou plusieurs des mesures de protection ci-dessous ne soient prises :

- utiliser une alimentation électrique qui ne subira pas de dommages en cas d'application à sa sortie d'une tension supérieure à sa propre tension de sortie. Cette information est rarement publiée dans les alimentations électriques commerciales, il n'est donc pas toujours possible d'obtenir l'assurance positive que l'alimentation survivra à une telle condition.
- Placer une batterie en parallèle avec la sortie d'alimentation.
- Placer un régulateur shunt tel que dans l'image ci-dessous.



1.7 Environmental Condition

You can guarantee the safe operation of the Lafert Smartris Compact Drive by ensuring that it is installed in an appropriate environment.

Features	***Details***
Operating ambient temperature according to IEC 60068-2-2	-10 °C to 40 °C (14 °F to 104 °F)
Maximum Surrounding Air Temperature:	40°C (104 °F)
Air humidity during operation	Relative humidity < 85%, non-condensing
Installation altitude	< 1000 m above sea level without affecting performance
Protection class	IP20
Use in Pollution degree 3 Environment	3 (EN 61800-1, EN61800-5-1)

Table 9 - Environmental Conditions

Caution

The Lafert Smartris Compact Drive dissipates its heat by convection or by conduction. The maximum ambient operating temperature of 40 °C (104 °F) must not be exceeded.
The Lafert Smartris have a Warning temperature drive (value depends by Manufacturer) readable by CANOpen (0x4301) and Warning Logic Board temperature (> 63°C) readable by CANOpen (0x4501)

Conditions ambiantes

Attention

Le variateur Lafert Smartris dissipe sa chaleur par convection ou par conduction. La température ambiante maximale de fonctionnement de 40 °C (104 °F) ne doit pas être dépassée.
Les Lafert Smartris ont un variateur de température d'avertissement (la valeur dépend du fabricant)lisible par CANOpen (0x4301) et une température de carte logique d'avertissement (>63 °C) lisible par CANOpen (0x4501)

1.8 Transport and Storage

1.8.1 Transport

- Transportation only in original packaging by qualified personnel
- Avoid hard impacts and vibrations
- Transport temperature: -20/70 °C, max. 20 K/hour fluctuation
- Transport air humidity: Relative humidity max. 95%, non-condensing
- If the packaging is damaged, check the drive amplifier for visible damage.

Transport

The drive amplifier contains components that are sensitive to electrostatic charge and can be damaged when handled improperly.
Ensure proper ESD handling by qualified personnel.

Transport

L'amplificateur de puissance contient des composants sensibles aux charges électrostatiques et pouvant être endommagés en cas de manipulation incorrecte.
Veiller à une manipulation correcte de la décharge électrostatique par le personnel qualifié.

1.8.2 Packaging

- ESD-compatible box
- Identification: Label attached to the outside of the box

1.8.3 Storage

Storage	Details
Storage Environmental Ambient temperature	-10 °C to 70 °C (14 °F to 158 °F)
Air humidity during operation	Relative humidity < 90%, non-condensing

HOW TO STORE A LAFERT DRIVE	
Short-Term Storage & Long-Term Drive Storage Indoor	• Storage at a temperature between -10° / +70° C • No condensation allowed (humidity < 90%) • Cover the equipment during installation for prevent infiltration of dust, metallic shavings, water, oil… • No liability is assumed for errors caused by tampering the system or bad storage.
Short-Term Storage (weeks or months)	• Protect the drive from the elements, vibration and extreme heat
Long-Term Storage (years)	• Location has to be clean, dry, environment with minimal to no vibration, such as away from railroad tracks and major freeways
Out of storage and Into Service	• Remove Dust and Dirt • For a long storage (6 or more months), provide DC bus capacitor regeneration (supply Vbus "+" and "-" at 48Vdc 1h) before starting work.

Table 10 – Storage

1.9 Approvals

1.9.1 CE Conformity

The Lafert Smartris Drive was tested in authorized testing laboratories in accordance with the requirements of this documentation.

The Lafert Smartris Drive is in conformity with the following **EC Directives:**

- Machinery Directive 2006/42/EC
- Electromagnetic Compatibility (EMC) (*2014/30/EU*)
- RoHS Directive (*2011/65/EU - 2015/863/EU*)
- WEEE Directive (*2012/19/UE*)

1.9.2 Safety

EN 61800-5-1 Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy.
EN 60204-1:2018 - Electrical equipment of machines

1.9.3 UL Recognized

UL 61800-5-1 *Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements - Electrical, Thermal and Energy*

USL: Approval according to standards of the United States in accordance with UL 61800-5-1
CNL: Approval according to national Canadian standards in accordance with C22.2 No. 274

UL Markings:

- Maximum Surrounding Air Temperature: 40 °C
- These devices are intended to be used in a pollution degree 3 environment.
- Integral Solid State short circuit Protection
- Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes
- For Canada (CSA): Integral solid state short circuit protection does not provide branch circuit protection.
- Fuse: use only UL listed (see chapter 3)

1.9.4 EMC Requirements

In terms of emission and immunity, the Lafert Smartris Drive fulfills the requirement for the category "second environment" (industrial environment).

EN 61800-3 - Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods.

1.9.5 Safety Conformity (STO)

The Lafert Smartris Drive provides a two-channel, functionally safe STO function (Safe Torque Off).
The function disables the PWM, and the drive can be switched safely to torque OFF.

The circuit design has been tested and subsequently assessed by Lafert. According to that assessment, the circuit design used for the "Safe Torque Off" safety function in the Lafert Smartris Drive is suitable for meeting the requirements for SIL X in accordance with

- ***EN61508*** - Functional safety of electrical/electronic/programmable electronic safety-related systems
- ***EN61800-5-2*** and category SIL… – Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional

- ***EN ISO 13849-1:2015*** - Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design.
- ***EN ISO 12100:2010 -*** Risk assessment and risk reduction

The subsystems (Lafert Smartris Drive) are fully described in terms of safety by the following characteristics:

EN 13849-1	EN61800-5-2	PFHD [1/h]
PLd	SIL2	8,32 E-07

1.9.6 Environmental Conditions for Vibration/Shock

The drive fulfills the following specifications:

1. Vibration according to DIN ***EN 60068-2-6:2008***
   - Sweep1 (***EN 60068-2-6***)
     Frequency range 20Hz < f < 500Hz 50m/s2
     Acceleration 1Oct/min
     50 cycles
   - Sweep2 (***2006/42/EC***)
     Frequency range 10Hz < f < 57Hz 0.075mm
     Acceleration 1Oct/min
     1 cycle
2. ***EN60721-3-5***: Classification of Environmental Conditions Part 3: Classification of Groups of Environmental Parameters and Their Severities
   - 10Hz < f < 30Hz +6dB/Oct
   - 30Hz < f < 200Hz 0.005g2/Hz
   - 200Hz < f < 500Hz -12 dB/oct
   - 30 minutes

1.10 Motor/Circuit Protection

Circuit breaker hardware to protect the motor is not required as the motor is protected from overloading by an I^2t function in the software.
The parameters for this function are:

- Nominal Current
- Peak Current
- Time of overload

Nominal and Peak Current are characteristics of motors, Time is written in a default value that depends to load and motor but is programmable by user.
It is also programmable the behavior of Drive after Overload time:

1) Drive goes in Overload Alarm
2) Drive gives at maximum Nominal Current

There is also a function that protects motor to over temperature by a motor temperature sensor: drive goes in Motor Overtemp Alarm above sensor threshold.

	**Caution** The Lafert Smartris Drive have Warning Motor Temperature (> 130°C) readable by CANOpen (0x4A01)

	**Attention** Les variateurs Lafert Smartris ont un avertissement de température moteur (>130 °C) lisible par CANOpen (0x4A01).

1.11 Startup

Startup is prohibited within the scope of the EC directives until it has been determined that the machine/system in which this Lafert Smartris Compact Drive is installed corresponds to the regulations within these directives.

For installation in machines and systems, start of intended use of the Lafert Smartris Compact Drive is prohibited until it has been determined that the machine or system complies with the provisions of the EC Machinery Directive 2006/42/EC and the EC EMC Directive 2014/30/EU.

For use in residential areas, additional EMC measures are necessary.
It is the responsibility of the manufacturer of the machine or system to ensure that the threshold values, as stipulated by the EMC regulations, are adhered to.

1.11.1 Mechanical installation

- For the mechanical installation, the ESD instructions must be observed.
- The drive amplifier (control cabinet version) must be protected from fog, water and penetration of metallic dust in the electrical cabinet.
- The drive must be checked for mechanical damage before installation. Only install flawless drive amplifiers.
- Installation in an electrical cabinet, sufficient ventilation must be provided.
- The operation of drive amplifiers exposed to condensation is not permitted.

Caution

- Installation may only be performed in a de-energized state!
- Systems that are electrically connected must be properly secured so they cannot be switched back on and warning signs must be put up.
- Assembly may only be performed by trained personnel

Mise en marche

Attention

- L'installation ne peut être effectuée qu'à l'état hors tension !
- Les systèmes qui sont connectés électriquement doivent être correctement sécurisés afin qu'ils ne puissent pas être rallumés et des signaux d'avertissement doivent être mis en place.
- Le montage ne peut être effectué que par un personnel formé.

1.11.2 Correct Use

The Lafert Smartris Compact Drive are intended for operation of permanent magnet synchronous servo motors with compatible feedback systems in stationary machines and systems.
Installation of the Lafert Smartris Compact Drive is only approved in industrial environments. For use in residential areas, additional EMC measures are necessary. The user must prepare a hazard analysis of the final product.

Caution

Other uses must first be approved by the manufacturer.

Attention

Toute autre utilisation doit au préalable être approuvée par le fabricant.

1.11.3 Improper Use

The Lafert Smartris Compact Drive is not suitable for operation of motors other than synchronous servo motors or motors with non-compatible feedback systems.

In addition, the following applications are expected from intended use.
The installation of drives in areas at risk, where inflammable substances or combustible vapors or powders are present, could trigger fire outbreaks or explosions. As such, install the drives far away from said areas at risk, even if they are used with motors fit for use under these conditions.

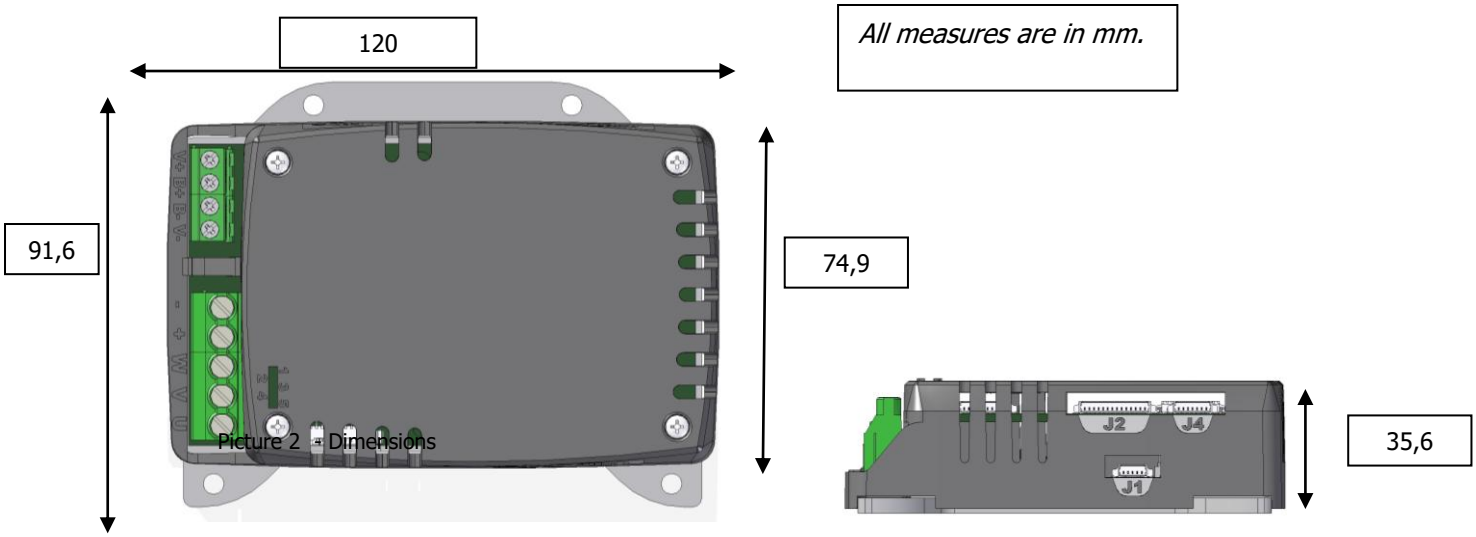
1.12 Maintenance

Maintenance
The Smartris Compact Drive is maintenance free. Opening the Smartris Compact Drive voids the warranty.

Repairs
The Smartris Compact Drive may only be repaired by the manufacturer. Opening the Smartris Compact Drive voids the warranty and safety according to the specified standards is no longer ensured.

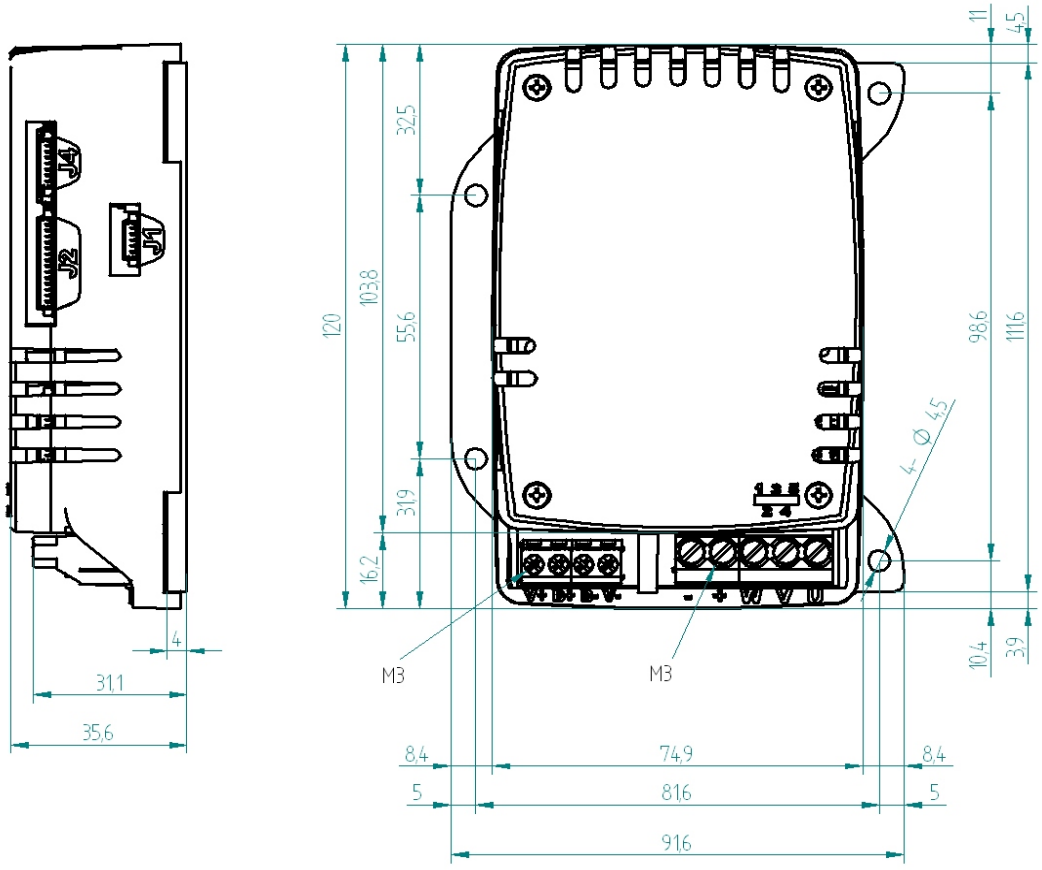
2 | DIMENSIONS

2.1 Size Dimension



All measures are in mm.

Picture 2 - Dimensions



MECHANICAL SPECIFICATIONS	
Weight [kg]	0,326
Height with plug [mm]	35,6
Width [mm]	120
Depth [mm]	91,6 - 74,9

Table 11 - Dimensions

2.2 Mechanical Installation

Safety Instructions:

- For the mechanical installation, the ESD instructions must be observed.
- The drive must be protected from fog, water and penetration of metallic dust in the electrical cabinet.
- The drive must be checked for mechanical damage before installation.
- In an installation in an electrical cabinet, sufficient ventilation must be provided.
- The operation of drive exposed to condensation is not permitted.

2.3 Electrical Installation

Safety instructions. For the electrical installation, the ESD instructions must be observed:

Caution

- Systems that are electrically connected must be properly secured so they cannot be switched back on and warning signs must be put up.
- Before startup, it must be checked that the wiring is correct and is free of mechanical damage. Only drive with wiring in flawless condition may be put into operation.
- Incorrect voltage, reverse polarity and nonconforming wiring can damage or destroy the drive.
- Inadeguate protection of the power supply can damage the cables or the drive.
- Observe the separate instructions for the STO safety function.

Installation électrique

Attention

- Les systèmes qui sont connectés électriquement doivent être correctement sécurisés afin qu'ils ne puissent pas être rallumés et des signaux d'avertissement doivent être mis en place.
- Avant la mise en service, il faut vérifier que le câblage est correct et exempt de dommage mécanique. Seul le variateur dont le câblage est impeccable peut être mis en fonction.
- Une tension incorrecte, une polarité inversée et un câblage non conforme peuvent endommager ou détruire le variateur.
- Une protection inadéquate de l'alimentation peut endommager les câbles ou le variateur.
- Respecter les autres instructions pour la fonction de sécurité STO.

2.4 Requirements for Power adapters and Supply Voltage

The STO's 24 VDC logic supply and 48 VDC power supply must be provided voltage sources with safe extra low voltage in or supply voltage sources having only

Caution

The use of unsuitable power adapters not in SELV/PELV design can lead to dangerously high voltages in the even resulting in injuries or death.

Exigences des adaptateurs d'alimentation et de la tension

Attention

L'utilisation d'adaptateurs d'alimentation inappropriés non conformes à la conception SELV/PELV peut entraîner des tensions dangereusement élevées, voire des blessures ou la mort.

The 48 Vdc power adapter supply must permit backfeed up to 60 Vdc, as the drive can generate a voltage up to 60 Vdc at the power adapter terminals when operating as a generator. The power adapter should be designed for such operation.

Otherwise, suitable action must be taken to prevent backfeed.

2.5 Requirements for Heat-sink

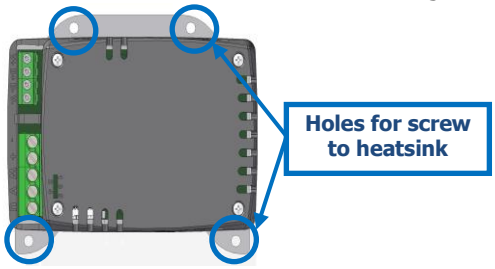
The Smartris Compact Drive is rated for continuous operation. If you need to use in Continuous Duty (S1), you need to add a heat-sink:

Heat-sink SPECIFICATIONS	
Smartris (1500W)	add it to a heat-sink with Rth = 2.1°C/W

In case you need less power, you can reduce the heat-sink:

Max Power	Heat-sink
600 W	No heatsink needed
1500 W	add it to a heat-sink with Rth = 2.1°C/W

The drive can also be mounted with the cooling unit using the four holes (4 mm diameter) at the heat-sink.

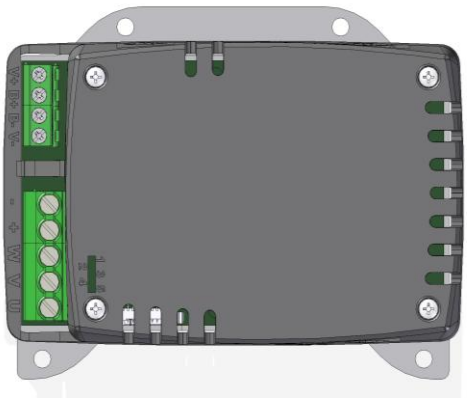


2.6 Mounting and Installation Space

The installation space must meet the requirements of protection class IP20 at least and needs a space of 10mm to other devices.

2.6.1 Mounting position

The Smartris Compact Drive can be installed in any mounting position.
An orizontal mounting position with a cooling unit should be used to achieve optimum heat dissipation in case of use of heatsink with cooling fins.
Performance will decrease if the Smartris Compact Drive is not in mounting position, or if the converter is used with insufficient cooling.



Picture 3 - Mounting

3 | TECHNICAL DATA

3.1 Sizes Main Power Supply

ID	Smartris Series Model	AGV Payload	MOTOR POWER	MOTOR CABLE	SUPPLY CABLE	FUSE CE
		[kg]	[W]	[mm²] - AWG	[mm²] – AWG	[A]
1	S1	600	430	2,5 -AWG14	2,5 -AWG14	16
		1000	600	4 -AWG10	4 -AWG10	32
2	M1	1500	1000			

Table 12 - Technical Data AGV

Smartris Series Model	INPUT		OUTPUT		FUSE UL				
	Input Voltage (Vdc)	Maximum Input Current @48Vdc(A)	Maximum Output Current (A)	Maximum Output Power (W)	Fuse Manufacturer	Fuse Model	Voltage Rating	Current Rating (A)	Symmetrical A.I.C. (KA)
S1	Nominal 24Vdc-48Vdc Range 20Vdc-60Vdc	13	12.5	600	LITTELFUSE	TLS Series	170Vdc	15	100KA
M1		27	25,8	1500				30	

Table 13 - Technical Power Data

N.B. the list above is an example: the drive is available to use with Lafert or other motor types with similar characteristics.

This manual is available for the following feedback:

- Resolver
- Incremental Encoder
- SinCos Encoder

4 | OPERATION MODE FUNCTIONS

Caution
Smartris Compact Drive has a Safety Torque OFF (STO), so verify that this circuit is correctly supplied (see STO Chapter) before all operation functions.

Attention
Le variateur Smartris possède une fonction Safety Torque OFF (STO), il convient donc de vérifier que ce circuit est correctement alimenté (voir chapitre STO) avant de démarrer ses fonctions.

4.1 Drive Control Mode

The drive can be piloted in 3 different modes:

- Analog Mode
- CANOpen Mode
- Modbus Mode

Information
Note: The **Drive Control Mode** is set by an internal parameter. To change the Control Mode please contact the manufacturer

4.2 Analog Mode

In this operation mode the Drive can be piloted with an analog reference -10 Volt +10Volt. Giving voltage on +VREF and –VREF (see paragraph Connector J4) it is possible to supply to the drive the speed set point.

The motor speed will depend from the reference voltage given on +VREF and –VREF and from the maximum speed available on the drive.
The input range of the reference voltage for the Speed Set Point is from –10V to +10V.
The Speed Set Point is proportional to the voltage supplied on the concerned input.
Giving a +10V voltage the motor will set to the maximum speed in clockwise rotation, motor front, while giving a -10V the motor will set to the maximum speed in counterclockwise rotation, motor front.

Example Default: +/- 10V → [-MaxSpeed;+ MaxSpeed]			[-MaxTq; + MaxTq]
Input Voltage	**Rotation**	**Speed**	**Torque (*)**
+10V	clockwise	+ 3000 r.p.m	Max
-10V	counterclockwise	- 3000 r.p.m	- Max
0V	Stop	0 rpm	0
+5V	clockwise	+ 1500 r.p.m	Half of max
-5V	counterclockwise	- 1500 r.p.m	- Half of Max

Information
(*) Note: In **Analog Mode** is possible to use the Torque control mode using the same input as in Speed control mode. To change the Analog Control Mode to Torque please contact the manufacturer

Information
(*) Note: It is possible to modify the analog reference:

- 0 = +/-10V
- 1 = 0...10V
- 2 = +/-5V

- 3 = 0...5V
- 6 = 0...10V = [-MaxSpeed; + MaxSpeed]
- 7 = 0...5V = [-MaxSpeed; + MaxSpeed])

Default Value +/-10V, to modify contact the Manufacturer

J3 - Digital SIGNAL			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
1	DIN1	Digital Input 1	
2	DIN2	Digital Input 2	
3	DIN3	Digital Input 3	
4	DIN4	Digital Input 4	
5	DIN COMMON	Common Input	
6	NC		
7	NC		
8	DOUT COMMON	Common Output	
9	DOUT 1	Digital Output 1 – DRIVE OK	
10	DOUT 2	Digital Output 2 - Open Drain - Programmable	
11	DOUT 3	Digital Output 3 - Open Drain - Programmable	
12	DOUT 4	Digital Output 4 – Brake Command (with brake is externally supplied)	

Table 14 – Digital I/O Wiring

J4 – Analog I/O SIGNAL			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
1	VinAN1 Pos	Analog Input Neg	
2	VinAN1 Neg	Analog Input Pos	
3	+10V	10 Vdc Output	
4	Analog GND	GND Analog Reference	
5	NC		
6	VoutAN1 Pos	Analog Output Pos	
7	VoutAN1 Neg	Analog Output Neg	

Table 15 - IO Analog Mode

To move the motor is necessary that the inputs IN1 and IN2 are ON.

IN1	IN2	DRIVE STATE	STATUS 1 LED GREEN	STATUS 2 LED YELLOW	LED VIEW
OFF	**X**	STAND-BY	"BLINK"	OFF	2 BLINK - 50% 3 OFF 4 OFF
X	**X**	FAULT – See Diagnostic Chapter	"BLINK" code [x]	"BLINK" code [y]	2 see code 3 4 OFF
ON	**ON**	RUN	ON	OFF	2 ON 3 OFF 4 ON
ON	**OFF**	STOP	ON	ON	2 ON 3 ON 4 ON
X	**X**	SAFETY – STO OFF (see STO Chapter)	OFF	"BLINK"	2 OFF 3 BLINK - 50% 4 OFF

Table 16 - Analog Mode Led Status

IN3 is programmable input for the logic *Electronic Dynamic (Emergency) Stop;* it is possible to enable/disable this function and select the logic:

1) IN3 ON→OFF activate the Electronic Dynamic Emergency Stop

2) IN3 OFF→ON activate the Electronic Dynamic Emergency Stop

To move the motor is necessary that the inputs IN1 and IN2 are ON. See Digital I/O chapter

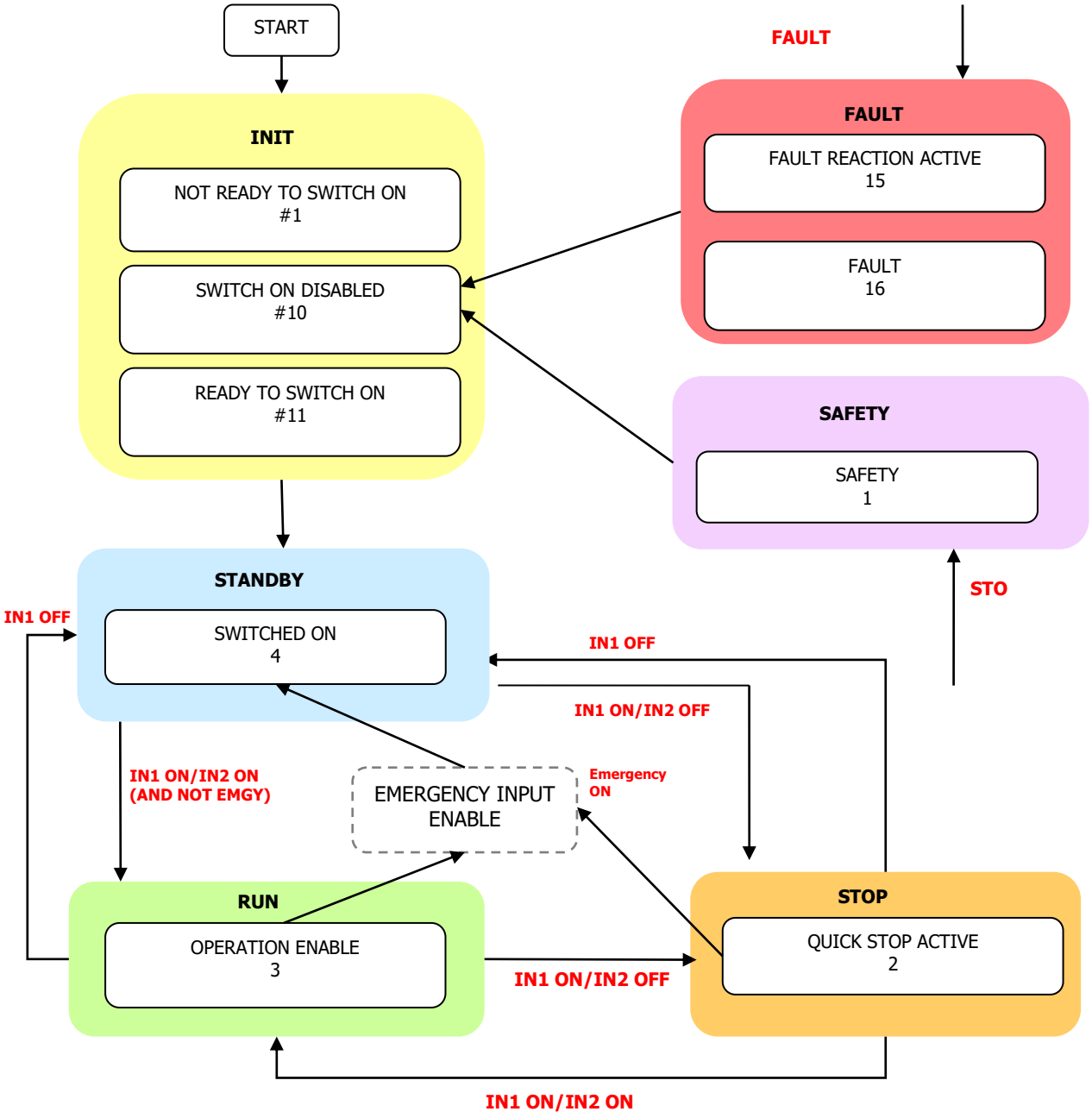
Variable Monitoring

In Analog Mode it's possible to monitor a list of variables on drive by CANOpen, connecting a CAN Interface and using LafertDrive SW:

- Object 2002h: Drive Status Mode
- Object 2003h: Warning
- Object 2004h: State Lafert Servo Drive Machine
- Object 2030h: Temperature Drive
- Object 2031h: Temperature Motor
- Object 2032h: Temperature Heat Sink
- Object 2041h: Voltage Bus
- Object 2050h: Torque Current
- Object 2053h: Velocity Filtered
- Object 2054h: Energy i^2t
- Object 2060h: Impulse
- Object 2070h: Torque Current Windowed
- Object 2080h: STO Statusword
- Object 3020h: Drive Digital Input
- Object 3021h: Digital Input 1
- Object 3022h: Digital Input 2
- Object 3023h: Digital Input 3
- Object 3024h: Digital Input 4
- Object 3030h: Drive Digital Output
- Object 3031h: Digital Output 1
- Object 3032h: Digital Output 2
- Object 3033h: Digital Output 3
- Object 3034h: Digital Output 4
- Object 4000h: Safety State
- Object 4100h: State Communication CAN
- Object 4101h: Counter Communication CAN
- Object 4102h: Settings Communication CAN
- Object 4103h: Error Communication CAN
- Object 4200h: alarm Monitoring
- Object 6041h: statusword
- Object 603Fh: Error Code
- Object 6064h: Position Actual Value
- Object 6077h: torque Actual Value
- Object 606Ch: Velocity Actual

(*) Note: Refers to Lafert CANOpen Manual to see all the variable

4.2.1 DAC monitoring



Picture 4 - Analog Mode State Machine

It is possible to configure the analog output as a monitoring. The object to set DAC configuration is 3050h

- Analog Output = 0: Disabled
- Analog Output = 1: Set as General Purpose
- It is possible to set a Digital value in the sub-index 2 and reading in the output.
- Read analog Output (object 3050h: 3)
- Example: Analog Ouput configured as "Velocity Monitoring" value (object 3050h: 2)

4.3 CANOpen Mode

The Smartris Compact Drive is available with CANOpen (DS301-DS402) alternatively to the Analog Mode: see the CANOpen Chapter for instructions.
To use CANOpen Smartris connected to laptop (free PC Tools available on the WEB) a USB to CAN interface is needed and one suggested is:
PCAN-USB - IPEH-002021 (Peak manufacturer)

https://www.peak-system.com/PCAN-USB.199.0.html?&L=1
See also "Lafert CANOpen Manual"

4.4 Modbus Mode

The Smartris Compact Drive is available with Modbus RS485 Control Mode alternatively to the other Control Mode: see the Modbus Chapter for instructions.
To use Modbus Smartris connected to laptop (free PC Tools available on the WEB) a USB to RS485 interface is needed and one suggested is:

https://ftdichip.com/products/usb-rs485-we-1800-bt/
See also "Lafert Modbus Manual"

4.5 Ramp Speed Set-up

It's possible to set the drive in ramp mode. This Operation mode makes that the variation of speed can be defined by ramp defined by user.

Enable of ramp on speed set point is performed by a flag *(contact Manufacturer for drive in Analog Mode)*
Ramp are enabled when this bit is checked. If you enable this bit you must save on E2Prom and then reset drive before to go in run mode.
There are two parameters that rule action of ramp, time to accelerate from 0 to max speed and time to decelerate from max speed to 0.

Ramp up delay is specified by *RampAcc* on *Drive Parameters (contact Manufacturer)*,
and ramp down is specified by *RampDec* on *Drive Parameters (contact Manufacturer)*,
If the speed ramps are active, each variation of speed set point will correspond a ramp with this parameter.

These parameters are specified in millisecond, their maximum values are 32000. Minimum value depends by max velocity of drive. If you specify a too low value you will get a parameter program error.

This ramp operation mode not is active with STOP command.
During the RUN state If Run command drive down, the drive STOP motor rotation with rotor torque with ramp programmed in *RampDec*.

4.6 Motor Brake

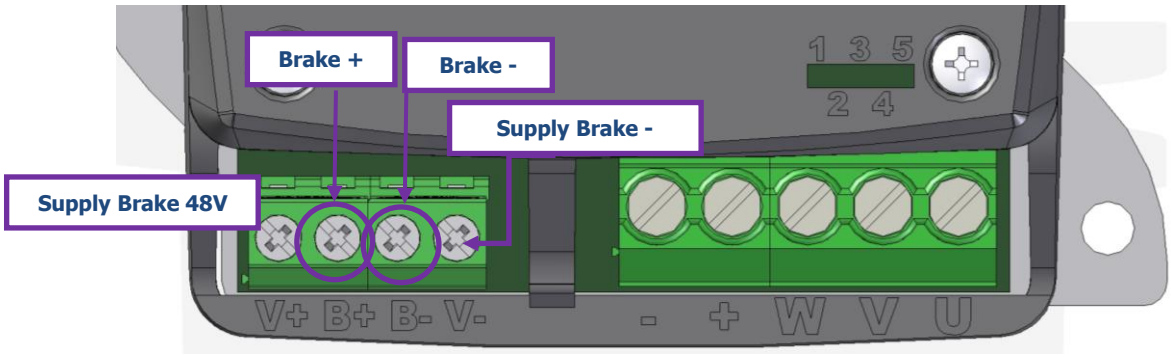
The Motor Brake Management is an output who can drive and supply power directly to a motor brake.

Warning
It is possible to use **DOUT4 - Digital Output 4** – to drive a relay for brake management with externally power supplied

Mise en garde
Il est possible d'utiliser une **DOUT4 – Sortie numérique 4** – pour piloter un relais pour la gestion des freins avec alimentation externe.

To enable this function, you must check BIT_BRAKE (second from the top) into window mask Customer Flag. The brake can be set in Automatic or Manual Mode:

- **Automatic Mode:** The brake will be released (Brake+ = 24V) automatically when the Smartris Compact Drive is set in RUN/Enable.
- **Manual Mode:** the user can be releasing the brake using a dedicated command in CANOpen/Parameter in RAM.
-



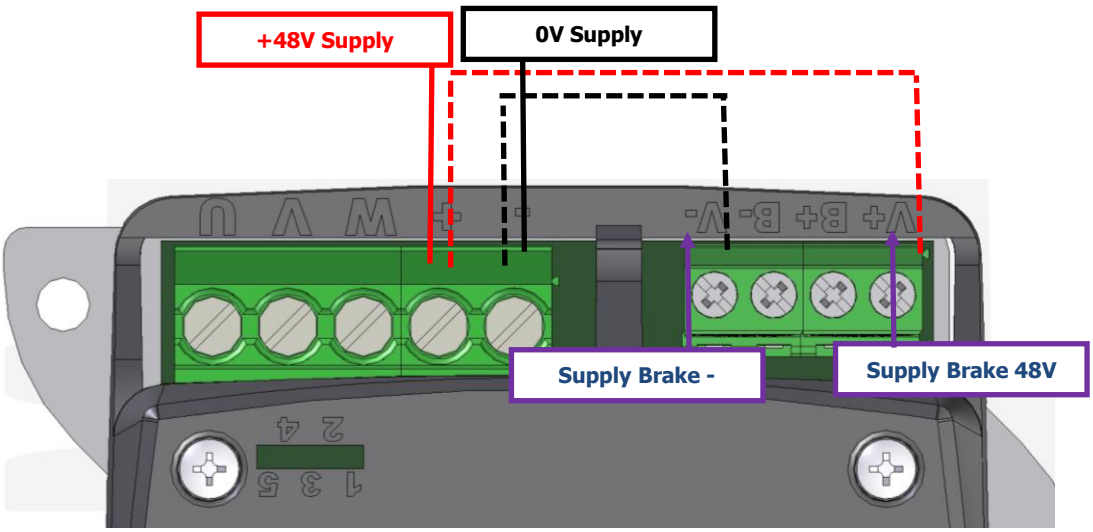
Brake Options			
N°	**Field**	**Configuration**	**Definition**
1	Motor Brake Option (*)	0_b 1_b	Motor Brake disabled or Motor Brake is not present Motor Brake enabled
2	Motor Brake Delay	[ms * 10]	Delay open command. This timeout is the delay between STBY Status and unlock brake.
3	Unlock Brake time	[ms * 10]	Delay between STOP and RUN mode before unlock Brake. This timeout depends by kind of motor brake.
4	Brake timeout	[ms * 10]	Only without Dynamic Brake (see object 0x3007) Max time programmed for natural Inertia deceleration. At the end of this timeout the brake is locked, and drive will be in STBY status.
5	Automatic/Manual Mode Configuration	0_b 1_b	Automatic Mode Activated Manual Mode Activated
6	Motor Brake Status	0_b 1_b	Brake Status: activated → Motor is locked Brake Status: released → Motor is not locked
7	Brake Type	1 2	Magnetic Brake Spring Brake

Table 17 – Brake Options

	Warning
⚠	**(*)** If the motor does not have the brake, this value has 0 as default value. The user CAN'T enable because it is not present.

	Mise en garde
⚠	**(*)** Si le moteur n'a pas de frein, cette valeur a 0 comme valeur par défaut. L'utilisateur NE PEUT PAS l'activer car il n'est pas présent.

	Information Connect "+V" to "+" and "-V" to "-". For different connection contact manufacturer.



4.6.1 Manual Brake Mode

In Analog mode set flag *(contact Manufacturer)* "MANUAL BRAKE" to command the brake use **ParComBrake**

- **ParComBrake** = 1 BRAKE released → motor axis free
- **ParComBrake** = 0 BRAKE active → motor axis locked

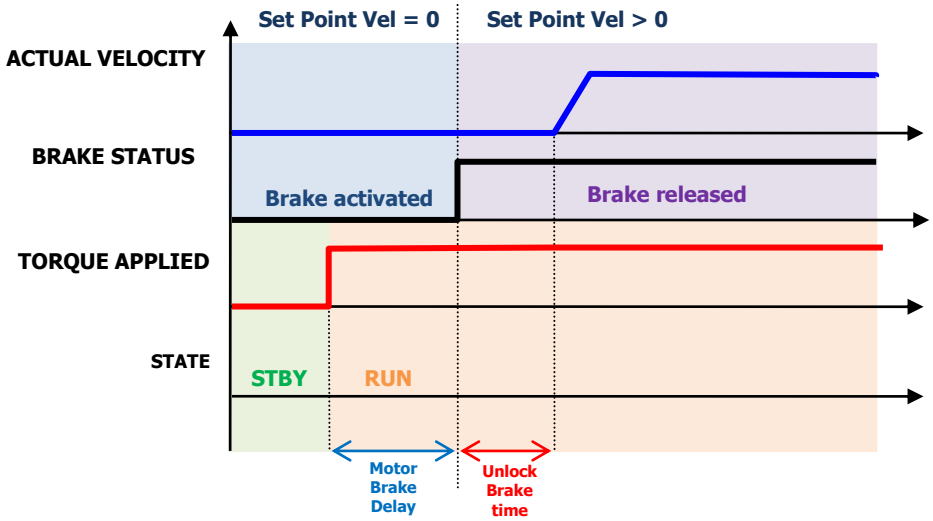
In CANopen Mode set **bit 1** on 60FEh subindex 1,

- **SetBrake** [index 60FEh, subindex 1, bit 0] = 1 BRAKE RELEASED

4.6.2 Automatic Brake Mode

STANDBY → RUN:

The follow graph describes the timing of the brake when the drive moves from STANDBY state to RUN state.



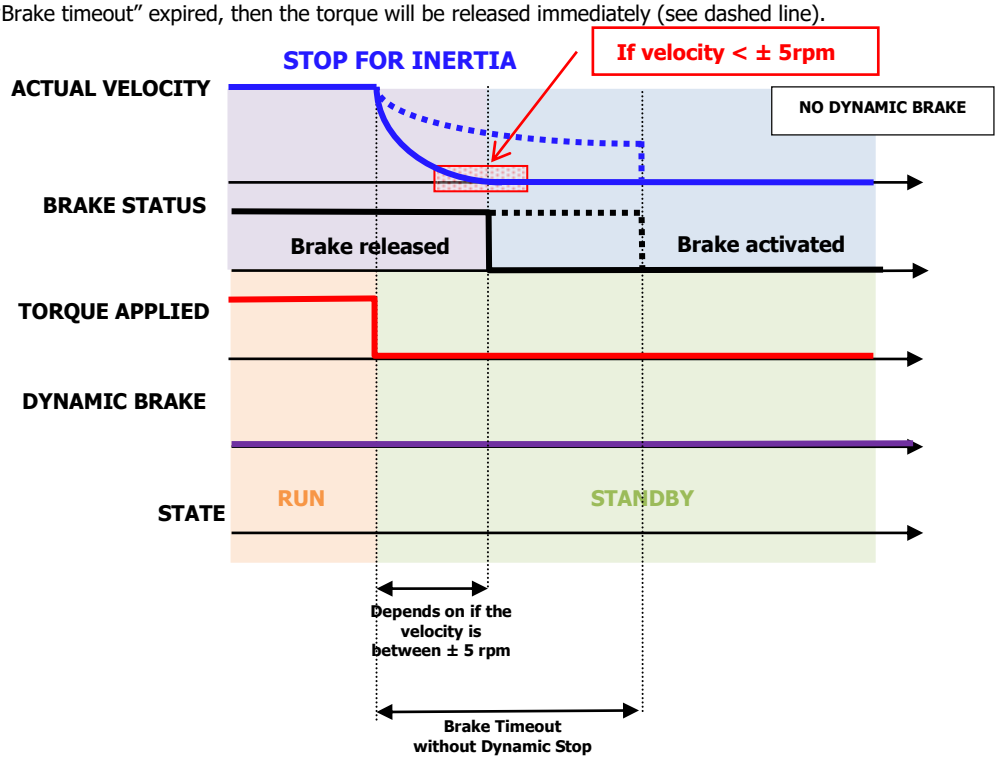
Picture 5 - Brake timeframe Automatic: Standby to Run

4.6.3 Electronic Dynamic Stop

Option	Definition
OFF (without)	the drive will decrease speed with natural inertia. When the speed is zero the drive lock motor brake, but if deceleration speed is major than delay time in set a flag on *Drive Parameters*, the drive however lock brake.
ON (with)	the motor will decrement speed with a ramp set by *electronic dynamic stop* parameters. When the ramp finish, the drive lock brake motor and stay in STOP for a delay time programmed with *DynStop* parameter, finally the drive will turn in STBY mode with locked brake.

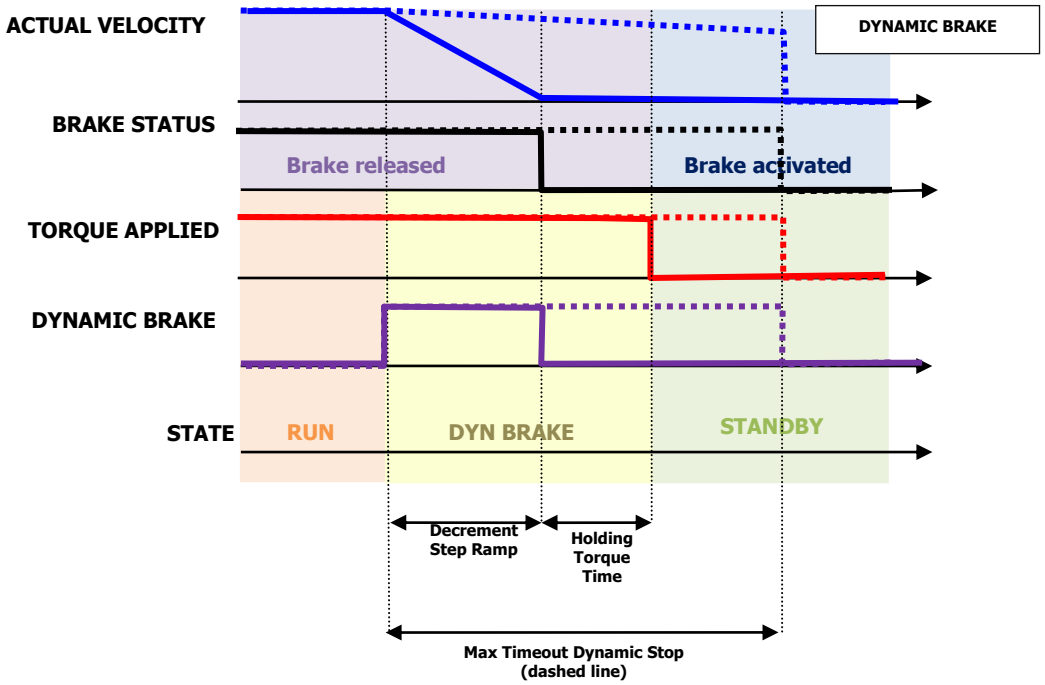
RUN → STANDBY:

Graph without Electronic Dynamic Stop: The motor will stop for inertia when the velocity is lower +/- 5 rpm. If the motor fails to stop and the time "Brake timeout" expired, then the torque will be released immediately (see dashed line).



Picture 6 - Run to Standby without Dynamic Stop

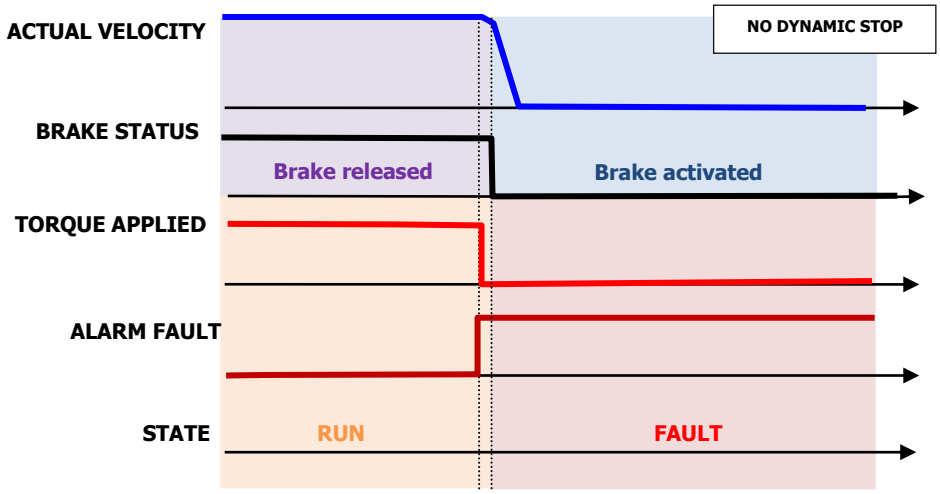
"Max Timeout Dynamic Stop" expired, then the torque will be apply immediately (see dashed line).



Picture 7 - Run to Standby with Dynamic Stop

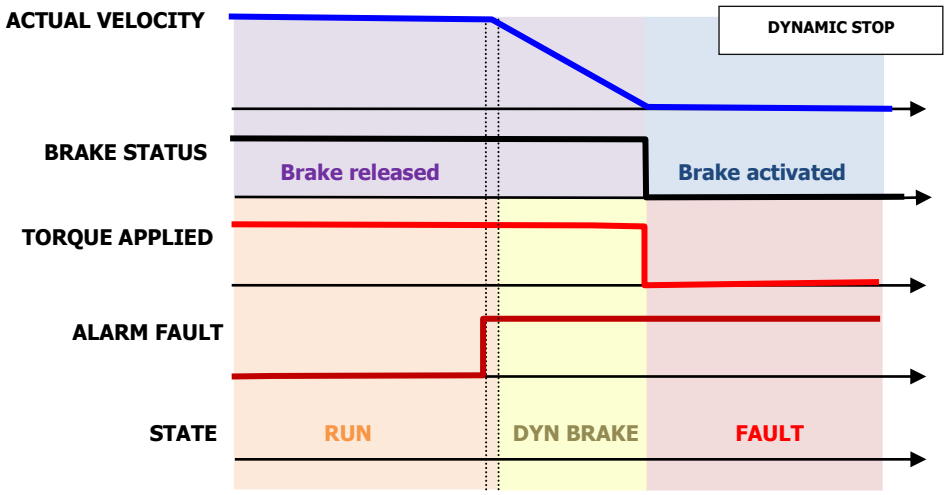
FAULT CONDITION: RUN → FAULT

Graph without Electronic Dynamic Stop: the brake is immediately activated.



Picture 8 - Fault condition: Run to Fault without Dynamic Stop

Graph with Electronic Dynamic Stop: the drive waits the actual velocity will be 0 to activate the brake.



Picture 9 - Fault condition: Run to Fault with Dynamic Stop

4.7 Torque limit

Positive/Negative torque limit value (FW 2.0.1)

It is possible to set a Torque limit (in Analog and CANOpen mode) to set the configured maximum torque in the motor. The value shall be given percent of rated current. In Analog Mode is possible to set a unique value to Positive/Negative while in CANOpen there are different values of maximum torque:

- Positive takes effect in the case of motive operation is positive velocity or regenerative operation is negative velocity.
- Negative torque takes effect in the case of motive operation is negative velocity or regenerative operation is positive velocity

The default value of Torque limit is 100% and modifies can't be saved in e^2prom memory but it can be changed in RAM.

Warning

This object is controlled by some limits of drive. If the value is not correct the drive sends an Abort Code.

If the value is not correct during initialization the drive sends an error messages with Emergency Protocol. See Error Code 0x8B23. The range is [1;100] %

Mise en garde

Cet objet est contrôlé par certaines limites d'entraînement. Si la valeur n'est pas correcte, le variateur envoie un code d'abandon.

Si la valeur n'est pas correcte lors de l'initialisation, le variateur envoie un message d'erreur avec le protocole d'urgence. Voir le code d'erreur 0x8B23. La plage est [1;100] %

4.8 Digital I/O

In Lafert Drives are available:

- 4 Digital Inputs **DIG-INx**
- 4 Digital Outout **DIG-OUTx**
- 2 Safety Digital Input **DIG-STO**

4.8.1 Digital Input - Default Value

When is unset the flag "Enable CAN" (flag on *Drive Parameters -contact Manufacturer*) the drive is in "ANALOG MODE" so to move the motor are used 2 digital inputs:

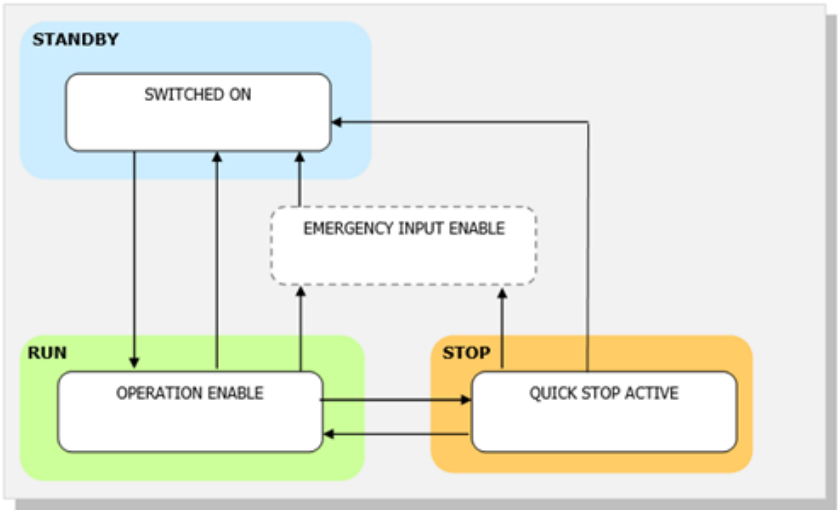
- **DIG-IN1** = RUN in Analog Mode

- **DIG-IN2** = STOP in Analog Mode

If it is available, the STO Safety: if the STO is active the drive goes in SAFETY status independently to other selection.

In case of FAULT the drive goes in FAULT State.
Instead, if is set "CAN Protocol" the State Machine follows the "controlword" (6060h) and Dig In are ignored.

DIG-IN3 can be programmed as "***Enable Input Emergency***".
In this case DIG-IN3 is used to go from RUN to STANDBY in emergency condition with dynamic Stop.



Picture 10 - Emergency enable configuration

It is possible to enable this function:
1. SERIAL: setting flag on *Drive Parameters (contact Manufacturer)*
2. CANOPEN: setting object 0x3008h (Emergency Input Enable) subindex 1

There is the possibility to select the negative front to select the Dynamic Stop:
1. SERIAL: setting flag on *Drive Parameters (contact Manufacturer)*
2. CANOPEN: setting object 0x3008h (Emergency Input Enable) subindex 2

The digital input number 3 can be configured as enabling signal hardware to move from "Operation Enable" state [RUN] to "Switched On" state [STANDBY].

Warning
It can be considered as emergency signal but it isn't safety certificated (for disabling the power in safety certificated condition referred to STO chapter of Drive User Guide).

Attention
Il peut être considéré comme un signal d'urgence mais il n'offre pas une garantie de sécurité (pour désactiver l'alimentation en condition de sécurité garantie, se référer au chapitre STO du Guide de l'utilisateur du variateur).

DIG-IN4 is Reset Drive Software.

4.8.2 Digital Input (Programmable)

From Firmware release 2.0.1 the Digital Inputs are programmable using internal parameters (modifiable by Lafert software). Contact the Manufacturer to set the different function for Digital Inputs. It is possible read

and modify (from firmware release 2.3.5) the settings of Digital Input with object of CANOpen protocol or with "Lafert Studio Application" software.

In Analog Mode the drive can be controlled in two different modes:

1. Analog Reference (for Torque or Velocity profile):
   The reference is proportional to the speed full scale or to the maximum current.
   The reference can be [-10…+10] V (default), [-5…+5] V, [0…+10] V and [0…5] V. To set a different range than the default range (±10V), contact the Manufacturer.
   For example:
   If the full-scale velocity is 3000 RPM and the analog reference [-10…+10] V is [-3000…+3000] RPM.
2. Pre-set of digital set point (only velocity profile):
   The pre-sets are defined together Manufacturer. To use them and to be defined contact the Manufacturer.
   It is possible to define 4 pre-sets with 2 digital set-points, or 4 digital set-points, or 8 digital set-points or 15 digital set-points.

The default digital inputs configuration is the drive in analog reference to range (±10V) (see paragraph "Digital Input -Default Value") and the

- Digital input 1: RUN
- Digital input 2: STOP
- Digital input 3: EN. EMERGENCY
- Digital input 4: RESET

To control the drive in analog mode the RUN function must be defined. This function of digital input needs to move the drive in the state machine.

	Information
	To change Digital Input **DEFAULT** configuration contact manufacturer

The different combination for analog reference configuration is composed by at least digital input configured by RUN and other function:

- **STOP**: this function is the command to move the drive in STOP state
- **EN. EMGY**: this function is the command of enable emergency; it needs to move the drive in STANDBY state.
- **RESET**: this function is the command reset (it is a hardware reset). The reset has a filter with 100ms.
- **DCW** (*): this function is the signal of a limit switch for clockwise. If the input state is 1 the drive goes in STOP state.
- **DCCW** (*): this function is the signal of a limit switch for counterclockwise. If the input state is 1 the drive goes in STOP state.
- **DIR**: this function is the command to invert the Set Point
- **V/C**: this function is the command to change the mode profile velocity in torque profile and vice versa. The condition is processed when the drive is in standby state.
- **Zero Pos**: possibility to write 0 value on actual position

Note (*): the functions of limit switch must be set together. If the drive is configured with only one limit switch, then the drive sends a fault "programming error data set".

To have the drive with digital set points it needs to have at least a digital input configured by function SETVELx. Follow it is described the 4 combinations:

- PRE-SET 1: number 2 Digital Set Points.

  Digital Inputs configuration: one digital input configured by RUN and one digital input configured by SETVEL1

  The other 2 inputs free can be set by function: RESET, STOP, EN. EMRGY, DIR, DCW, DCCW (the limit switch must be configured together).

- PRE-SET 2: number 4 Digital Set Points.

  Digital Input configuration: one digital input configured by RUN and two digital inputs configured by SETVEL1 and SETVEL2. The other input free can be set by function: RESET, STOP, EN. EMRGY, DIR.

- PRE-SET 3: number 8 Digital Set Points.

Digital Input configuration: one digital input configured by RUN and other digital inputs configured by SETVEL1, SETVEL2, SETVEL3. There is no one input available for other functions.

- PRE-SET 4: number 15 Digital Set Points.

  Digital Input configuration: all digital inputs configured by SETVEL1, SETVEL2, SETVEL3 and SETVEL4. When all digital inputs are 0 is the command to move the drive from RUN state to STANDBY state, when any digital input change 1 then the drive moves in RUN. There is no one input available for other functions.

	CONFIGURATION DIGITAL INPUTs				PRE-SET
				SETVEL1	**1**
			SETVEL2	**SETVEL1**	**2**
		SETVEL3	**SETVEL2**	**SETVEL1**	**3**
Digital Set Points	**SETVEL4**	**SETVEL3**	**SETVEL2**	**SETVEL1**	**4**
Dig. Set Point 0	0	0	0	0	**1**
Dig. Set Point 1	0	0	0	1	
Dig. Set Point 2	0	0	1	0	**2**
Dig. Set Point 3	0	0	1	1	
Dig. Set Point 4	0	1	0	0	**3**
Dig. Set Point 5	0	1	0	1	
Dig. Set Point 6	0	1	1	0	
Dig. Set Point 7	0	1	1	1	
Dig. Set Point 8	1	0	0	0	**4**
Dig. Set Point 9	1	0	0	1	
Dig. Set Point 10	1	0	1	0	
Dig. Set Point 11	1	0	1	1	
Dig. Set Point 12	1	1	0	0	
Dig. Set Point 13	1	1	0	1	
Dig. Set Point 14	1	1	1	0	
Dig. Set Point 15	1	1	1	1	

Note:

1. In pre-set configuration the input function V/C is forbidden because the presets are available only Velocity profile mode.
2. The function DCW and DCCW must be set together (this function can be set only for PRE-SET 1).
3. For PRE-SET 4 the Digital Set Point 0 is not available because this combination of digital inputs is the command to move in standby state.

Every digital input can be set with a different function available. It is not important the sequence of the function, it must set the RUN function when the drive is configured in analog mode (except PRE-SET4).
The word that defines the functions available is composed by bits, every bit describes the function:

BIT	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	-	-	-	ZERO POS	DIR	VEL/CUR	SETVEL4	SETVEL3	SETVEL2	SETVEL1	DCCW	DCW	RST	EMGY	STOP	RUN

Where

Bit	Configuration
0	"RUN" (used only in Analog Mode): this input is the command to move the drive in RUN state.
1	"STOP" (used only in Analog Mode): this input is the command to move the drive in STOP state
2	"EMERGENCY INPUT ENABLE": when the option of digital input 3 is defined "Emergency Input Enable" this input is the command to move the drive in STANDBY state.
3	"RESET": when this function is enabled the input configured can put the drive in reset (it is an hardware reset). If the digital input is configured as reset, the reset has a filter with 100ms.
4	"DCW": this function is to configure the input with an actuator for clockwise. If the input state is 1 the drive goes in STOP state.
5	"DCCW": this function is to configure the input with an actuator for counterclockwise. If the input state is 1 the drive goes in

	STOP state
6	"SETVEL1" (used only in Analog Mode): This function is to configure the Set Point value defined by "File Parameters". If the digital inputs are set with this function, then the Set Points available are 2.
7	"SETVEL2" (used only in Analog Mode): This function is to configure the Set Point value defined by "File Parameters". If the digital inputs are set with the functions "SETVEL1" and "SETVEL2", then the Set Points available are 4.
8	"SETVEL3" (used only in Analog Mode): This function is to configure the Set Point value defined by "File Parameters". If the digital inputs were set with the functions "SETVEL1", "SETVEL2" and "SETVEL3", then the Set Points available are 8.
9	"SETVEL4" (used only in Analog Mode): This function is to configure the Set Point value defined by "File Parameters". If the digital inputs were set with the functions "SETVEL1", "SETVEL2", "SETVEL3" and "SETVEL4", then the Set Points available are 15. If this function is set then all digital inputs are used. When all dital inputs are 0 the drive is in STANDBY, to have the RUN function it needs to have at least one digital input as 1.
10	"VEL/CUR" (used only in Analog Mode): If the digital Input is selected with this function then the drive change the mode operation (Velocity Profile and Torque Profile), the function can be used only in standby state.
11	"DIR" (used only in Analog Mode): This function changes the direction of the motor. The set point changes the polarity.
12	"ZERO POS": This function if '1' set the actual position will be 0, It does not move the motor in ZERO position, but it reset the actual position.

Table 18 – Programmable Inputs

Warning

- RUN, STOP, SETVEL1, SETVEL2, SETVEL3, SETVEL4, DIR and V/C are functions for digital Input for Analog Mode
- EMERGENCY INPUT ENABLE is the function to move the drive in "Switched On" state of DSP402 (or "STANDBY" state of the MSM of LSD) from the "Operation Enabled" state of DSP402 (or "RUN" state of the Macro State Machine of LSD). This command is used for emergency stop. See object 3008h "Emergency Enable Parameters

Entrée numérique (programmable)

Attention

- RUN, STOP, SETVEL1, SETVEL2, SETVEL3, SETVEL4, DIR et V/C sont des fonctions pour l'entrée numérique dans le mode analogique.
- EMERGENCY INPUT ENABLE est la fonction permettant de déplacer le variateur dans l'état « Allumé » du DSP402 (ou « VEILLE » du MSM du LSD) depuis l'état « Fonctionnement actif » du DSP402 (ou « MARCHE » de l'état de la macro Machine de LSD). Cette commande est utilisée pour l'arrêt d'urgence. Voir l'objet 3008h « Paramètres d'activation d'urgence ».

4.8.3 Digital I/O Safety STO (where available)

DIG-STO: see relative chapter.

4.8.4 Digital Output

From Firmware release 2.3.5 the Digital Outputs are programmable using internal parameters (modifiable by Lafert software). Contact the Manufacturer to set the different function for Digital Outputs. It is possible read and modify the settings of Digital Outputs with object of CANOpen protocol, Modubus's registers or with "Lafert Studio Application" software.
The default digital output configuration is

- Digital Output 1: DRIVE OK
- Digital Output 2: WARNING
- Digital Output 3: READY
- Digital Output 4: BRAKE

DIG-OUT1: shows if the drive is:

- '1' = Drive OK
- '0' = Drive in FAULT

DIG-OUT2 shows if the drive is:

- '1' = There is a Warning activate
- '0' = No warning

DIG-OUT3 shows if the drive is:
- '1' = Motor is ready to move
- '0' = Motor is not ready to move

DIG-OUT4 shows the BRAKE status:
- '1' = brake released; motor axis free
- '0' = brake active, motor blocked

It is possible with CANopen DSP402 read the status of Digital Outputs with 0x60FE.
The digital outputs are programmable, configurations available are:

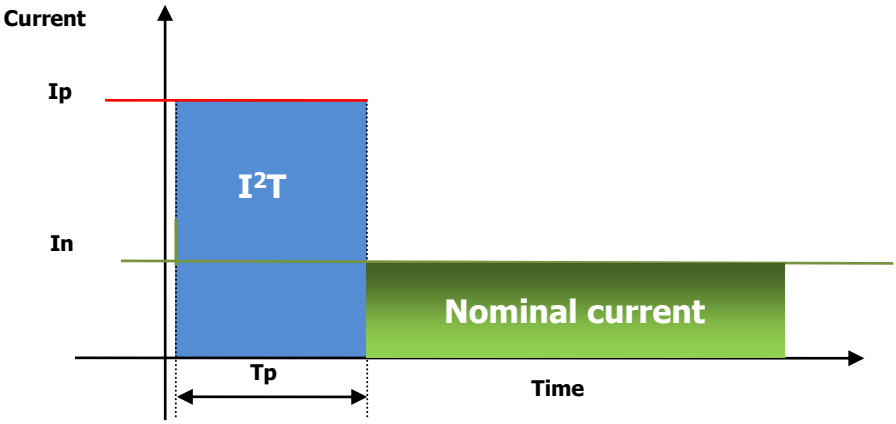
- BIT 0 – FUNCTION 1 - "DRIVE OK": the level defines if the drive is in alarm or not. If the level is '1' the drive does not have alarm, and it is in normal condition.
- BIT 1 – FUNCTION 2 - WARNING": the level defines if there was at least warning. To know what the warning has occurred it is necessary to read the warning object 0x2003.
- BIT 2 – FUNCTION 3 - "TARGET REACHED": reserved
- BIT 3 – FUNCTION 4 - "BRAKE STATUS": the level defines the state of brake.
- BIT 4 – FUNCTION 5 - "READY": verifies if the drive is ready to go in run
- BIT 5 – FUNCTION 6 - "MOTOR MOVE": it shows the motor moving. The threshold is object $606F_h$:0 " Velocity Threshold" with timer 6070_h: 0 "Velocity Threshold Timer". If the velocity exceeds this threshold the bit "MOTOR MOVE" will be '1'. This control is valid for all profiles.
- BIT 6 – FUNCTION 7 – "I2T Limit": in case of motor in I2T limitation (Overload alarm disabled) the Digital Out is ON

	Information
	To change Digital Output **DEFAULT** configuration contact manufacturer

4.9 Overload Management (I^2T)

The Smartris Compact Drive uses the I^2t protection method to prevent motor winding and insulation damage caused by high motor temperature due to motor excessive work.
The I^2t algorithm evaluates the motor dissipating heat without any sensor. When the evaluated temperature exceeds the maximum, I^2t algorithm protects the motor placing the drive in Fault Overload

The I^2t principal algorithm calculation is as follows:
$I^2T = (Ip^2 - In^2) * Tp$



Picture 11 - I^2T Management
Where:
- Ip – motor peak current in rms

- In – motor nominal current in rms
- Tp – motor peak current time in seconds

It is possible with CANopen DSP402 read the status with the bit 11 of statusword (0x6041 object).
During the limitation there is emergency message that describes when the drive is in Warning Limitation i2t for Overload (error code 0x2351) and in alarm (error code 0x2350).

The Smartris Compact Drive manage also 2 kinds of Overload:

- Overload at low speed (default 30 rpm - settable only by manufacturer)
- Protection to Overload close events.

4.9.1 Overload at low speed

In Smatris drive there is a function to modify the Overload function depending by speed.
Under a specific value the Energy is reduced. This means that at low speed the I^2t time is reducing to half and the Rated Current is around 70% of the standard.
At normal speed there is no effect.

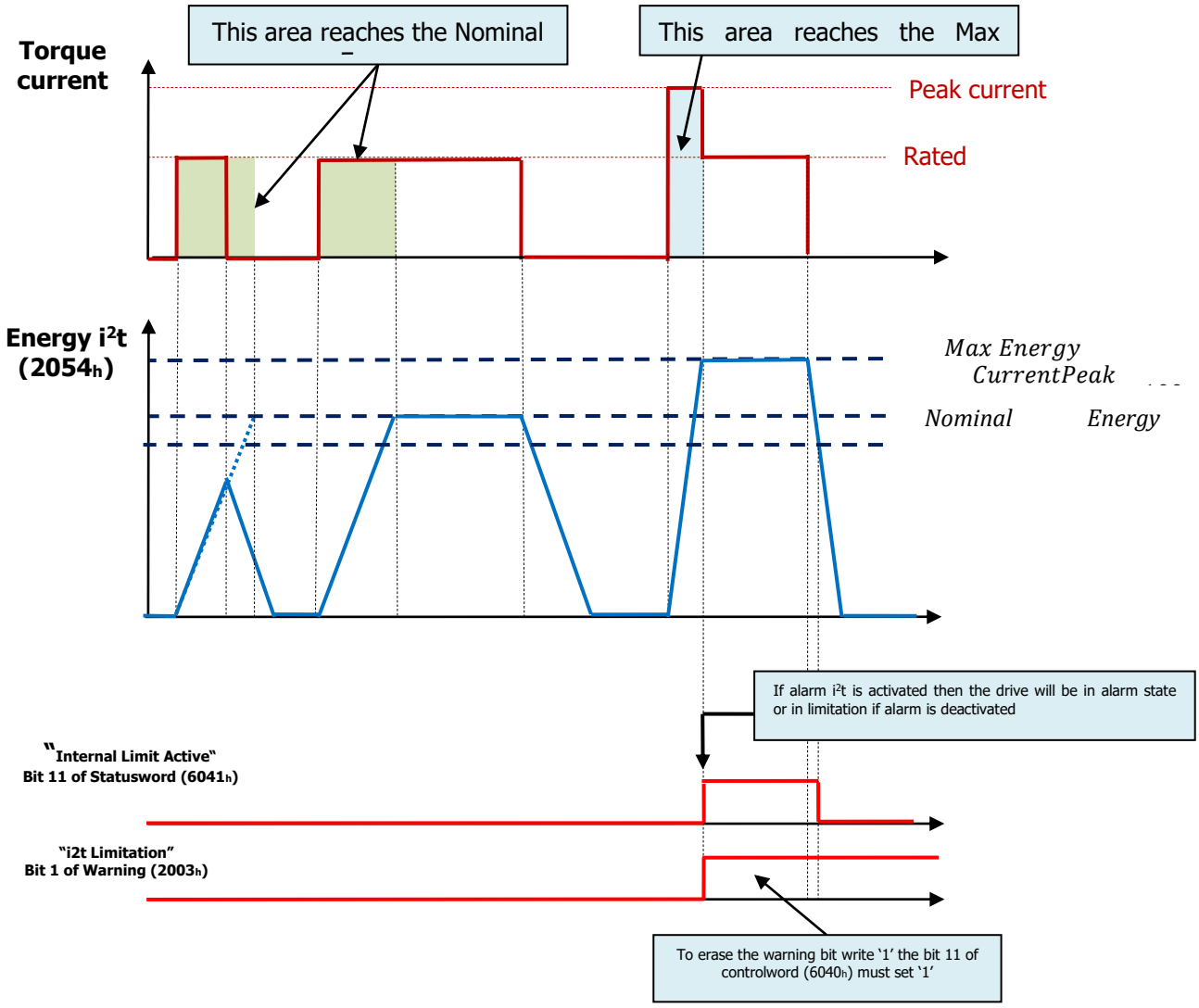
It is possible with CANopen DSP402 read the status with the bit 11 of statusword (0x6041 object).
During the limitation there is emergency message that describes when the drive is in Warning Limitation i2t for Overload (error code 0x2351) and in alarm (error code 0x2350).

4.9.2 Overload with closer events

There is a function that prevents the drive goes to Run if numerous close I^2t events have occurred.
After 2 consecutive Fault Overload Events it is necessary to wait one minute before enabling the drive, otherwise, the drive will go into Fault I^2t Overload Protection (code 5,2)

It is possible with CANopen DSP402 to read the alarm (error code 0x2352).

Following graph shows the i^2t protection:



4.10 OVER SPEED

The drive has the alarm Over Speed (default set to 10% over the Maximum Limit Velocity defined).

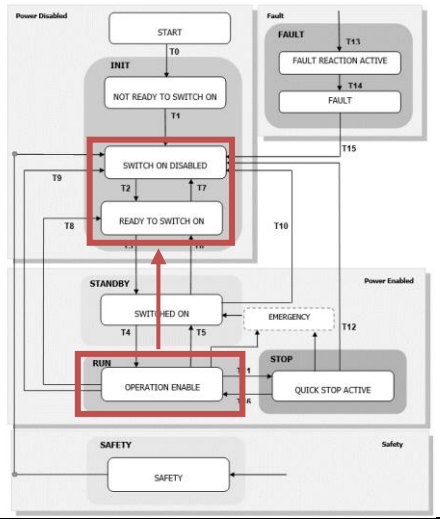
4.11 BRAKE MANAGEMENT AFTER STOP

After firmware 236, the user can configure different modes of brake use during the transition out of the RUN" operation enable" state.

	Information
	It is necessary to write new parameters (either objects in CANopen or registers in MODBUS). To change in Analog Mode configuration contact manufacturer

	Warning
	The Stopping mode conditions are available only with Velocity Profile Mode

Transition to INIT "Switch On Disabled" with controlword:



This transition is valid only CANopen.

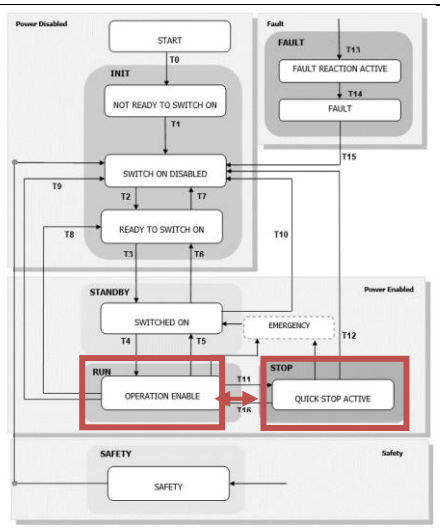
- To go in "Ready to switch on" (INIT) the drive needs receive a "shutdown" command of controlword.
- To go in "Switch On Disabled" (INIT) the drive needs receive a "Disable Voltage" command of controlword.

It's possible to exit from "operation enabled" (RUN) to "Ready To Switch On" or "Switch On Disabled" (INIT) using specific command of controlword.

This transition can be configured writing value:

- 0 = The drive switch-off the drive power stage and the motor will stop by inertia
- 1 = The drive switches-off and the motor will stop with a deceleration with a specific ramp that can be configured by the user

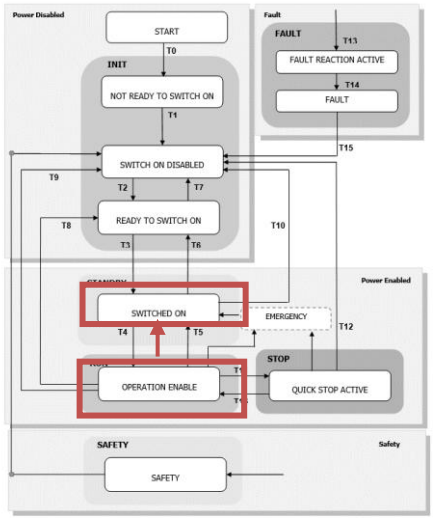
Transition to STOP "Quick Stop Active" with controlword or digital command:



To exit from "operation enabled" (RUN) to "quick stop active" (STOP) it needs to set the command "Quick Stop".

This transition can not be configured writing value: the drive will go immediately in stop (without ramp), in this state the drive will be in holding torque

Transition to STANDBY "Switched On" with controlword:

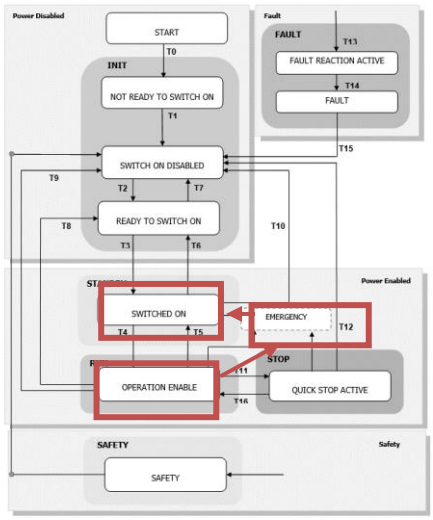


It's possible to exit from "operation enabled" (RUN) to "switched on" (STANDBY) using "Disable Operation" command of controlword or digital input command.

This transition can be configured writing value:

- 0 = The drive switch-off the drive power stage and the motor will stop by inertia.
- 1 = The drive switches-off and the motor will stop with a deceleration with a dynamic ramp. This operation mode grants a deceleration with a specific ramp that can be configured by the user.
- -1 = The drive will stop immediately with setpoint set to 0
- -2 = The drive switch-off the drive power stage and the motor will stop by inertia. When the motor is not running the drive remains stopped with torque for a time delay
- -3 = The drive will stop immediately with setpoint set to 0 and the motor brake is locked immediately
- -4 = The drive switch-off the drive power stage and the motor brake is locked immediately
- -5 = The drive switches-off and the motor will stop with a deceleration with a S-Ramp. This operation mode grants a deceleration with a specific ramp that can be configured by the user. (Enable from FW 240 with S-Ramp profile)

Transition to STANDBY "Switched On" with Emergency command



It's possible to exit from "operation enabled" (RUN) to "switched on" (STANDBY) consider these different ways with "emergency command":

- Use "Emergency Input" if a digital input is programmed as "EMERGENCY" function. This is a hardware physical input at 24V. In case of a transition level (0 to 24V or 24V to 0 depending on configuration) the drive will go in "Switched On" (STANDBY).
- Use "Emergency command" if the bit of controlword is set. While motor is running, the master controller can move the drive in "Switched On" (STANDBY) writing '1' in bit of controlword (command EMERGENCY).

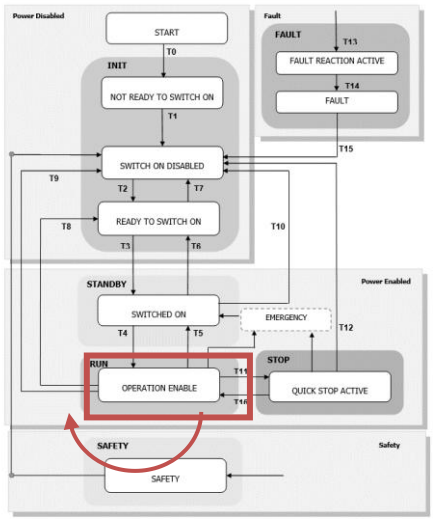
If the drive has torque applied means that the drive is in "operation enabled" (RUN) state or "quick stop active" (STOP) state, if one digital input is configured as "Emergency Input" the customer can use this digital to move the drive in "switched on" (STANDBY) state.

This transition can be configured writing value:

- 0 = The drive switch-off the drive power stage and the motor will stop by inertia.
- 1 = The drive switches-off and the motor will stop with a deceleration with a dynamic ramp. This operation mode grants a deceleration with a specific ramp that can be configured by the user.
- -1 = The drive will stop immediately with set point set to 0
- -2 = The drive switch-off the drive power stage and the motor will stop by inertia. When the motor is not running the drive remains stopped with torque for a time delay
- -3 = The drive will stop immediately with setpoint set to 0 and the motor brake is locked immediately
- -4 = The drive switch-off the drive power stage and the motor brake is locked immediately

	• -5 = The drive switches-off and the motor will stop with a deceleration with a S-Ramp. This operation mode grants a deceleration with a specific ramp that can be configured by the user. (Enable from FW 240 with S-Ramp profile)

Transition to Stay In "Operation Enabled":



This transition is valid only CANopen.

When switching modes in "operation enabled" (RUN), the transition proceeds as if bit 8 (Halt bit Command) in the controlword has been set. While motor is running, in case bit 8 in controlword has been set (Halt bit Command), motor will stop immediately (without ramp) maintaining "operation enabled" (RUN). When motor will read 0 speed, torque still be present (and maintained) at motor shaft.

This condition is used in the following modes:

- Profile Velocity
- Profile Torque

If the master controller switch the controlword bit 8 (Halt bit Command)

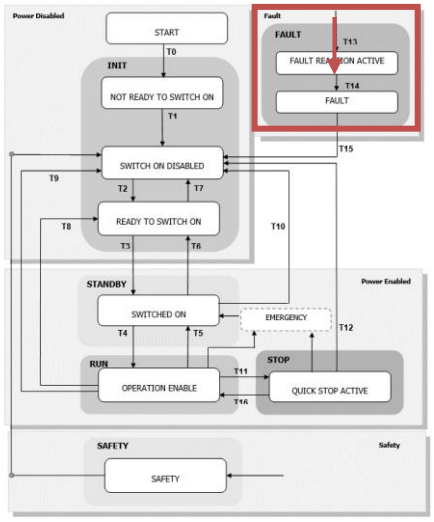
- 0 → 1 the trajectory generator ramps its control output down to zero
- 1 → 0 the trajectory generator ramps its control output up to the target.

In both cases the trajectory generator takes the profile acceleration and velocity type (profile velocity) or the torque slope and torque type (profile torque) into consideration. To have more information it needs read the chapter relatives "Velocity Profile" and "Torque Profile" Halt bit Command description (bit 8 of controlword).

To stay in "operation enabled" (RUN) with motor in STOP is possible also setting the Set Point equal 0: the Customer has to fix at 0 rpm the speed set point. In this case drive will perform a stop with a deceleration ramp configured in object 6084h "Profile deceleration".
Motor will be ramped to 0 rpm and the status of "Operation Enabled"(RUN).

It is possible to remain in the state with the motor with torque applied using HALT command bit 8 of controlword.

Transition To "Fault Reaction Active" :



When the fault occurred the drive exits from "operation enabled" (RUN) (and from all states) considering the value of parameter that it defines the configuration of transition.

Some alarms are not configurable with dynamic stop and the drive will stop (turn off the PWM immediately) and it will go in fault state without dynamic stop. These alarms are:

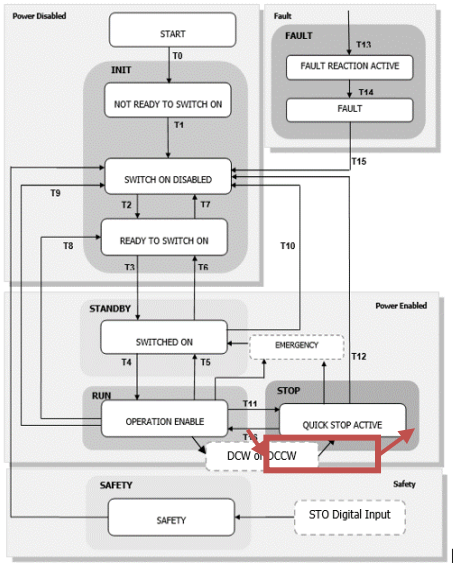
- Over Current
- Over Voltage
- Over Speed
- Feedback Resolver Error

This transition can be configured writing value. The value can be:

- 0 = the drive will go in "Fault Reaction Active" (FAULT) will go immediately (without ramp) and the motor will stop by inertia.
- 1 = the drive will go in "Fault Reaction Active" (FAULT) state with ramp controlled.
- -1 = the drive will go in "Fault Reaction Active" (FAULT) and it will stop immediately with setpoint set to 0
- -2 = the drive will go in "Fault Reaction Active" (FAULT) and it switch-off

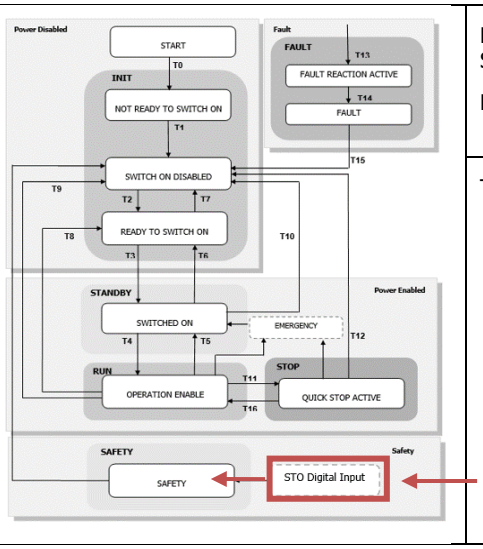
	the drive power stage and the motor will stop by inertia. When the motor is not running the drive remains stopped with torque for a time delay • -3 = the drive will go in "Fault Reaction Active" (FAULT) and it will stop immediately with setpoint set to 0 and the motor brake is locked immediately • -4 = the drive will go in "Fault Reaction Active" (FAULT) and the drive switch-off the drive power stage and the motor brake is locked immediate7 • -5 = the drive will go in "Fault Reaction Active" (FAULT) and it switches-off and the motor will stop with a deceleration with a S-Ramp. This operation mode grants a deceleration with a specific ramp that can be configured by the user. (Enable from FW 240 with S-Ramp profile)

Transition to STOP "Quick Stop Active" with Dig. Input (DCW or DCCW)



	If the digital inputs are configured like Digital Limit Switch Clockwise (DCW) and Digital Limit Switch Counter Clockwise (DCCW) means that when these inputs are triggered and the motor speed is not zero (positive velocity and negative velocity correspondent), the drive will go in "Quick Stop Active" immediately with set point at 0. To exit for this condition (and from state "quick stop active") the master controller has to send an opposite set point or the limit switch must be disabled.
	This transition can not be configured writing value: the drive will go immediately in stop (without ramp), in this state the drive will be in holding torque

Transition To "Safety" state with STO



	From all states, also from "operation enabled" (RUN), it is possible to enable STO if it is available. Refer to chapter "Safety" to have more information.
	This transition can be configured writing value. The value can be: • 0 = the drive goes immediately in safety and it disables the PWM. The brake is not activated and the motor will stop with inertia. • 1 = the drive goes immediately in safety and it disables the PWM and it locks immediately the brake.

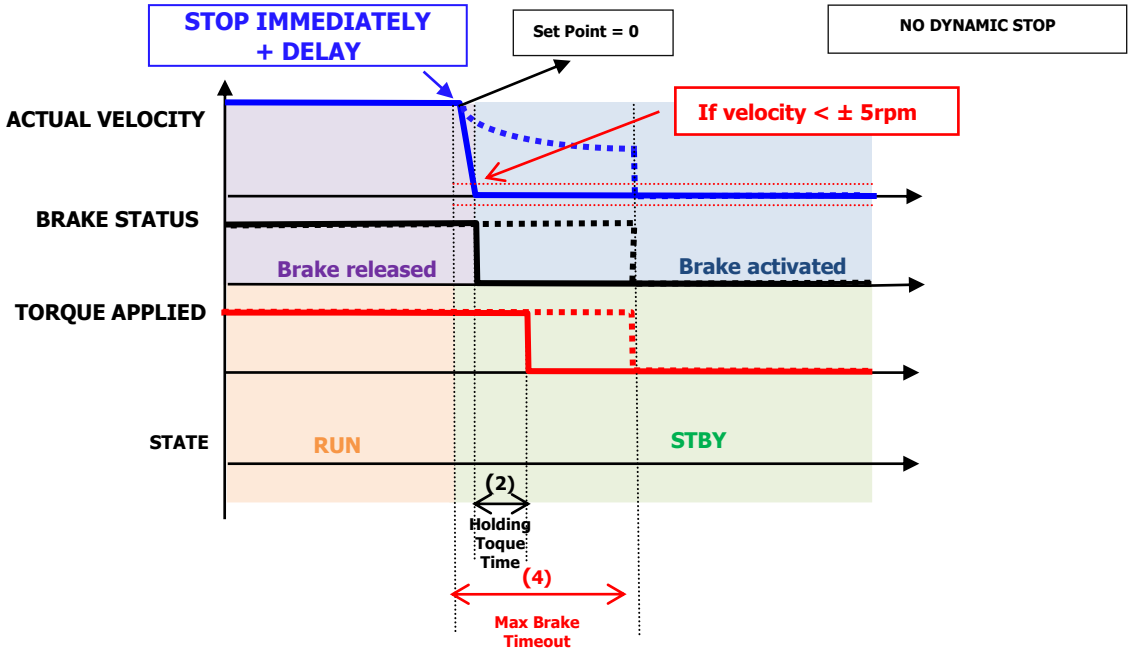
4.11.1 Graphs for different Stopping Mode (FW 2.3.8)

TRANSITION STOPPING MODE '-1':

The follow graph describes the timing stop of drive when the electronic Dynamic Stop is not applied.

The motor will stop with set point = 0, when the velocity is lower ±5 rpm the drive locks motor brake and the torque is applied for "Holding torque time".

If the motor fails to stop and the time "Max Brake timeout" is expired, then the torque will be released immediately and the brake is locked (see dashed line).



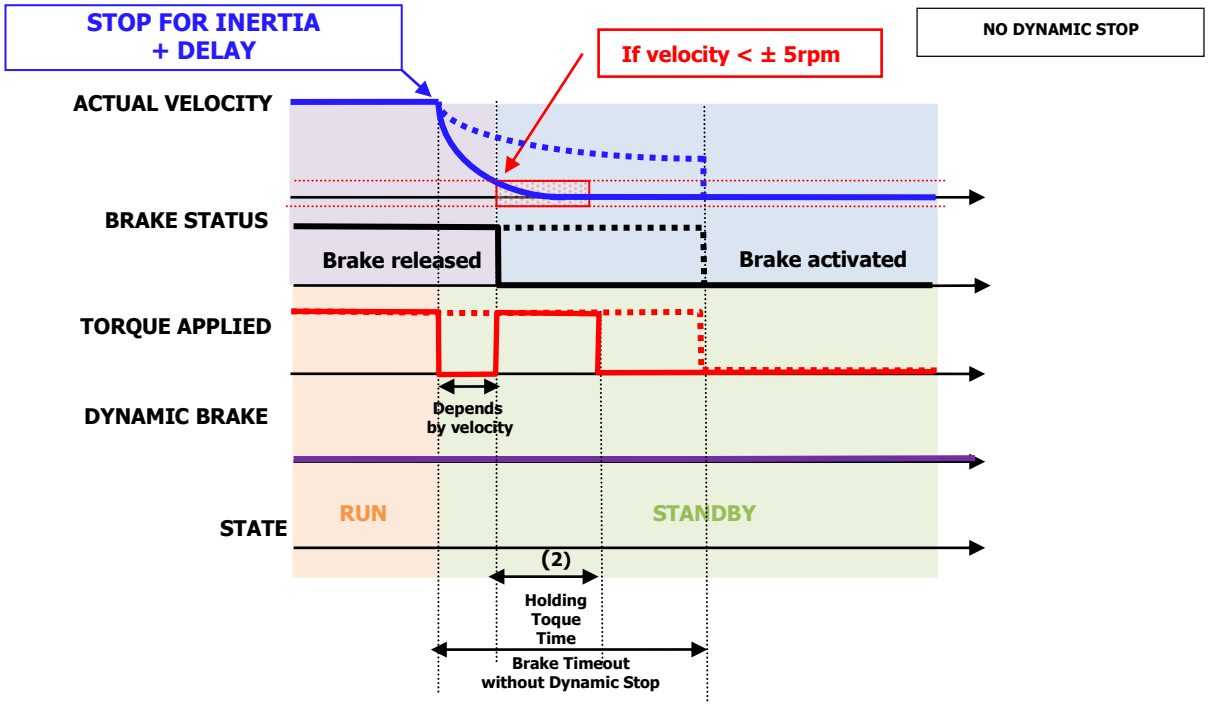
Picture 12– Dynamic Stop timeframe: To Standby without Dynamic Stop (-1)

TRANSITION STOPPING MODE '-2':

The graph above describes the timing stop of drive when the electronic Dynamic Stop is not applied.

The motor will stop because it is switch-off the drive power stage. When the velocity is on the range ±5 RPM it actives the electronic brake motor and It re-enables the drive function until the time delay is expired.

If the motor fails to stop and the time "Max Brake timeout" is expired, then the torque will be released immediately, and the brake is locked (see dashed line).

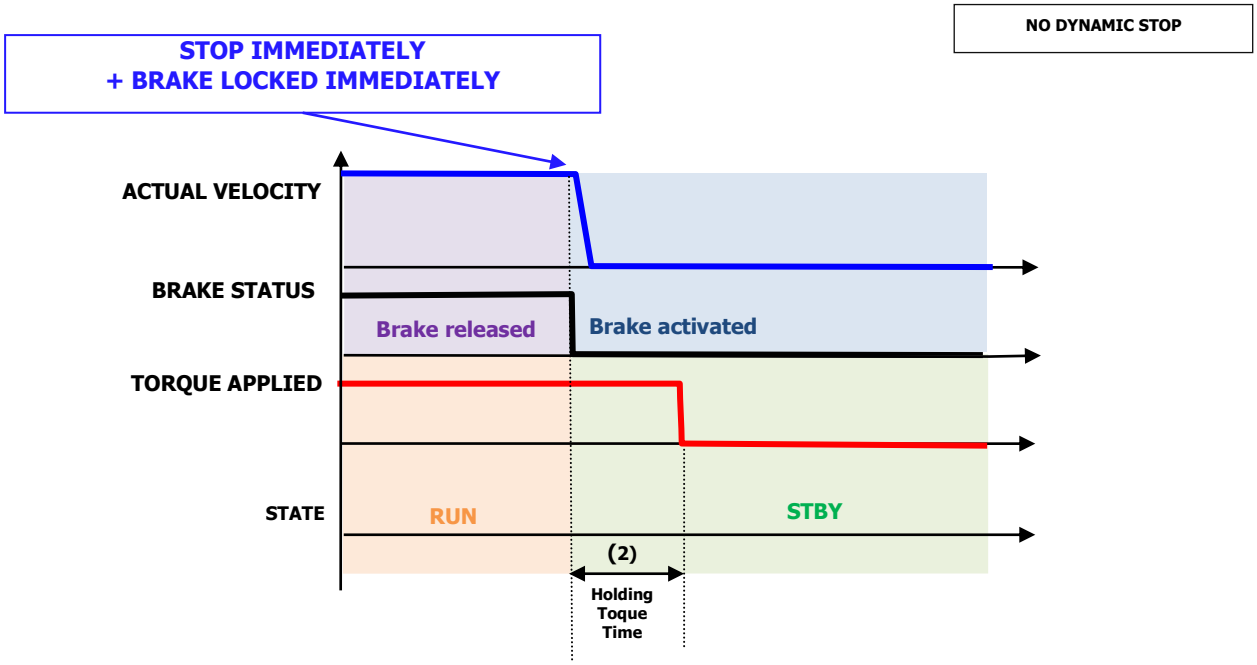


Picture 13 - Dynamic Stop timeframe: to Standby without Dynamic Stop (-2)

TRANSITION STOPPING MODE '-3':

The follow graph describes the timing stop of drive when the electronic Dynamic Stop is not applied.

The motor will stop immediately and the brake motor is locked immediately. In this case the set point is also set to 0.



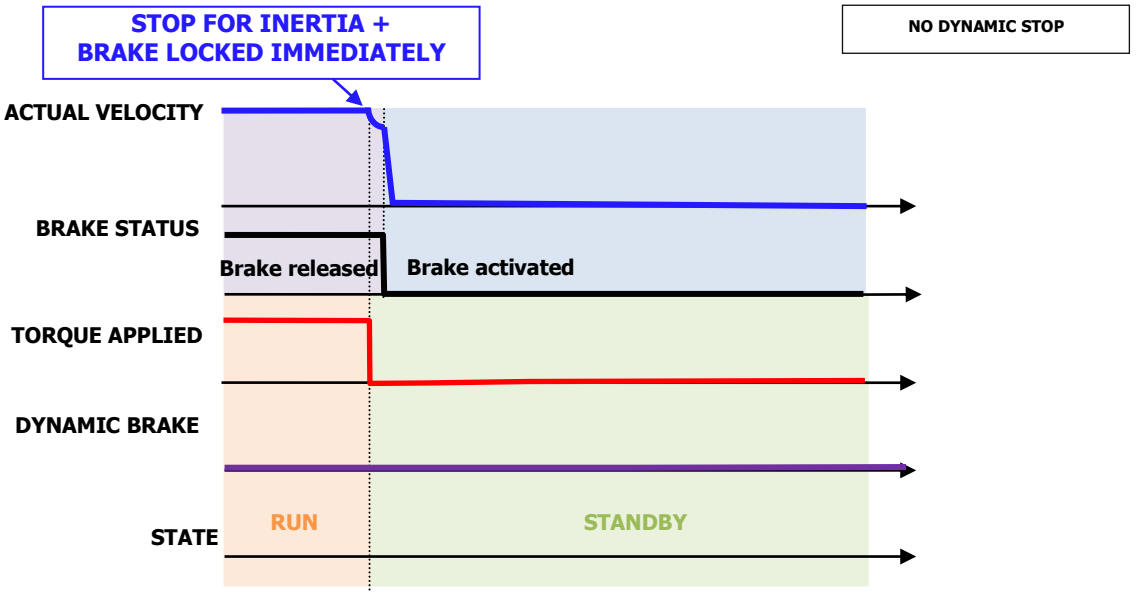
Picture 14 – Dynamic Stop timeframe: To Standby without Dynamic Stop (-3)

TRANSITION STOPPING MODE '-4':

The follow graph describes the timing stop of drive when the electronic Dynamic Stop is not applied.

The motor will stop immediately, and the brake motor is locked immediately.

In this case the motor is switch off and it should be stop by inertia, but the brake stops the motor.



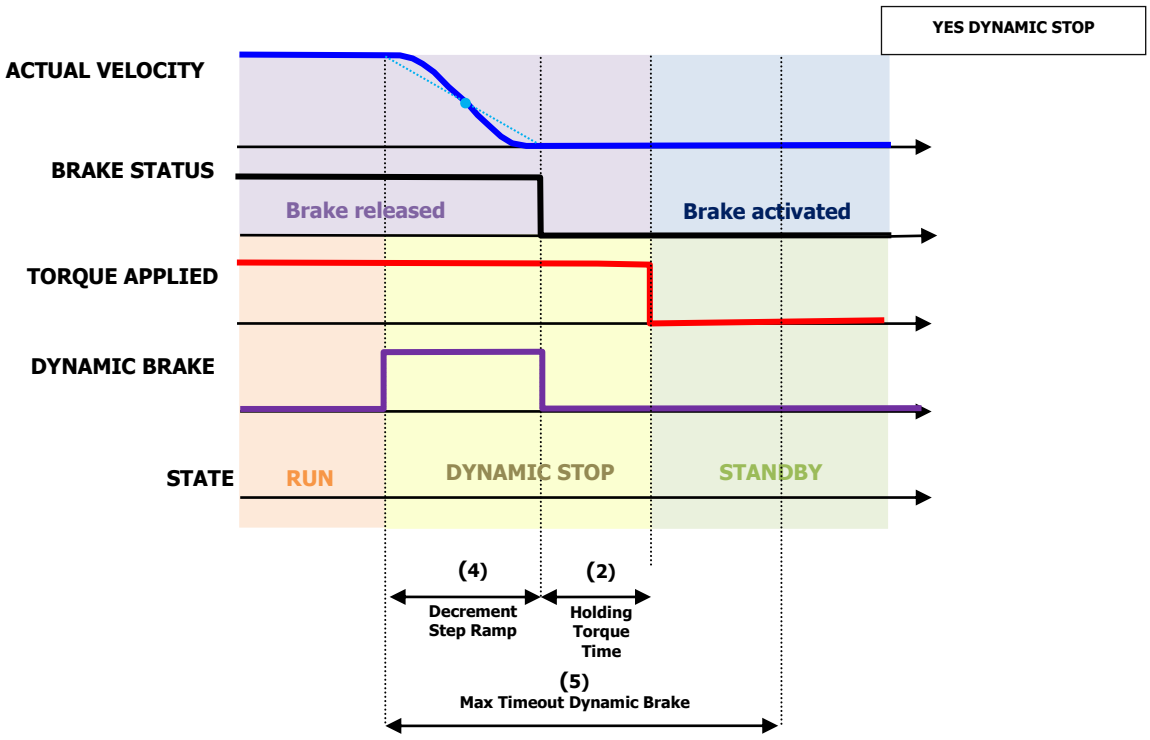
Picture 15 - Dynamic Stop timeframe: to Standby without Dynamic Stop (-4)

TRANSITION STOPPING MODE '-5':

The follow graph describes the timing stop of drive when the electronic Dynamic Stop is applied.

It slows down with down S-RAMP is programmable.

When the velocity is on the range ±5 RPM it disables the drive. This stopping mode is available only with motion profile configured as SRAMP (value -2 or -3)



Picture 16 - Dynamic Stop timeframe: to Standby with Dynamic Stop (-5)

This condition will be present when the drive state move from RUN state (operation enabled in DSP402) to STANDBY state (Switched ON in DSP402).

4.12 S-Ramp (FW 2.4.2)

Introduction:

Theory

In a point-to-point move, the rate of change in acceleration is known as jerk.
In some applications, high rates of jerk can cause excessive mechanical wear or material damage.
To support varying levels of jerk tolerance, it needs to introduce new motion profiles defined S-Curve.
An S-Curve is a trajectory which is constrained to jerk, acceleration and velocity. By smoothing out the edges, S-curve motion profiles reduce abrupt acceleration changes and thereby smooth out the motion.

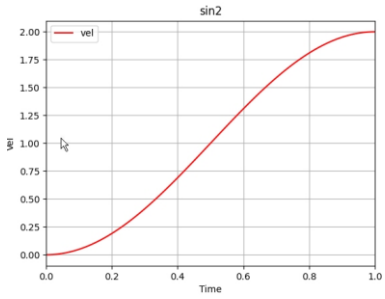
An S-Curve $\sin^2$ based consists of 5 phases:

- Smooth acceleration from 0 to maximum acceleration value (at T/2 of acceleration phase)
- Smooth decrease of acceleration from max to 0 (target velocity reached)
- constant velocity phase (if required)
- Smooth negative acceleration from 0 to maximum deceleration value (at T/2 of deceleration phase)
- Smooth decrease of deceleration from max to 0 (0 velocity reached)

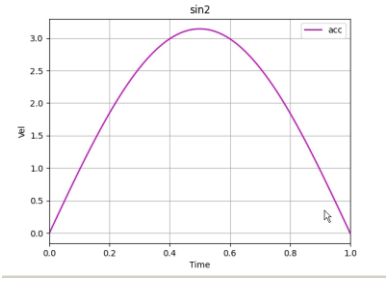
4.12.1 Description

S-curve profile the built-in reference generator computes a profile with an S-curve shape of the speed using $\sin^2$ calc. S-Ramp defines a trajectory for the velocity set point to move from a V0 to Vr (Velocity Target) in each time.

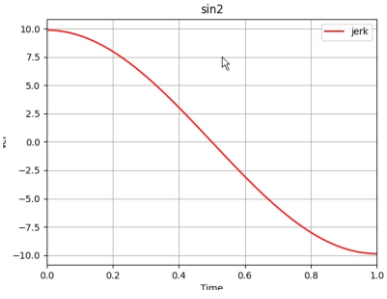
Example of a velocity trajectory from V0 = 0 to Vr = 2 in 1 sec



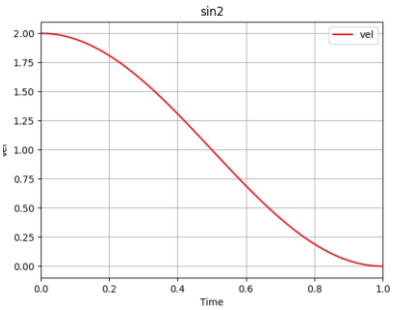
Example of an acceleration trajectory from V0 = 0 to Vr = 2 in 1 sec



Example of a jerk trajectory from V0 = 10 to Vr = 2 in 1 sec



Example of a velocity trajectory from V0 = 2 to Vr = 0 in 1 sec



4.12.2 Programmability (CANOpen)

The motion S-Curve is set by a parameter using programming in serial interface (file parameters *file.ibd*) or it is possible write parameter with object via CANopen (DS402) or with register using Modbus.

Object used in CANopen:
S-ramp or trapezoidal ramp will be programmed specifying value

- Object 6086h = Motion profile type

Parameters to define trajectory:

- Object 60FFh = Target Velocity
- Object 6083h = Profile acceleration
- Object 6084h = Profile deceleration

Other relevant Parameters:

- object 607Fh =Max Velocity
- object 60C5h=max acceleration
- object 60C6h = max deceleration

Max Jerk for acceleration and max jerk for deceleration:

- object 60A3h = 2
- object 60A4h sub 00 = 2
- object 60A4h sub 01 – Begin and End jerk during acceleration
- object 60A4h sub 02 - Begin and End jerk during deceleration

Register used in Modbus:
The same values will be written in registers for Modbus configuration (see Modbus Manual).

S-ramp or trapezoidal ramp will be programmed specifying value

- Register 0x0066 = Motion profile type

Parameters to define trajectory:

- Register 0x0042 = Target Velocity
- Registers 0x0130, 0x0131 = Profile Acceleration
- Registers 0x0132, 0x0133 = Profile Deceleration

Other relevant Parameters:

- Register 0x0003 = Max Velocity
- Registers 0x0134, 0x0135 = Max Acceleration
- Registers 0x0136, 0x0137 = Max Deceleration

Max Jerk for acceleration and max jerk for deceleration:

- Constant Profile Jerk Use = 2
- Registers 0x012C, 0x012D = Begin and End jerk during acceleration
- Registers 0x012E, 0x012F = Begin and End jerk during deceleration

4.12.3 Functionality

The S ramps can be run with Jerk control or without control. This behaviour will be programmable with parameter "Motion Profile Type".

Upon receipt of a new speed set point or a new acceleration value, the parameters for the ramp generation will be calculated and verified its correspondence with the set limits of maximum

acceleration and jerk (in case of Jerk controlled).

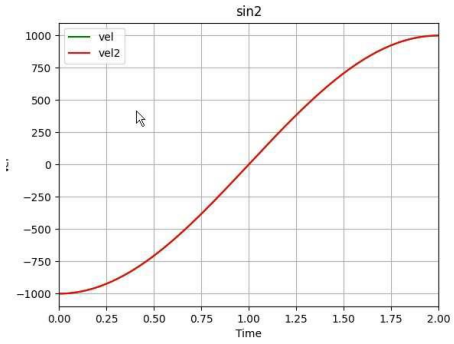
In case the above limits are not respected the ramp will not be executed and an error message will be provided with different actions.

The different actions can be:

- discard the received value of speed set point that doesn't meet Jerk limit (only in case of jerk controlled)
- Recalculation in real time of new lower acceleration for meet jerk limit and execute trajectory to new speed setpoint (at the moment this behaviour is not implemented and will be verified implementation feasibility)

If you work with different values for Profile Acceleration and Profile Deceleration you need to know when acceleration and deceleration are applied. Acceleration is applied when you perform a ramp where absolute value of final velocity is greater than absolute value of initial velocity. Deceleration instead is applied when absolute value of final velocity is lower than absolute value of initial velocity, regardless the sign of velocity. A special case is when you perform a "cross S ramp".
A cross S ramp is a motion where the sign of initial velocity is opposite to the sign of final velocity.

Example of an S ramp from -1000 Rpm to 1000 Rpm



In the case above is applied the Profile acceleration parameter. If initial velocity is positive and final velocity is negative instead profile deceleration is applied.

It will be possible to perform emergency braking with ramp S. This feature will be programmable and the parameters for ramp S braking will be separated from the others.

Parameters for quick stop and Emergency are to be determined.

- Disable operation option code
- Shut down option code
- Fault reaction option code
- Emergency option code

For perform emergency breaking with S ramp you need to program value = -5 in relevant parameter. Each type of emergency breaking, S ramp or linear ramp, will cause a discontinuity in speed and acceleration, with jerk not limited.

4.12.4 Limitation & Measure Unit

Does not support modification of current move, once the ramp has started it cannot be interrupted. This means that any new speed set point will only be considered after the ramp has been completed. A series of moves requires a series of discrete profiles

- Target Velocity = RPM or Inc/s
- Acceleration or Deceleration = RPM/s or Inc/s^2
- Jerk = Velocity/s^2

Functional Requirements

The mode of operations is "profile Velocity" with digital set point (not analog).
The fieldbus are CANopen or Modbus.

4.12.5 Configuration

Before to move the motor with S-Ramp the drive must be configured.
It needs to have the firmware version ≥ 240, if the drive has old release, it must be upload.

Procedure to configure parameters:

Write object Motion profile type"

- value '-2'→ "*Man*. Spec S-Ramp with Jerk Limited": It means that the S-Ramp is limited by Jerk value calculates in the firmware, if the target velocity is out of range by jerk calculation the drive answers with "abort code".
- value '-3'→ "*Man*. Spec S-Ramp without Jerk": It means that the S-Ramp is not limited by Jerk.

Write Factor Group of Jerk like Velocity and acceleration Factor Group. If the user units of drive is

- INC: write "Jerk Factor" num and div with value '1'
- RPM: write "Jerk Factor" num with value '16384' (equal resolution) and write Jerk Factor div with value '60'

The "Jerc Factor" object must be saved in eeprom before to use.

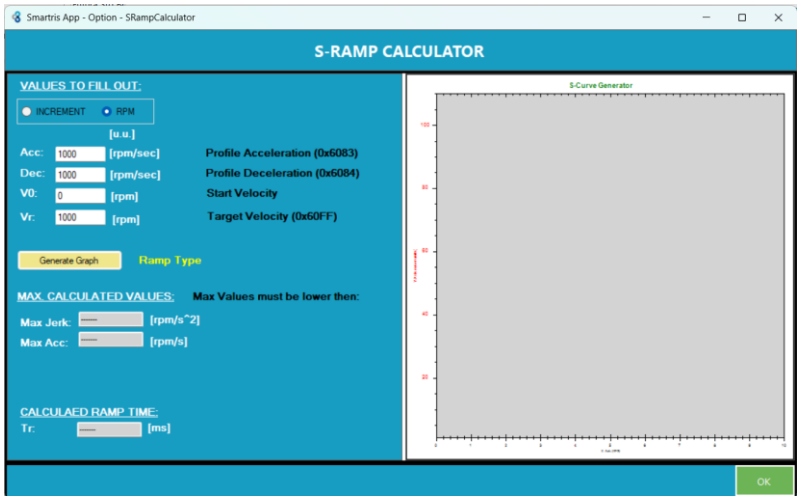
Write object "Jerk Profile 1" and "Jerk Profile 2" according by application and user units.

4.12.6 Reference Values

To choose the parameters of the S CURVES, there is an application integrated with the SmartrisApp that generates the curve.

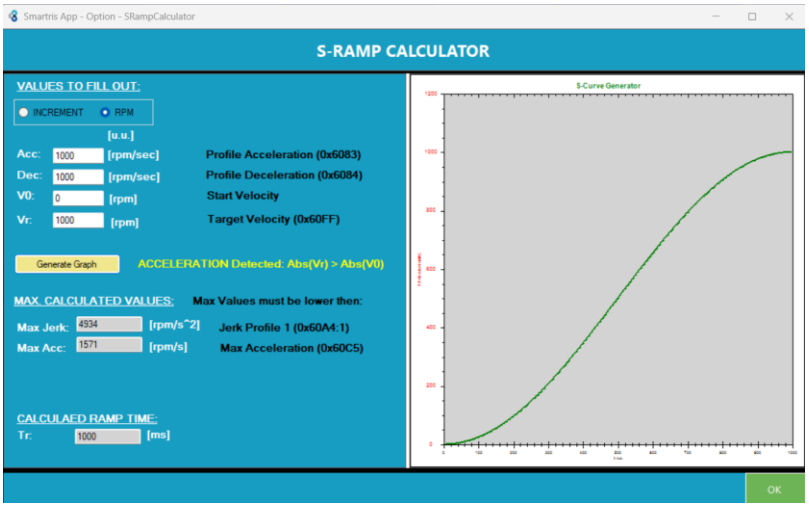
Open SmartrisApp and click button "Utilities" 

and "SRamp Calculator".
This window is open:



According by application write camps Acc, Dec, V0 and Vr.
Fill in Acceleration and Deceleration Parameters.
Write "Start velocity" (V0) and "Final Velocity" (Vr) and generate the graph.

Graph generated:



The "Max Jerk", "Max Acc" and "Tr" are value calculated after graph generation.

The user must verify that the values are correct and compatible with the application.

- The "Max Jerk" calculated must lower than "Jerk Profile 1" or "Jerk Profile 2" depending by slope of curve.
- The "Max Acc" calculated must be lower than "Max acceleration" or Max Deceleration, depending by slope of curve.

The "Tr" value is the time it takes to make the whole curve.
Note:

- It is not possible to change on the fly the set point of S-ramp. If the new target is sent during S-ramp, the new value will be used at the end of the curve with new calculation

- It is possible to move the drive from "operation enabled" state (RUN) to "Switched on disabled" by controlword or emergency using S-Ramp programmable. It needs to set "Electronic Dynamic Stop Parameters" subindex 8 the value "Decrement step ramp – SRAMP" (unit in rpm/s) and the value '-5' relative at movement (Disable Operation Option Code)

- The behaviour of "Quick Stop" and "halt" bit is the same, are not affected by S ramp

5 | STO (SAFE TORQUE OFF)

Information

In case of drive with STO it is possible to disable the Safety STO hardware connecting a +24Vdc between pin 1-3 (STO1) e 2-3 (STO2) on J6 connector

The Safety Circuit provides drive integrated safety function according to IEC 61800-5-2:2016.
STO (Safe Torque Off) Module prevents the creation of torque in the motor and corresponds to a "*category 0*" an uncontrolled stop in accordance with stop of IEC 60204-1. This means that the motor will coast to a stop when the "STO" function is activated, this method of stopping should be confirmed as being acceptable to the system the motor is driving.

The "STO" function is recognized as a fail-safe method even in the case where the "STO" signal is absent and a single fault within the drive has occurred.

The purpose of the "STO" function is to provide a method of preventing the drive from creating torque in the motor in the absence of the "STO" input signals (Terminal 1-2 with reference to 3), this allows the drive to be incorporated into a complete safety control system where "STO" requirements need to be fulfilled.

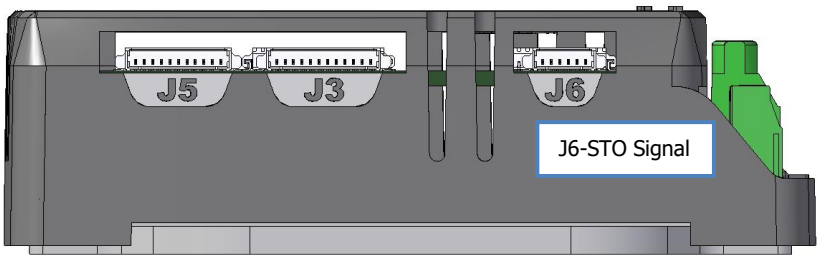
The "STO" function can typically eliminate the need for electro-mechanical contactors with cross-checking auxiliary contacts as per normally required to provide safety functions.

5.1 STO (Safe Torque Off)

Power, that can cause rotation (or motion in the case of a linear motor), is not applied to the motor.
In STO condition, the drive will not provide power to the motor which cannot generate torque.
Note:

1. This safety function corresponds to an uncontrolled stop
2. This function may be used where power removal is required to prevent an unexpected start-up.
3. In circumstances where external influences (i.e., falling of suspended loads) are present, additional measures (i.e., mechanical brakes) may be necessary to prevent any hazard.

5.1.1 STO Connection



J6 – Safety STO SIGNAL			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
1	STO IN 1	Safety Relays STO1	Red
2	STO IN 2	Safety Relays STO2	Black
3	STO IN COM	Common STO1 / STO2	Black
4	NC		Black
5	STO OUT	STO Out	Black
6	STO OUT COM	STO Out Common	Black

Table 19 – Safety STO Wiring

5.2 Hardware Specifics

STO Input	**Data**
STO Inactive status (Normal operation) Input voltage	20…33 Vdc
STO Active (SAFETY) input voltage	< 8 Vdc
Input current @ 24V	5 mA
Active response time (time between normal operation to **STO Active**)	10 mS
STO OUT specification (rated voltage/current)	30V / 0.2A

Are available 2 separated inputs STO IN1 e STO IN2 with reference STO IN COM, and 1 STO Output, both with galvanic isolation.

Input 1 **STO1**	**Input 2** **STO2**	**Output** **STO OUT**	**STO** **Statusword**	**Output SW** **STATUS**
0	0	CLOSE	SAFE STO	**SAFETY**
0	24V	CLOSE	SAFE STO 1	**SAFETY**
24V	0	CLOSE	SAFE STO 2	**SAFETY**
24V	24V	OPEN	NO STO	**OPERATION MODE**

Table 20 - STO Logic State

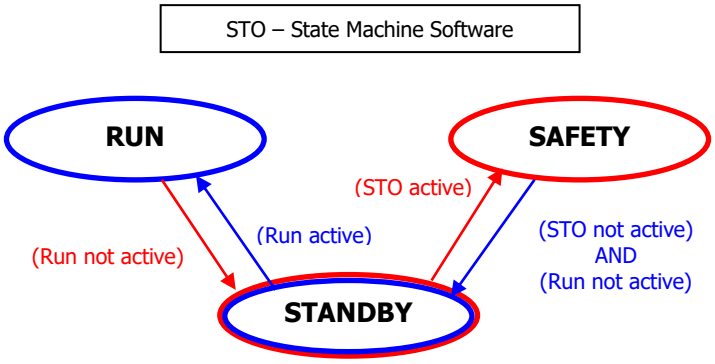
SAFETY status (no torque condition) is active when at least one input between STO1 and STO2 is 0V (not supplied).

Information

Safety controllers check their outputs periodically during normal operation. Their self-tests processes create pulses for the STO INPUT of the drive.
Test pulsed duration T< 1mS will not have any influence on the safety function.
Maximum Time to trigger STO function is 10mS.
Test pulses with T>1 mS could trigger STO status (**SAFETY**). This case will not create dangerous situations.

5.3 Software Specifics

Correct procedure to SAFETY is: RUN → STANDBY → SAFETY.



Picture 17 - STO Machine

Caution

To reactive the standby status is mandatory that STO and RUN are not active and do the procedure
- in Analog Mode: SAFETY → STANDBY → RUN
- in CANopen Mode: SAFETY → "SWITCH ON DISABLED" → "READY TO SWITCH ON" → "SWITCH ON" → "OPERATION ENABLED"

Attention

Pour réactiver l'état de veille, il est obligatoire que les fonctions STO et MARCHE ne soient pas actives.
La procédure est la suivante :
- en mode analogique : SÉCURITÉ → VEILLE → MARCHE
- en mode CANOpen : SÉCURITÉ → « ALLUMAGE DÉSACTIVÉ » → « PRÊT À L'ALLUMAGE » → « ALLUMAGE » → « FONCTIONNEMENT ACTIF »

5.4 Safe Operation Sequence Procedure

If an application requires controlled braking before using the STO function, the drive must be braked first and the STO function must be activate with a delay:

1. Controlled braking of drive
2. Once standstill is reached, disable the drive
3. In the case of a suspended load, mechanically lock the drive as well
4. Activate STO function.

	**Information** It is possible enable motor brake during safety procedure. Contact manufacturer.

Safe operating procedure

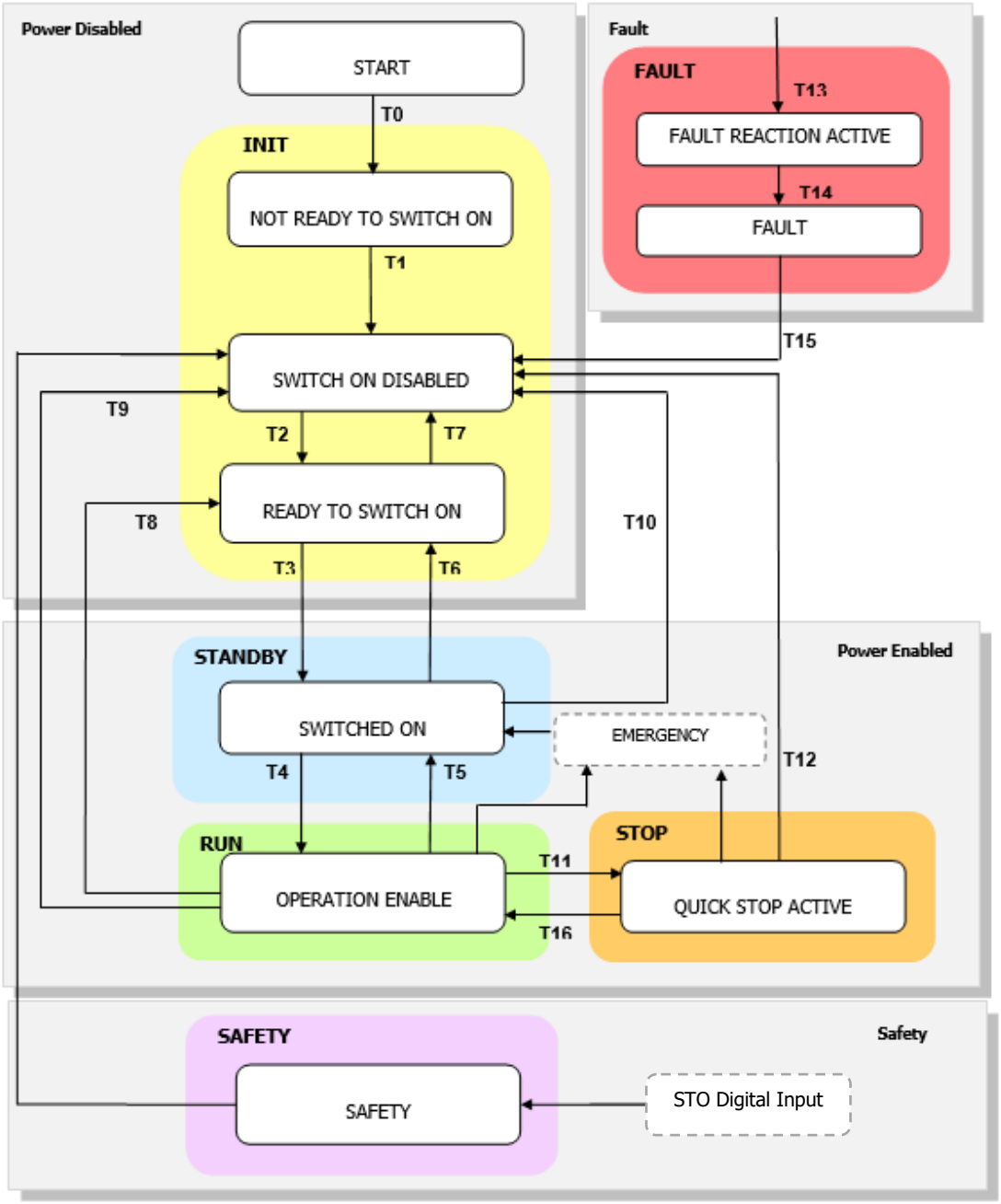
	**Caution** The Smartris Drive cannot hold the load with the STO function activated because the motor no longer supplies any torque. • If the STO function is activated during operation, the drive will stop in an uncontrolled manner. • If the drive has the Safety Torque OFF (STO), verify that this circuit is correctly supplied before all operation functions.

Procédure de fonctionnement sécurisé

	**Attention** Le variateur Smartris ne peut pas maintenir la charge avec la fonction STO activée car le moteur ne fournit plus de couple. • Si la fonction STO est activée pendant le fonctionnement, le variateur s'arrêtera de manière incontrôlée. • Si le variateur possède la fonction Safety Torque OFF (STO), il convient de vérifier que ce circuit est correctement alimenté avant de démarrer ses fonctions.

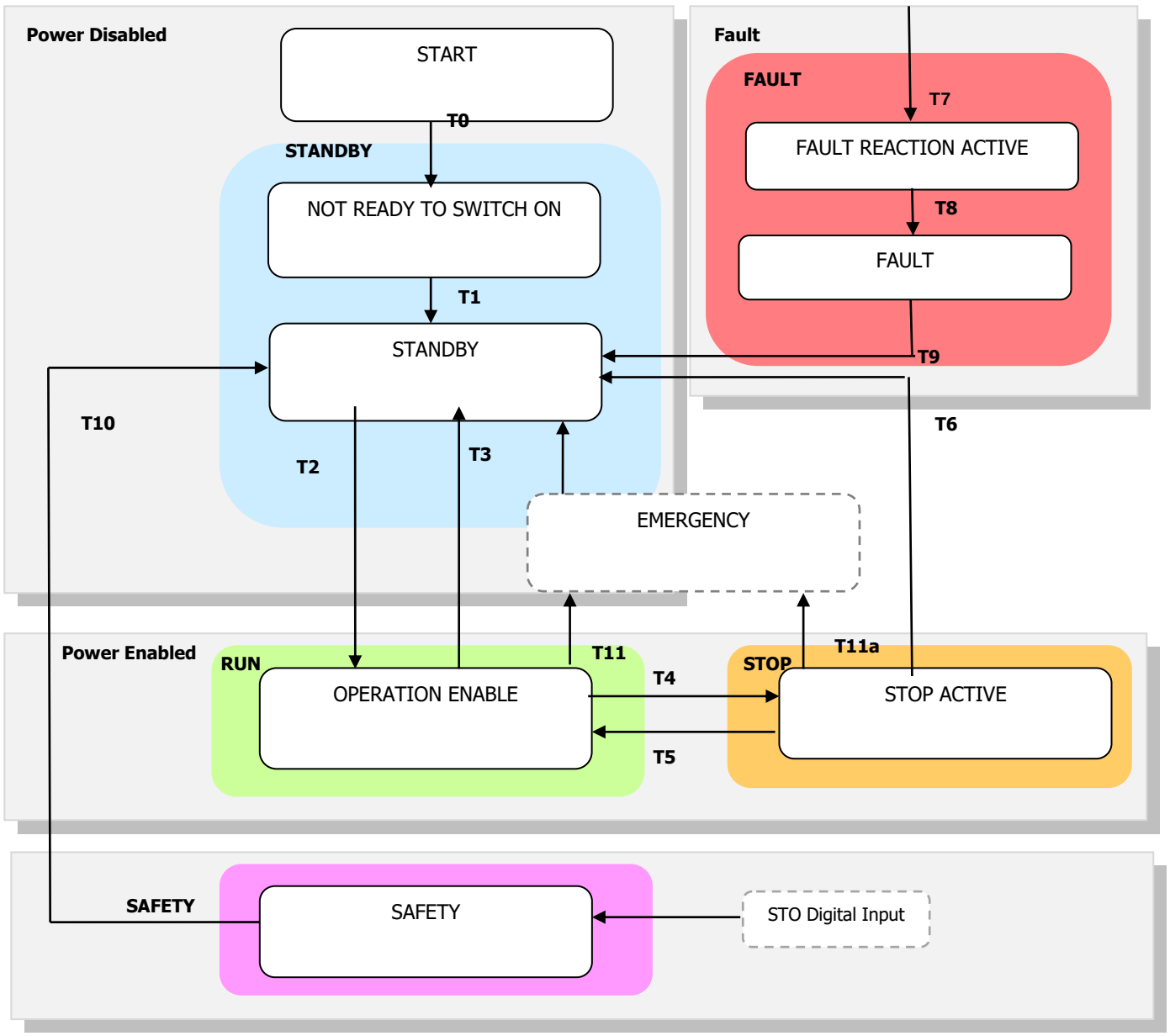
5.5 State Machine DSP402 with Safety State – CANopen Mode

The following picture shows the safety state. This state is added in the state machine DSP402.



5.6 State Machine with Safety State – Analog/Modbus Mode

The following picture shows the safety state in Analog Mode



Picture 18 - State Machine Analog Mode with Safety State

5.7 Safety Management

Follow STO event (Digital Input - Safety input) the drive will go in SAFETY state of Finite State Machine (FSM). This state is added in Finite State Machine standard of DSP402.

	Information
	The safety management can be configured by parameter "Safety FSM". There is a default value (0) called "Standard Lafert", but it is possible to change with other configurations (it is possible change in run time and saved in e^2prom). If the drive is in Analog Mode: contact manufacturer.

When the STO event occurs, there are 3 different cases:

- **STANDARD LAFERT: (0)**

  Following an STO event, the drive switches to the "SAFETY" state of FSM.
  The drive is in a certified safe condition until the STO is triggered.
  It remains in this state even when the STO is disarmed.
  In this case bit 14 of the status word (CANOpen SAFETY bit) is again set to '1'.
  When STO is removed, the drive is no longer safe condition but remains in the "SAFETY" state of FSM.

- **SAFETY DIRECT: (1) - only CANopen**

  After an STO event, the drive goes into the "SAFETY" state of FSM but automatically it moves to the "SWITCH ON DISABLED" state of FSM.
  The drive is in a certified safe condition until the STO is triggered.
  Bit 14 of the status word (CANOpen SAFETY bit) is set to '1' until STO is set.
  Once the STO is removed, the drive is still in the "SWITCH ON DISABLED" state of FSM.
  To move the drive to the FSM, it is necessary to write the controlword with the value 0x06 "shutdown" command.

- **SAFETY FAULT: (2)**

  After an STO event the drive produces a fault.
  After that, the drive goes in "FAULT" state of FSM.
  The master can send a "Reset" bit command by controlword and the drive moves in the "SWITCH ON DISABLED" state of FSM.
  To move the drive into FSM it is necessary to write the controlword command or digital Input and the STO must be removed.

Brake management during SAFETY is handled by custom parameter called "STO Option Code". The values are:

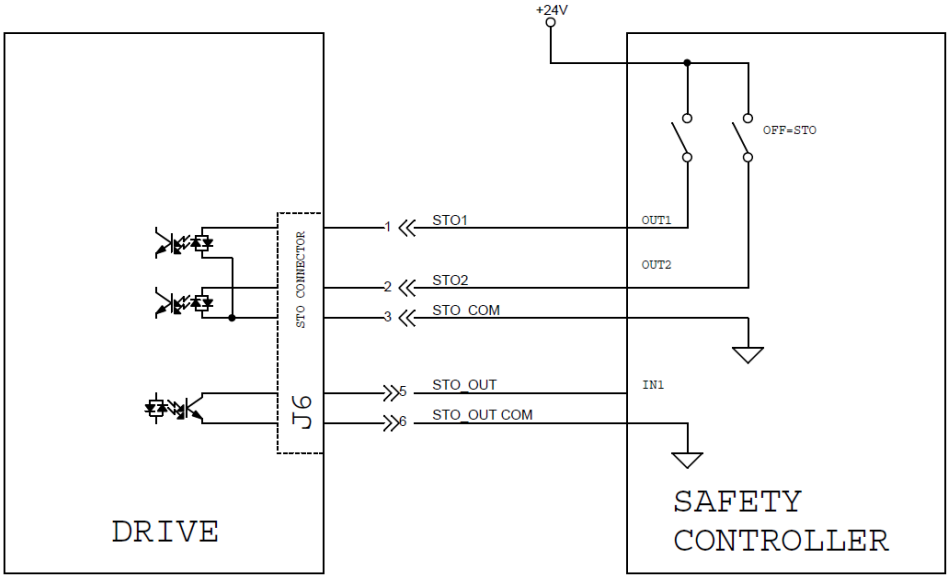
- 0 = brake released, default value (it will then be automatically closed in "switched-on")
- 1 = brake closed immediately and held before switching to "operation enabled"

	**Information** The brake managing during STO mode is not a Safety function

	**Caution** • In some applications additional measures may be required to fulfil the systems safety function needs: the "STO"function does not provide motor braking. In the case where motor braking is required a time delay safety relay and/or a mechanical brake arrangement or similar method should be adopted, consideration should be made over the required safety function when braking as the drive braking circuit alone cannot be relied upon as a fail-safe method.

	**Attention** • Dans certaines applications, des mesures supplémentaires peuvent être nécessaires pour répondre aux besoins de la fonction de sécurité du système : la fonction « STO » n'assure pas le freinage du moteur. Dans le cas où le freinage du moteur est requis, il convient d'adopter un relais de sécurité temporisé et/ou un dispositif de freinage mécanique ou une méthode similaire, il faut tenir compte de la fonction de sécurité requise lors du freinage, car le circuit de freinage du variateur seul ne peut pas être considéré comme une méthode sûre.

5.8 Example of Schematic Application



Picture 19 - STO Application

Safety controllers can read STO OUT that corresponding to STO STATUS OUTPUT.

5.8.1 Diagnostic of STO Circuit

The Drive continuously check the correct operation of STO Internal Circuits, during start-up and during safety and operating states.
If one of these checks fails, the drive is placed in a FAULT state, operation is inhibited and the type of error is indicated.
In this state of STO circuit error (drive in FAULT state) "DRIVE OK" digital output and "STO_OUT" digital output are OPEN.

5.9 Functional Check & Maintenance

The "STO" function should be included within the control systems scheduled maintenance program so that the function is regularly tested for integrity (Minimum once per 6 months), furthermore the function should be integrity tested following any safety system modifications or maintenance work.

Testing the "STO" Function
Verify that STO1 and STO2 behavior is congruent as in table below in every state.

Input 1 STO1	Input 2 STO2	Output STO OUT	STO statusword	Output SW STATUS
0	0	CLOSE	SAFE STO	**SAFETY**
0	24V	CLOSE	SAFE STO 1	**SAFETY**
24V	0	CLOSE	SAFE STO 2	**SAFETY**
24V	24V	OPEN	NO STO	**OPERATION MODE**

Before commissioning the system, the "STO" function should always be tested for correct operation, this should include the following tests:

- With the motor at standstill, and a stop command given to the drive:
  a. De-energize the "STO" inputs (blink the led state 2)
  b. Give a run command (See chapter 4) that the operation is in SAFE
- With the motor running normally (from the drive)
  a. De-energize the "STO" inputs

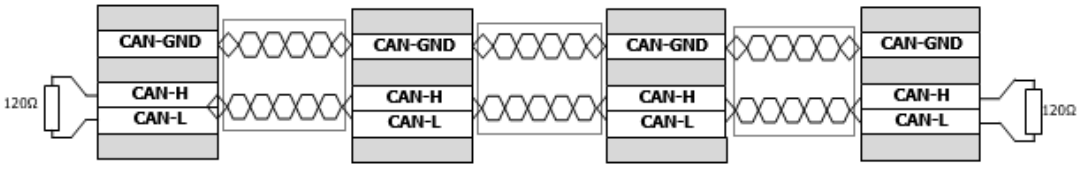
Check that the drive (blink the led state 2) and that the motor stops

6 | CANOPEN COMMUNICATION

6.1 CANopen Network Topology Overview

J5 - Communication SIGNAL			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
1	CAN_H	CAN_H Connection	
2	CAN_L	CAN_L Connection	
3	CAN_T	120 Ω Termination resistance CAN (connect to CAN H)	
4	CAN_GND	GND reference for CAN/RS485	

Table 21 – CANOpen Communication Wiring



Picture 20 - CANOpen Connection

All nodes of a network are principally connected in series, so that the CAN cable is looped through all controllers.
The two ends of the CAN cables have to be terminated by a resistor of 120Ω +/-5%. The CAN bus can be closed with a resistance terminator into to the drive using Pin 20. The CAN_T pin has to connect to CAN_H pin on Connector J5.
For cabling shielded cable with exactly two twisted pairs have to be used.

- One twisted pair is used for CAN-H and CAN-L.
- One twisted pair is used commonly for CAN-GND.

For further information refer to the Controller Area Network protocol specification, Ver. 2.0, Robert Bosch GmbH, 1991.

Technical data CAN bus cable:

- 2 twisted pairs, d ≥ 0,22 mm^2 shielded
- loop resistance < 0,2 Ω/m char.
- impedance 100-120 Ω

6.1.1 Server Relations

A CAN master (or client) is a controller that makes requests to nodes to respond to its commands. A CAN slave (or server) responds to the commands issued by the CAN master. The CAN protocol permits both single-master and multiple-master networks.

Information

The Lafert Servo Drive is the SLAVE and the machine controller or PLC is the MASTER.

Every servo drive has a unique ID in the range [1…127]. The network master does not require an ID. As a slave, the servo drive never sends an unrequested message, other than emergencies. The drive responds only to messages addressed to its ID or to broadcast messages, which have an ID of 0. All messages sent by a servo drive are marked with its own ID.

Caution

If two servo drives have been assigned the same ID, the CAN network may crash.

Aperçu topologique du réseau CANopen

⚠	**Attention** Si deux servomoteurs ont reçu le même ID, le réseau CAN peut se bloquer.

6.1.2 CANOpen Baudrate & Node ID

- Baudrate set by a CANOpen (Default 1000K)
- Node ID set by software (Default 1)

6.2 General Features of CAN

Compliance with the directives CiA DS301 v4.02 and DSP402 v2.0:

- Communication Network set by CANOpen object
- NMT- Network Management Protocol
- SDO - Service Data Object Protocol: upload, download and abort Protocol
- PDO - Process Data Object (4 TPDO, 4 RPDO), event timer, granularity 8 bit
- Emergency Protocol
- Heartbeat and Node guarding (Monitoring Protocol)
- Store non volatile memory (communication + manufacturer + device profile)
- Restore default CanOpen from non volatile memory
- Input/Output management by CANopen Object
- State Machine according by DSP402
- Profile Mode p402 supported: Profile Velocity Mode (see object 0x6502)

6.3 Communication CANopen Object (COB)

The communication objects are standardized with the DS301 CANopen communication profile.
The objects can be classified into 4 groups according to their tasks.

Special Objects
Emergency (**EMCY**)
SYNC

PDO

TPDO-1	RPDO-1
TPDO-2	RPDO-2
TPDO-3	RPDO-3
TPDO-4	RPDO-4

Communication Object

Network Management
NMT (Services)
NMT (Node Guarding)
NMT (Heartbeat)

SDO
Tx_SDO
Rx_SDO

- PDOs (process data objects) for real-time transmission of process data
- SDOs (service data object) for read and write access to the object Dictionary
- Objects for controlling CAN messages:
  - SYNC object (synchronization object) for synchronization of network devices
  - EMCY object (emergency object), for signaling errors of a device or its peripherals.
- Network management services:
  - NMT services for initialization and network control (NMT: network management)
  - NMT Node Guarding for monitoring the network devices

- NMT Heartbeat for monitoring the network devices

6.3.1 Object Dictionary

The most important part of a device profile is the Object Dictionary description. The Object Dictionary is essentially a grouping of objects accessible via the network in an ordered pre-defined fashion. Each object within the dictionary is addressed using a 16-bit index.

The general structure of the object dictionary is as follows:

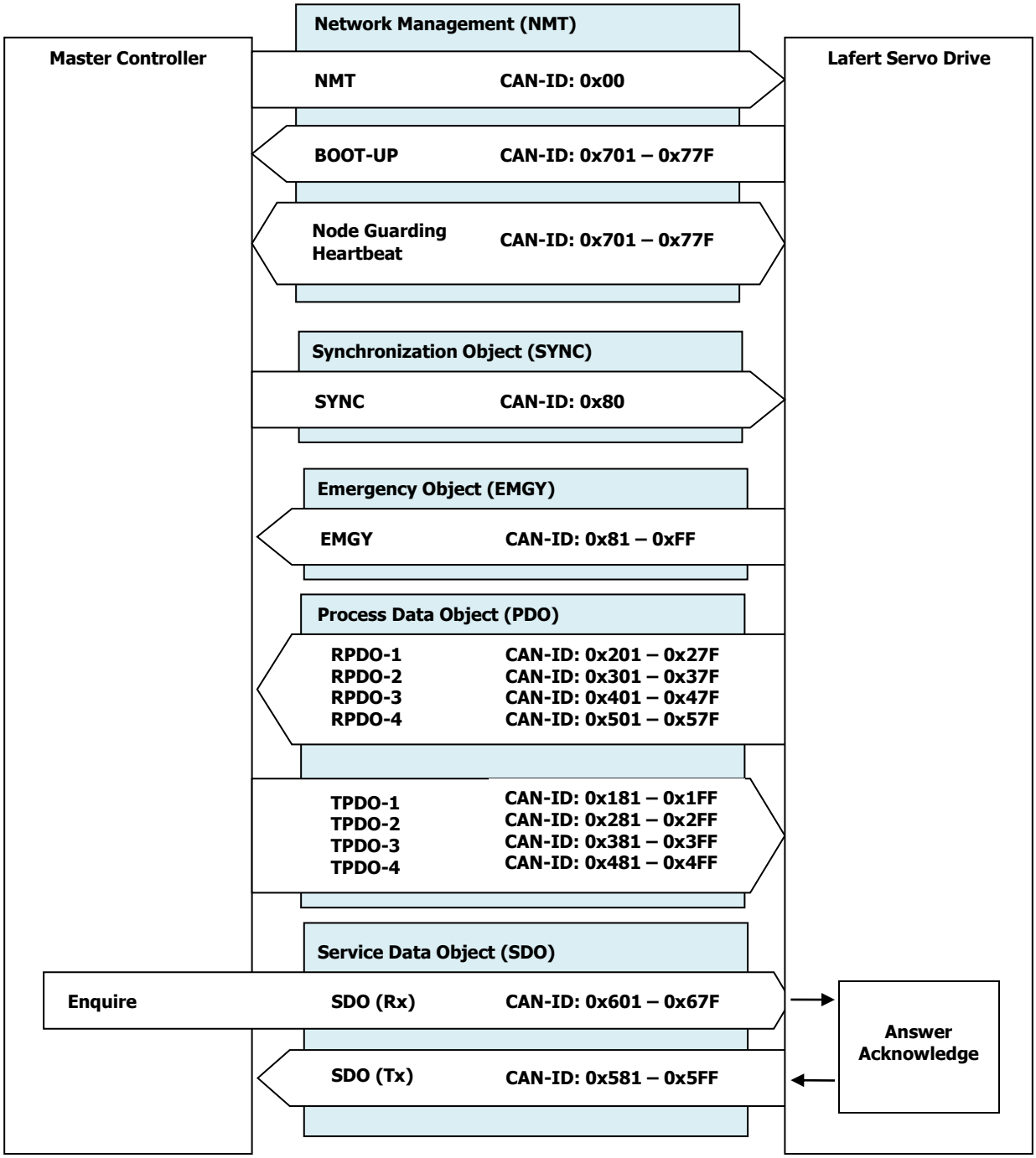
Index, Sub-Index (HEX)	OBJECT (Symbolic Name)	Name	Type	Attribute	M/O

- **Index, Sub-Index:** The Index column denotes the objects position within the Object Dictionary. This acts as a kind of address to reference the desired data field. The sub-index is not specified here. The sub-index is used to reference data fields within a complex object such as an array or record.
- **Object:** The Object column contains the Object Name and is used to denote what kind of object is at that particular index within the Object Dictionary.
- **Name:** The name column provides a simple textual description of the function of that particular object.
- **Type:** The type column gives information as to the type of the object. Eg: Boolean, Floating number, Unsigned Integer, Signed Integer etc.
- **Attribute:** The Attribute column defines the access rights for a particular object. Eg: rw (read and write access), wo (write only), ro (read only), Const (read only and value is constant).
- **M/O:** The M/O column defines whether the object is **M**andatory or **O**ptional

The Standard object dictionary is as shown below:

Index (HEX)	Object
0000	Not used
0001-001F	Static data types
0020-003F	Complex data types
0040-005F	Manufacturer specific Complex data types
0060-007F	Device Profile Specific Static Data Types
0080-009F	Device Profile Specific Complex Data Types
00A0-0FFF	Reserved for further us
1000-1FFF	Communication Profile Area
2000-5FFF	Manufacturer Specific Profile Area
6000-9FFF	Standardized Device Profile Area
A000-FFFF	Reserved for further use

For communication between controller and Lafert Servo Drive the following communication objects (COB) are available.



Picture 21 - Communication between Master Controller and Drive

6.4 Network Management (NMT)

The Network Management (NMT) is node oriented and follows a master-slave structure. NMT objects are used for executing NMT services. Through NMT services, nodes are initialized, started, monitored, resetted or stopped. All nodes are regarded as NMT slaves. An NMT Slave is uniquely identified in the network by its Node-ID, a value in the range of [1 to 127].

NMT requires that one device in the network fulfils the function of the NMT Master.

6.4.1 NMT Services

- **Module Control Services:** Through Module Control Services, the NMT master controls the state of the NMT slaves. The state attribute is one of the values (STOPPED, PRE-OPERATIONAL, OPERATIONAL and INITIALISING). The Module Control Services can be performed with a certain node or with all nodes simultaneously.

- **Error Control Service:** Through Error control services the NMT detects failures in a CAN-based Network. Local errors in a node may e.g. lead to a reset or change of state. Error Control services are achieved principally through periodically transmitting of messages by a device. There exist two possibilities to perform Error Control i.e. Node Guard and Heart Beat Error Control.

- **Bootup Service:** Through this service, the NMT slave indicates that a local state transition occurred from the state INITIALISING to the state PRE-OPERATIONAL.

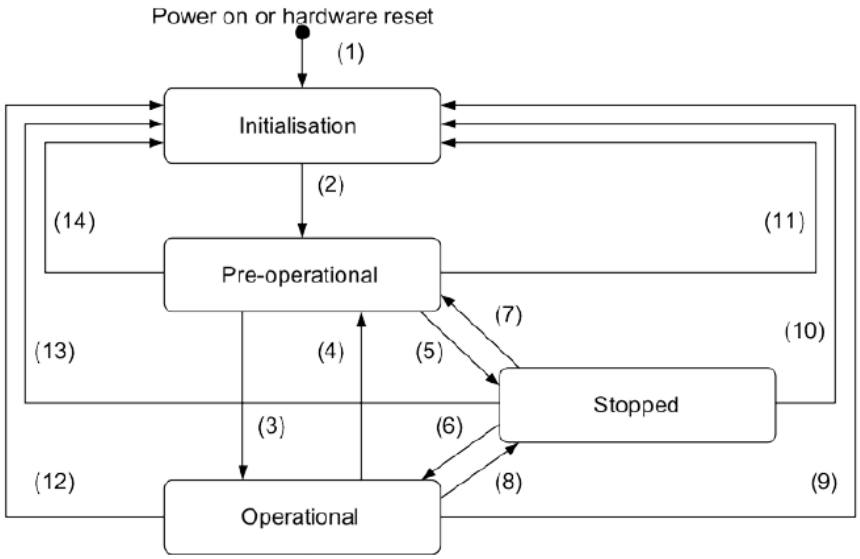
6.4.2 NMT state machine

The following picture shows the NMT state diagram of a CANopen device is specified.

CANopen devices enter the NMT state Pre-operational directly after finishing the CANopen devices initialization. During this NMT state CANopen device parameterization and CAN-ID-allocation via SDO possible. Then the CANopen devices may be switched directly into the NMT state Operational.

The NMT state machine determines the behaviour of the communication function unit.

The coupling of the application state machine to the NMT state machine is CANopen device dependent and falls into the scope of device profiles and application profiles.



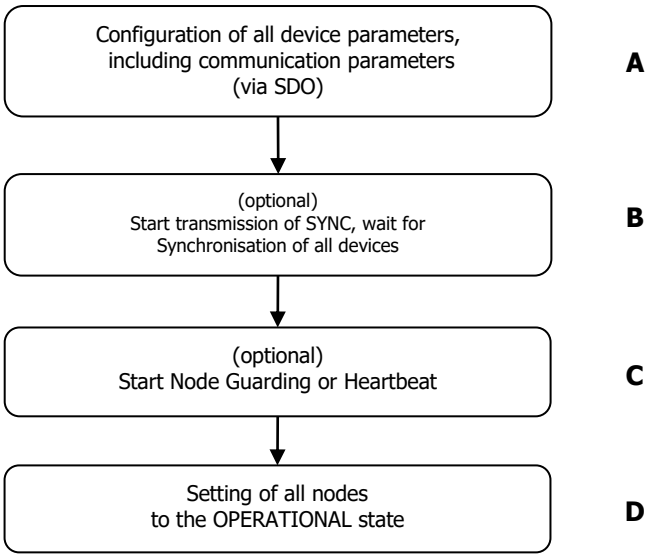
(1)	At Power on the NMT state initialisation is entered autonomously
(2)	NMT state Initialisation finished - enter NMT state Pre-operational automatically
(3)	NMT service start remote node indication or by local control
(4),(7)	NMT service enter pre-operational indication
(5),(8)	NMT service stop remote node indication
(6)	NMT service start remote node indication
(9),(10),(11)	NMT service reset node indication
(12),(13),(14)	NMT service reset communication indication

6.4.3 States and Communication Object Relations

Table below shows the relation between communication states and communication objects. Services on the listed communication objects may only be executed if the devices involved in the communication are in the appropriate communication states.

	Pre-operational	Operational	Stopped
PDO		X	
SDO	X	X	
SYNC	X	X	
TIME	X	X	
EMCY	X	X	
Node control and error control	X	X	X

6.4.4 Network Initialization Process



- STEP A): the device is in the node state PRE-OPERATIONAL which is entered automatically after power-on. In this state the devices are accessible via their default-SDO, the configuration of SDOs settings and optionally the setting of COB-IDs may be performed via SDO objects. In many cases a configuration is not even necessary as default values are defined for all application and communication parameters.
- STEP B): If the application requires the synchronisation of all or some nodes in the network, the appropriate mechanisms can be initiated in the optional Step B (now the SYNC feature is not implemented). It can be used to ensure that all nodes are synchronised by the SYNC object before entering the node state OPERATIONAL in step D. The first transmission of SYNC object starts within 1 sync cycle after entering the PRE-OPERATIONAL state.
- STEP C): In this step the Node guarding or Heartbeat can be activated using the guarding parameters configured in step A.
- STEP D): Now the master controller has to move the drive in OPERATIONAL state. With step D all nodes are enabled to communicate via their PDO objects.

6.5 SDO and PDO Protocol

The Lafert Drive can be parameterized via SDOs and controlled via PDOs.

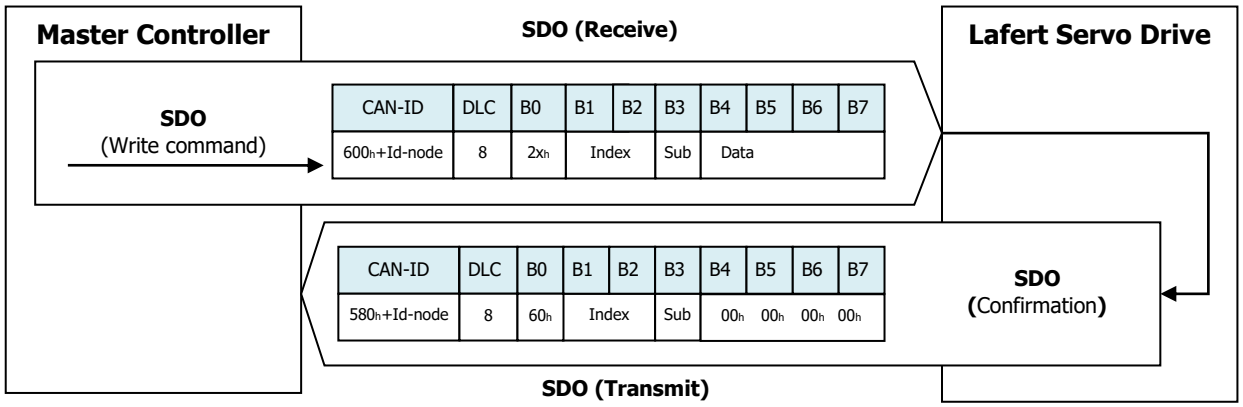
6.5.1 Access via data Objects (PDO/SDO)

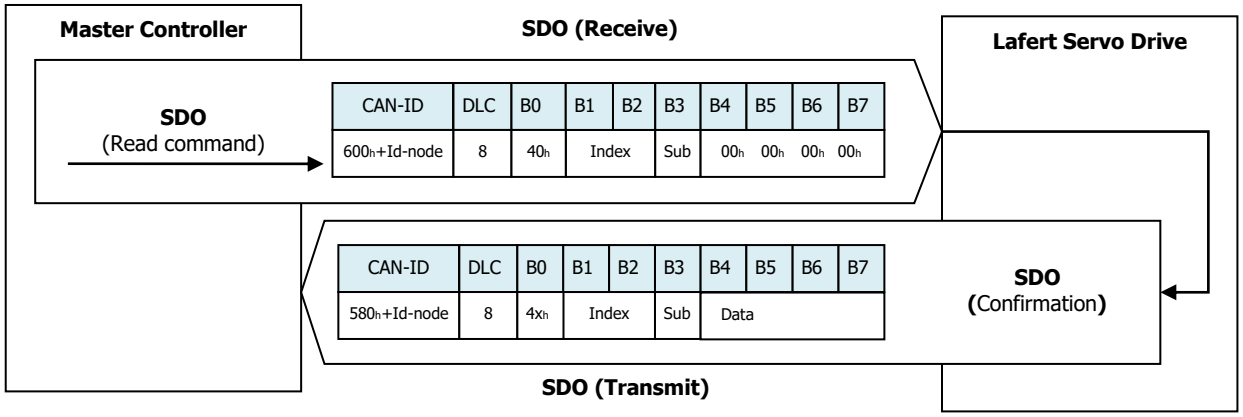
CANopen makes available a simple and standardised possibility for accessing the parameters of the Lafert Drive (i.e. Target Speed/profile Acceleration). A unique number (index and sub-index) is assigned to each parameter (CANopen obj). The totality of all adjustable parameters is contained in the object directory (OD).

All objects are defined in EDS file (electronic Data Sheet).

There are 2 methods for accessing CANopen objects via the CAN bus:

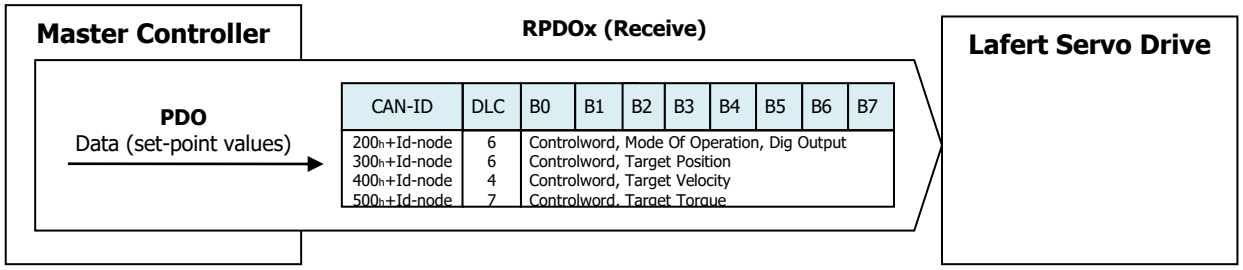
- **Access via Service data object (SDO):** confirmed type of access where the Lafert Drive acknowledges every parameter access



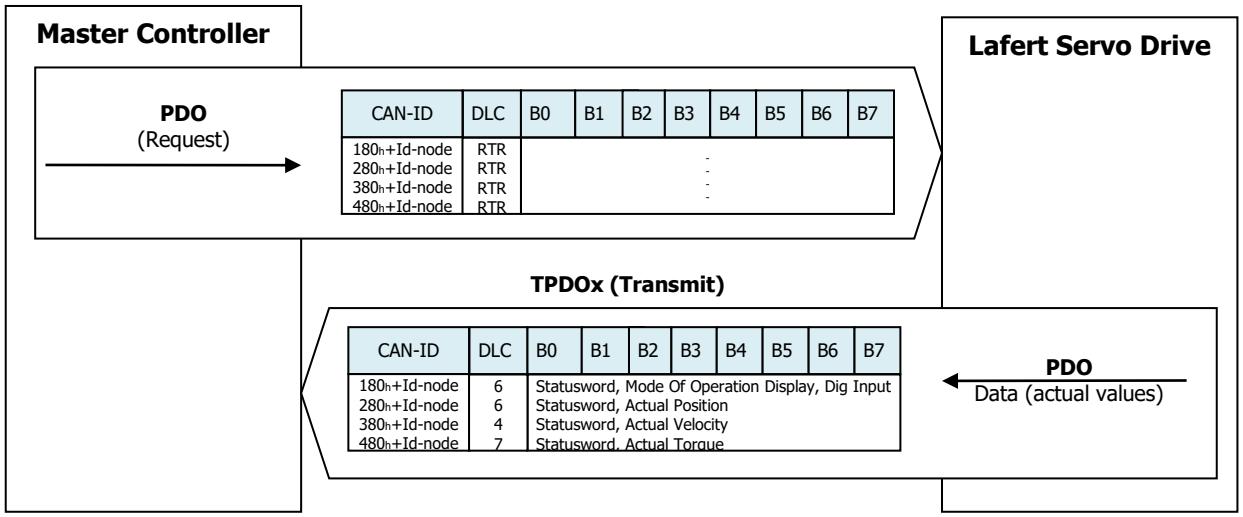


- **Access via Process data objects (PDO):** unconfirmed type of access for which no acknowledgement takes place.

  The Receive PDOs default mappings are composed by controlword and set points values:

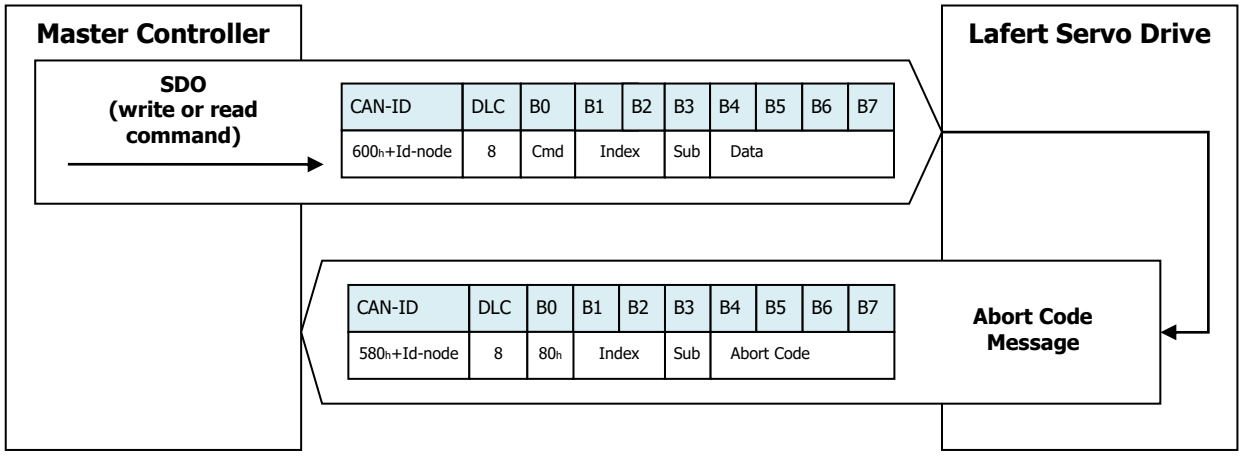


  The Transmit PDOs default mappings are composed by statusword and actual values:



- **Abort Code via Service data object (SDO)**: case of an error when reading or writing (for example, because the written value is too large), the Lafert Servo Drive answers with an error message instead of the acknowledgement.

  The cause of the fault was returned to the data (Abort Code) as an error code.



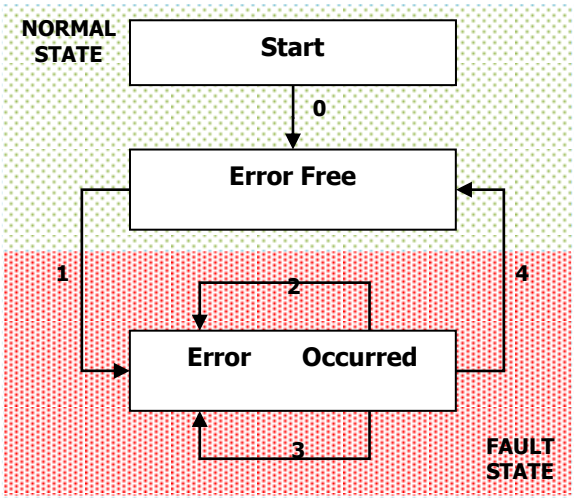
It is possible to change the default mapping because the drive supports the dynamic mapping. See the procedure into "Lafert – CANOpen Manual" document.

6.6 Emergency Protocol (EMCY)

The Lafert Servo Drive monitors the function of internal modules and of the firmware.
Whenever an error occurs, the parameterised error response is initiated and the corresponding EMCY message is transmitted.

The latest error message is always stored here in Error Code object (603Fh:0h). Also, it is in the highest error memory slot (1003h: 01h), the error memory always saves the 15 most recent error messages that can also be read out.

The Lafert Servo Drive also transmits an EMCY message once the error has been acknowledged.

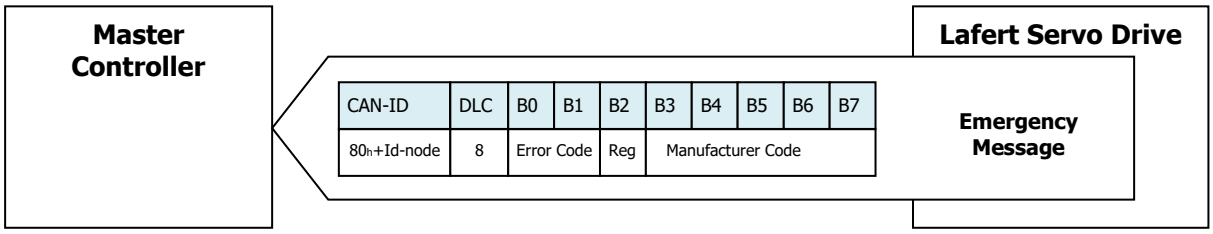


The following status transitions are possible:

Transition	Cause	Description
0	Initialisation completed	There is no error. The drive sends the error code 0000_h (Error reset/No error) and the state of CAN (8170_h)
1	Error occurs	No error was present and a new error occurs. The drive goes to Fault State. Verify the diagnostic state and the Emergency message.
2	Error acknowledgment not successful	Not all causes of error have been remedied and an error acknowledgement was performed.
3	New error occurs	There is an error and a new error occurs. An EMCY message with the error code for the new error (1003_h: 01_h, standard error field 1) is written.
4	Error acknowledgment successful	All causes of error have been remedied and an error acknowledgement was performed. The EMCY message was transmitted with error code 0000_h (Error reset/No error).

6.6.1 Emergency objects

The Lafert Servo Drive transmits an Emergency (EMGY) message whenever an error occurs.

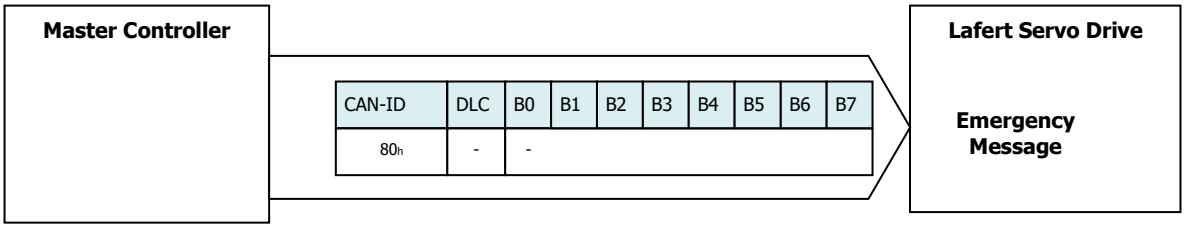


The CAN identifier (CAN-ID) is 80_h + Id-node. The data message identifies one univocal Error Code, it defines the alarm occurred.

For referring the defines of alarm see the "Lafert – CANOpen Manual"

6.6.2 Sync Message

The SYNC object is a network wide system clock. It is the trigger for synchronous message transmission. The SYNC has a very priority and contains no data in order to guarantee a minimum jitter.



6.7 Heartbeat and Node Guarding

There are two types of error control protocol: Node Guarding Protocol and Heartbeat protocol.
It is important and mandatory to have one of monitor control for CAN communication safety.

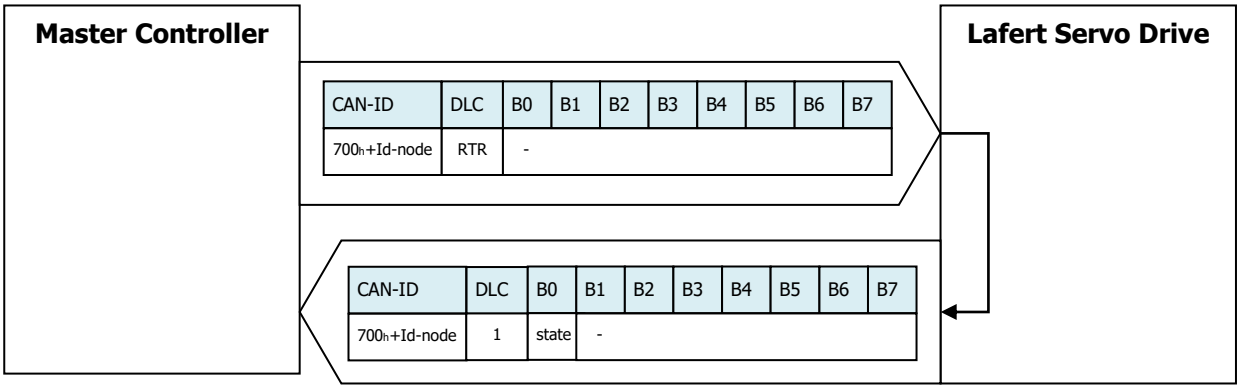
	**Caution** DS301 recommends using heartbeat in the new implementations due to the sensible nature of Guarding using the RTR frames.

Fonctions Heartbeat et Node Guarding

	**Attention** DS301 recommande d'utiliser la fonction Heartbeat dans les nouvelles implémentations en raison de la nature sensible de la fonction Guarding utilisant les trames RTR.

6.7.1 Node Guarding Protocol

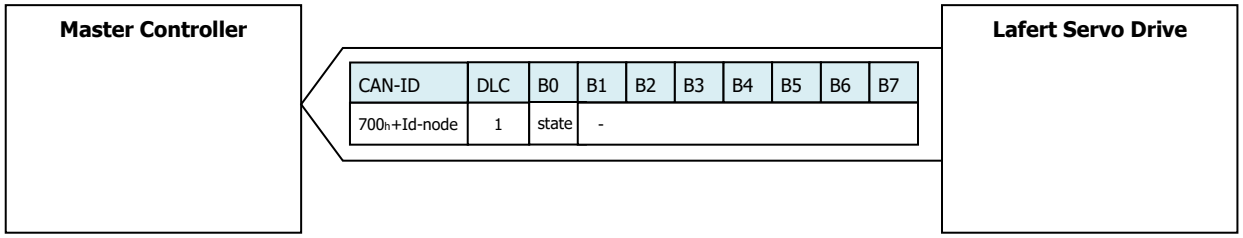
The guarding is achieved through transmitting guarding requests (Node guarding protocol) by the NMT Master. If a NMT Slave has not responded within a defined span of time (node life time) or if the NMT Slave's communication status has changed, the NMT Master informs its NMT Master Application about that event.



6.7.2 Heartbeat Protocol

The Heartbeat protocol is used to monitor the nodes in the network and verify that they are alive.

A heartbeat producer (usually a slave device) periodically sends at node id (700h+Id-node). The data part of the frame contains a byte indicating the node status.



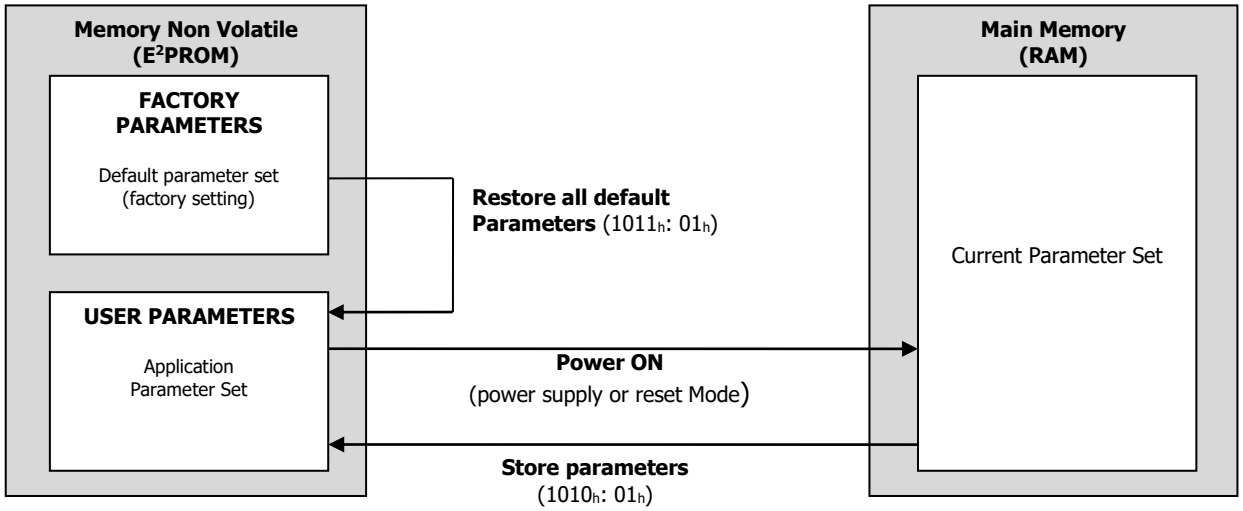
The heartbeat consumer reads these messages. If the messages fail to arrive within a certain time limit (defined in the object directory of the devices) the consumer can take action to, for example, reset the device or indicate an error. Frame format is: COBID + DATA (status of node)

A Heartbeat Producer transmits a Heartbeat message cyclically. One or more Heartbeat Consumer receives the message. The relationship between producer and consumer is configurable via the object dictionary.

Heartbeat has a default time at 200 ms

6.8 Store and Restore

The parameter sets contain all of the parameters required for operation.



6.8.1 Current parameter set (temporary)

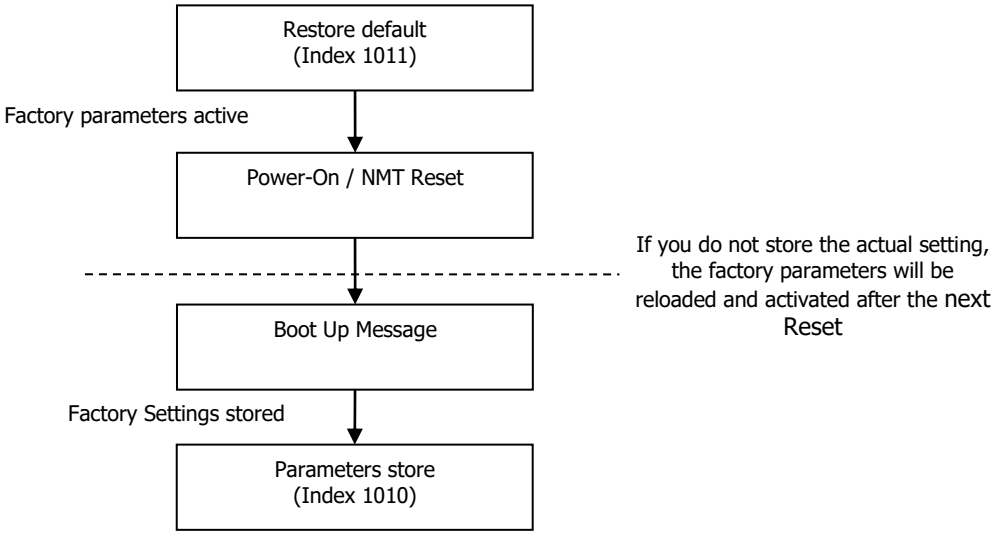
The current parameter set is located in the main memory (RAM) of the Lafert Servo Drive. Via SDO the current parameter set can be written or read in any desiderated way.

⚠	**Caution** If there is an interruption in the power supply or a Reset command all changes to the current parameter set are lost. To save the parameter in the memory non volatile using the "Store Parameter" (1010_h: 00_h) object.

Jeu de paramètres actuel (temporaire)

⚠	**Attention** En cas d'interruption de l'alimentation électrique ou d'une commande de réinitialisation, toutes les modifications apportées au jeu de paramètres actuel seront perdues. Sauvegarder le paramètre dans la mémoire non volatile à l'aide de l'objet « Enregistrer le paramètre » (1010_h: 00_h).

6.8.2 Default parameter set (Factory Settings)



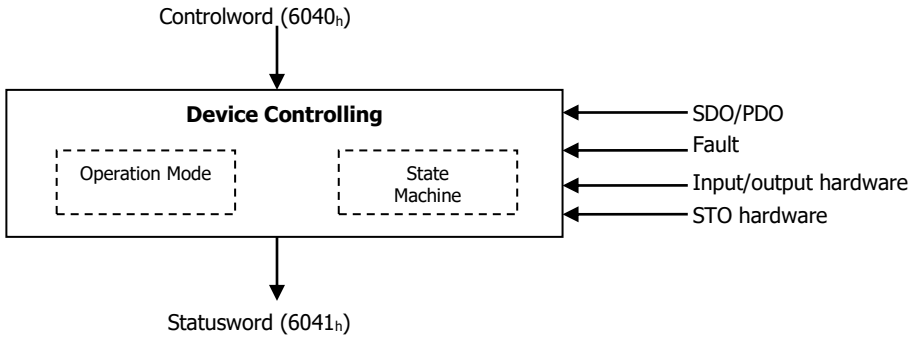
The default parameter set is the standard parameter set of the Lafert Servo Drive provided by the manufacturer and it is unchangeable. Using the object "Restore all default parameters" (1011_h: 01_h) the default parameter set can be loaded into the current parameter set in main memory.

6.8.3 Application parameter set

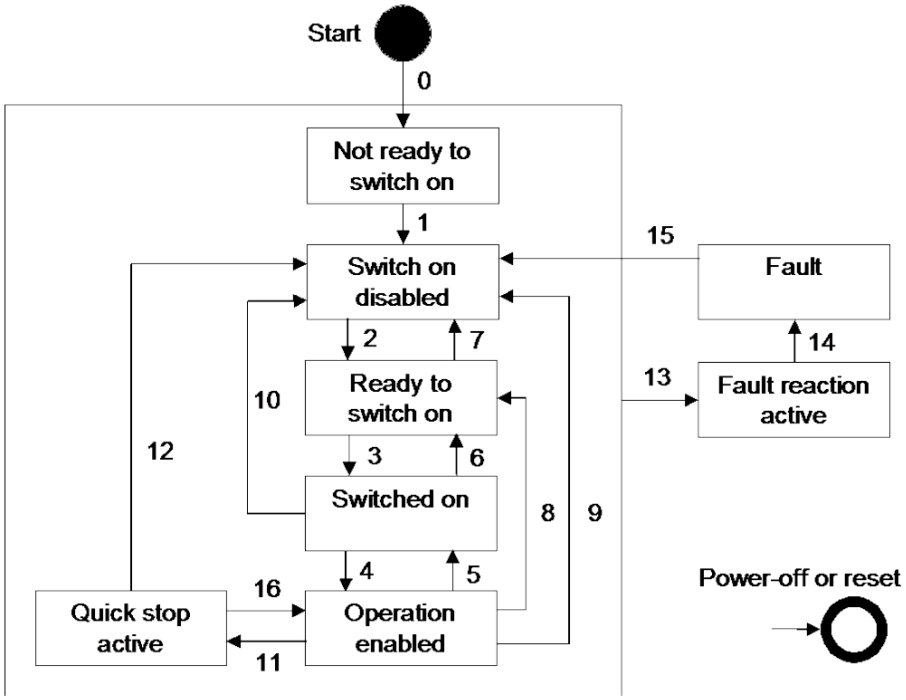
The application parameter set is loaded into the current parameter set of the main memory automatically at every Power ON of the power supply. Using the object "Store parameters" (1010_h: 01_h) the current parameter set can be saved into the application parameter set in permanent memory.

6.9 Device Control

The Lafert Servo Drive is controlled by CANopen using the Finite State Machine by profile DSP402.
State may changed using the *controlword* (6040_h) and/or according to internal events. The current state can be read using the *statusword* (6041_h).



6.9.1 Finite State Machine by DSP402



The device control is performed by a state machine according to DSP402.

State changes are triggered by internal events such as the occurrence of an error or external demand by means of *Controlword* (6040_h). *Statusword* (6041_h) gives feedback about the actual state.

After power-up and initialisation, the drive switches to the state "**Switch On Disabled"** automatically. In the state "**Operation Enabled"**, the drive is fully operational.

State	Description
START	The status is left after Power ON or at a Reset node and it changes automatically into "ready to switch on" mode. An existing brake is closed.
NOT READY TO SWITCH ON	The CAN bus interface is initialized and the CAN bus communication is approved. The output stage is switched off An existing brake is closed.
SWITCH ON DISABLED	The CAN bus communication is enabled and from this status, parameters can be updated. Status transitions can only be controlled by commands or triggered by error events. The output stage is switched off. An existing brake is closed, or gets closed.
READY TO SWITCH ON	The output stage is switched off. An existing brake is closed, or gets closed.
SWITCHED ON	The output stage is switched on. An existing brake is opened, or gets opened.
OPERATION ENABLE	The drive is controlled in accordance with its parameterized operating mode (e. g. velocity task or set-point values). The output stage is switched on. An existing brake is opened.
QUICK STOP ACTIVE	The output stage is switched on. An existing brake is opened. The drive stops the motion and either stays in quick stop with torque applied.

FAULT REACTION ACTIVE	An error has occurred. An existing brake is opened.
FAULT	An error has occurred. The drive remains in fault condition, until receives a Reset Fault.

Table 22 – Finite State Machine by DSP402

The drive moves in the state SAFETY from all states. To exit by Safety State it is necessary to send the controlword with command "Disable Voltage".

6.9.2 Object parameters of device control

The following objects are available for the control state machine.

Index	Object	Name	Type	M/O	Attr.	Description
6040h	VAR	controlword	UINT16	M	rw	This object shall indicate the received command controlling the PDS FSA.
6041h	VAR	statusword	UINT16	M	ro	This object shall provide the status of the PDS FSA.
6060h	VAR	mode of operation	INT8	M	rw	This object shall indicate the requested operation mode
6041h	VAR	mode of operation display	INT8	M	ro	This object shall provide the actual operation mode.
603Fh	VAR	Error Code	U32	M	ro	This object shall provide the error code of the last error which occurred in the drive device.
60FDh	VAR	Digital Inputs	U32	M	ro	This object shall provide digital inputs state.
60FEh	VAR	Digital Outputs	U32	M	rw	This object shall command the digital outputs.

For object's management referring to "Lafert – CANOpen Manual" document.

6.10 Profile Mode Supported

Different operation modes are available with the CiA 402 profile.

The "Supported Drive Mode" object (6502_h) defines the profiles mode supported.

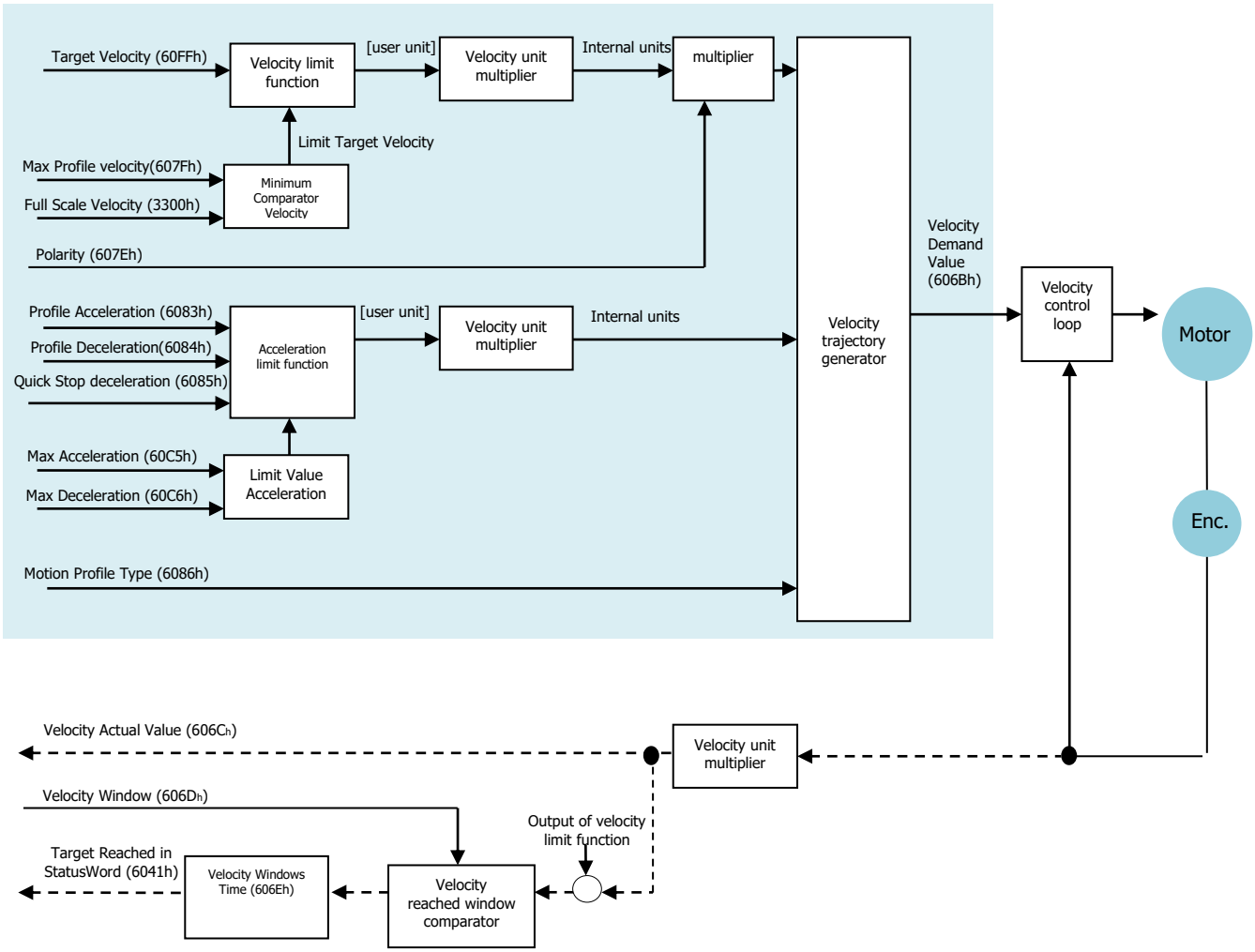
It is possible to change the profile using the "Mode of Operation" object (6060_h) for following profile:

- **Mode (1) Profile position mode**: *it is not available yet.*
- **Mode (3) Profile velocity mode**: *Reference velocity assignment by controller*
- **Mode (4) Profile torque mode**: *Reference torque assignment by controller*
- **Mode (6) Homing Mode**: *it is not available yet.*

The following profiles are supported but for using contact the manufacturer.

- **Mode (-1) Analog Mode:** the drive is controlled by serial command or hardware digital input
- **Mode (-2) Profile Reserved**

6.11 Profile Velocity Mode



This mode operates the motor in Velocity Mode with trapezoidal case. In the Profile Velocity operation mode the movement profile is defined by velocity and acceleration/decelerations commands. To activate the mode, the vale "3" must be set in "mode of operation" object (6060_h).

Object entries

The following objects are available for the control profile velocity and the behaviour of the drive.

Index	Object	Name	Type	M/O	Attr.	Description
$60FF_h$	VAR	Target Velocity	INT32	M	rw	This object shall indicate the configured target velocity and shall be used as input for the trajectory generator. The value shall be given in user-defined velocity units.
$607F_h$	VAR	Max Profile Velocity	UINT32	O	rw	This object shall indicate the configured maximal allowed velocity in either direction during a profiled motion.
6083_h	VAR	Profile Acceleration	UINT32	O	rw	This object shall indicate the configured acceleration. The value shall be given in user-defined acceleration units.
6084_h	VAR	Profile Deceleration	UINT32	O	rw	This object shall indicate the configured deceleration. The value shall be given in user-defined acceleration units.
$607E_h$	VAR	Polarity	UINT8	O	rw	This object shall indicate if the position demand value shall be multiplied by 1 of by –1.
$606B_h$	VAR	Velocity Demand Value	INT32	O	ro	This object shall provide the output value of the trajectory generator. The value shall be given in the user-defined

						velocity units.
606C$_h$	VAR	Velocity Actual Value	INT32	M	ro	This object shall provide the actual velocity value derived either from the velocity sensor or the position sensor. The value shall be given in user-defined velocity units.
606D$_h$	VAR	Velocity Window	UINT16	O	rw	This object shall indicate the configured velocity window. The value shall be given in userdefined velocity units.
606E$_h$	VAR	Velocity Window Time	UINT16	O	rw	This object shall indicate the configured velocity window time. The value shall be given in milliseconds.
606F$_h$	VAR	Velocity Threshold	UINT16	O	rw	This object shall indicate the configured velocity threshold. The value shall be given in userdefined velocity units
6070$_h$	VAR	Velocity Threshold Time	UINT16	O	rw	This object shall indicate the configured velocity threshold time. The value shall be given in milliseconds.

6.11.1 Velocity Profile Operation Mode:

In the Profile Velocity operation mode, the movement profile is defined by velocity and acceleration/decelerations commands.

To initiate a velocity-controlled profile:

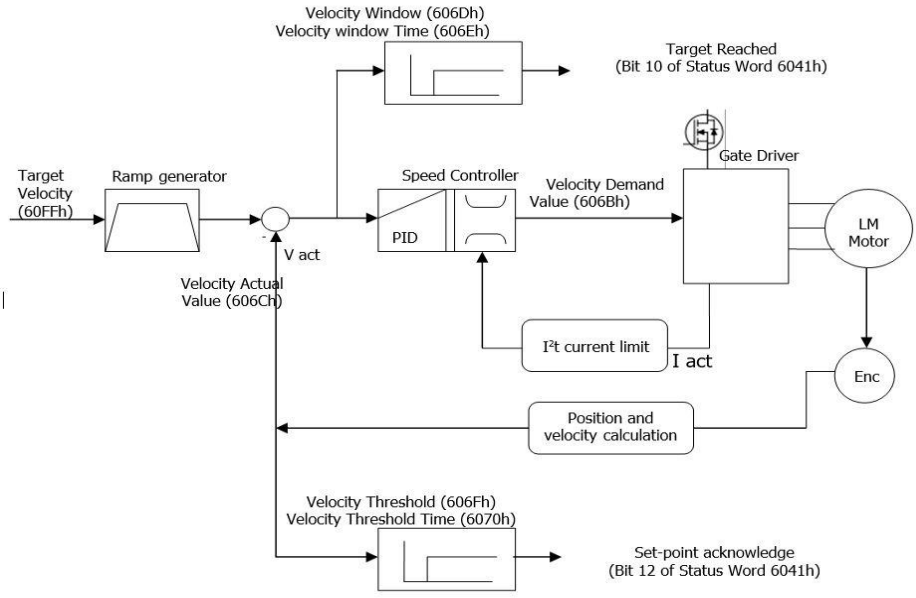
- Switch the operation mode to Profile Velocity mode by writing 3 to object 6060$_h$.
- Enable operation.
- Set acceleration/deceleration in object 6083$_h$/6084$_h$, respectively.
- Start motion by setting the target velocity in object 60FF$_h$.

Target velocity can be changed on-the-fly during motion. The profile acceleration/deceleration can be changed in run time, the others objects must be saved in e^{2}prom.

The motion ends when one of the following conditions is met:

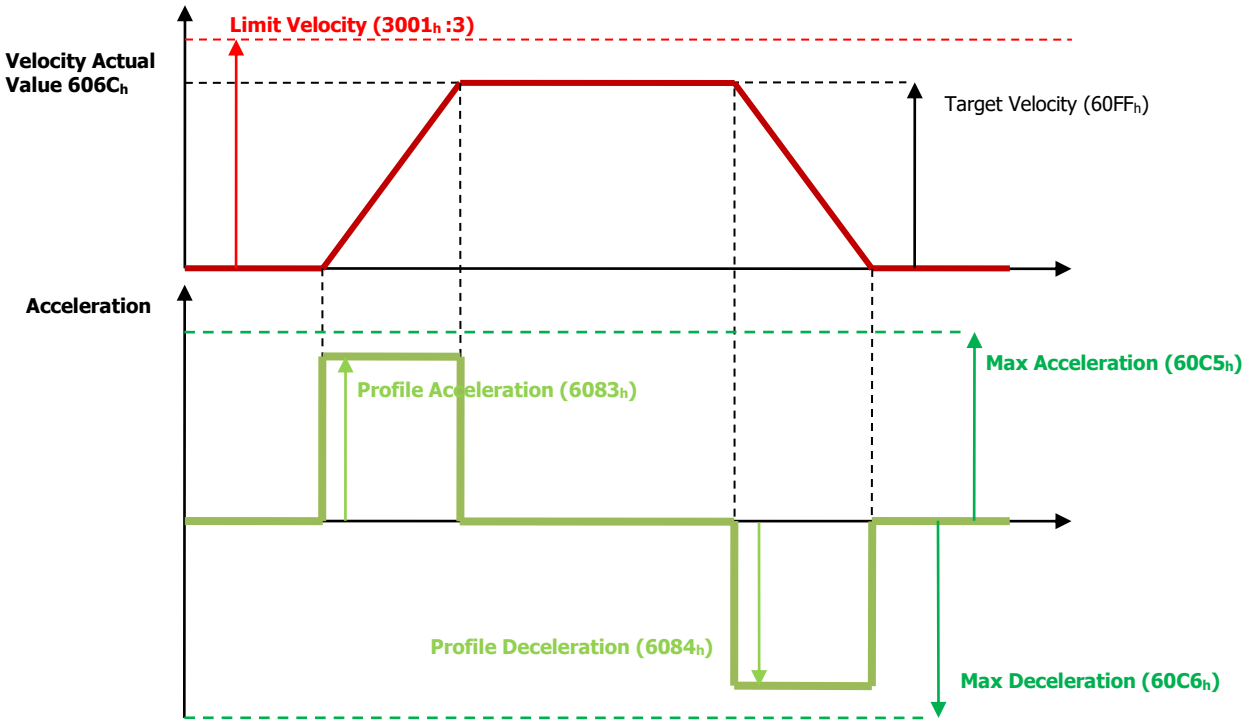
- Target velocity is set to 0
- Stop caused by Halt or Quick Stop
- Stop caused by an error

6.11.2 Controller structure

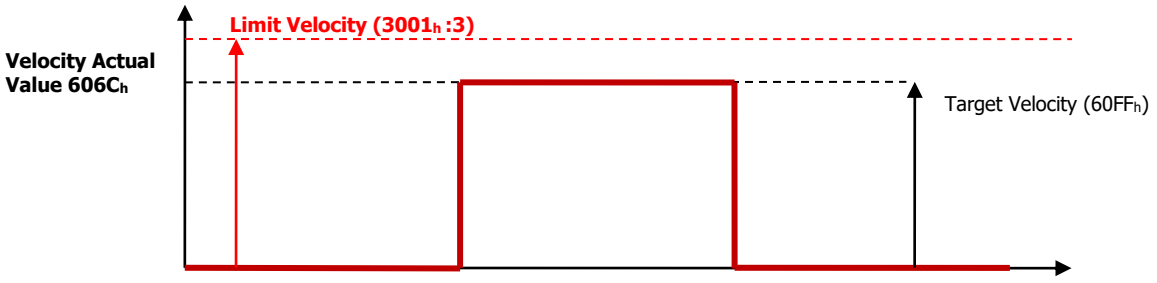


Diagrams Profile Velocity Mode

(p402) Linear Ramp: Value "**0**" (DEFAULT)

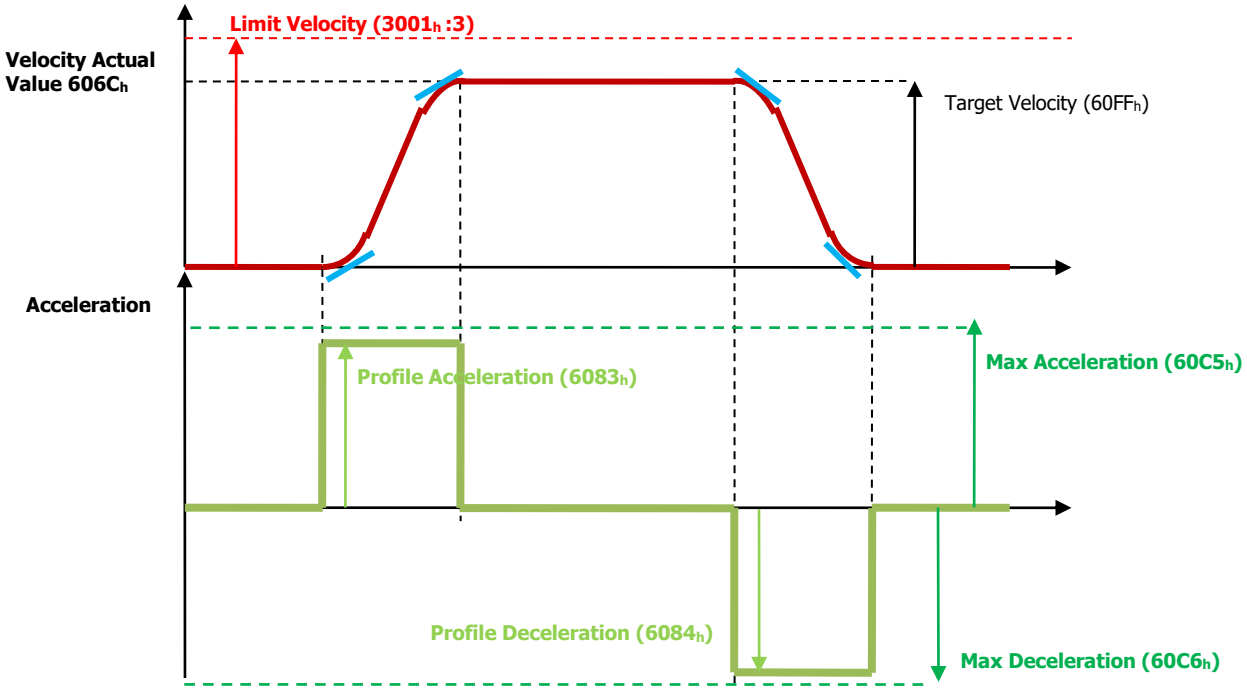


Manuf. Spec. Immediately: Value "**-1**" (ramps disabled)



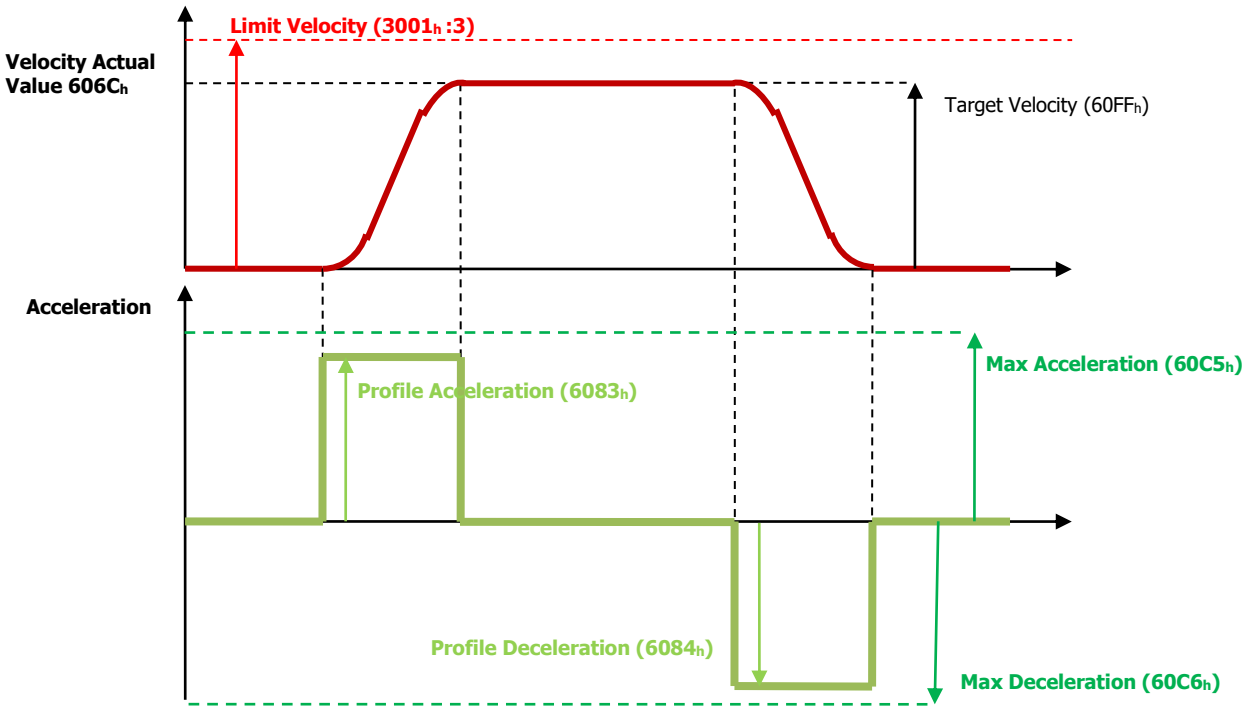
Manuf. Spec. S-Ramp Jerk-Limited : Value "**-2**"

It means that the S-Ramp is limited by Jerk value calculates in the firmware, if the target velocity (0x60FF) is out of range by jerk calculation the drive answers with "abort code" and it does not accept the new target velocity (to have more information read appendix "SRAMP PROFILE").



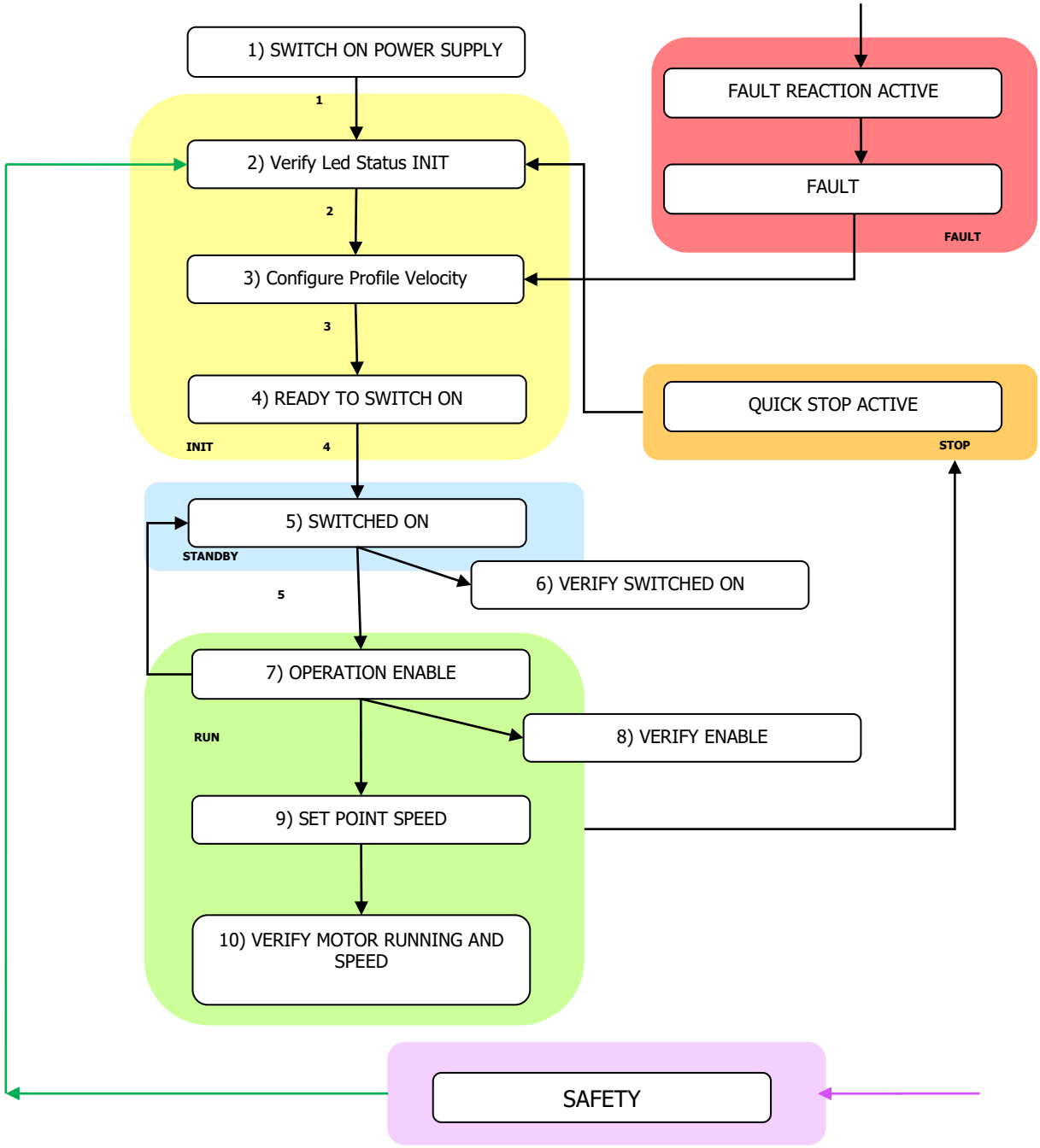
Manuf. Spec. S-Ramp Jerk-NoLimited : Value "**-3**"

It means that the S-Ramp is not limited by Jerk (to have more information read appendix "SRAMP PROFILE").



6.11.3 RUN Sequence

See picture below to the flow chart of running sequence



Picture 22 - CANOpen Run Sequence

1) Switch ON Power Supply
2) Verify LED Status 1/2 in INIT Mode
3) Configure Profile Velocity 0x6060 → 0x03
4) Set **READY TO SWITCH ON** State: write Control Word 0x6040 → 0x06
5) Set **SWITCHED ON** State: write Control Word 0x6040 → 0x07
6) Verify that the Smartris Drive is in SWITCHED ON: read Status Word 0x6041 → 0x23

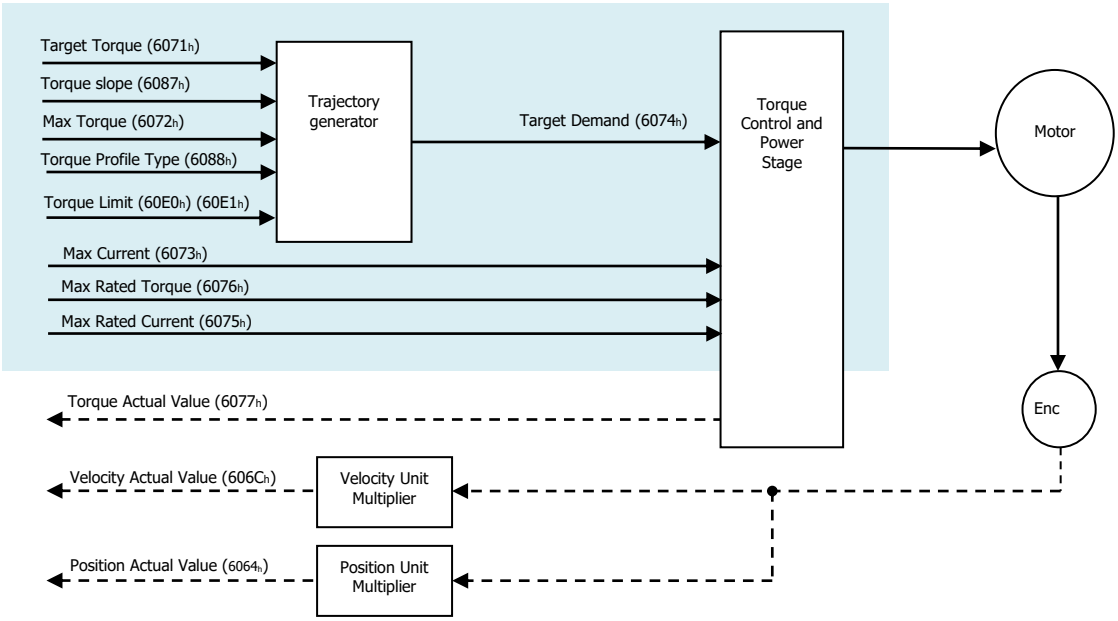
7) Set **OPERATION ENABLED** State: write Control Word 0x6040 → 0x0F
8) Verify LED STATUS ENABLED
   Verify that the Smartris Drive is in ENABLED: read Status Word 0x6041 → 0x27
   Verify that the brake is released
9) Write Speed Set Point: 0x60FF → 0x03e8 (for example set 1000 rpm)
10) Verify if the motor is running
    Verify the motor speed (after ramp): read 0x606C→ 0x03e8 (for example set 1000 rpm)

NOTES:

- The STO (SAFETY) command may can stop the running command immediately
- The Stop Command can stop the running command immediately
- A FAULT (see table in Diagnostic) can stop the running command immediately

6.12 Torque Profile

In the profile Torque operating mode the motor executes a movement according to a target torque or current sent by the master controller. The current regulator (torque control) is specified a current proportional to the target torque.



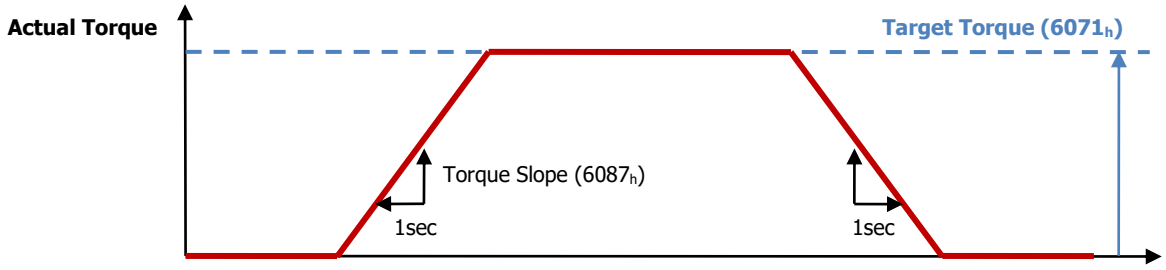
Object entries
The following objects are available for the control profile velocity and the behaviour of the drive.

Index	Object	Name	Type	M/O	Attr	Description
6071h	VAR	Target torque	INT16	M	rw	This object shall indicate the configured input value for the torque controller in profile torque mode. The value shall be given per thousand of rated torque.
6087h	VAR	Torque slope	U32	M	ro	This object shall indicate the configured rate of change of torque. The value shall be given in units of per thousand of rated torque per second.
6088h	VAR	Torque profile type	INT16	O	rw	This object shall indicate the configured type of profile used to perform a torque change.

6073h	VAR	Max current	U16	O	rw	This object shall indicate the configured maximum permissible torque creating current in the motor.
6075h	VAR	Motor rated current	U32	O	rw	This object shall indicate the configured motor rated current. It is taken from the motor's name-plate. Depending on the motor and drive technology, this current is DC, peak or r.m.s. (root-mean-square) current. All relative current data refers to this value. The value shall be given in mA.
6077h	VAR	Torque actual value	I16	O	ro	This object shall provide the actual value of the torque. It shall correspond to the instantaneous torque in the motor. The value shall be given per thousand of rated current.
6078h	VAR	Current actual value	I16	O	ro	This object shall provide the actual value of the current. It shall correspond to the current in the motor. The value shall be given per thousand of rated current. This value is filtered.
6079h	VAR	DC link circuit voltage	U32	O	ro	This object shall provide the instantaneous DC link current voltage at the drive device. The value shall be given in mV.
6074h	VAR	Torque demand	I16	O	ro	This object shall provide the output value of the trajectory generator. The value shall be given per thousand of rated torque.
60E0h	VAR	Positive torque limit value	U16	O	rw	This object shall indicate the configured maximum positive torque in the motor. The value shall be given percent of rated current. Positive torque takes effect in the case of motive operation is positive velocity or regenerative operation is negative velocity
60E1h	VAR	Negative torque limit value	U16	O	rw	This object shall indicate the configured maximum negative torque in the motor. The value shall be given percent of rated current. Positive torque takes effect in the case of motive operation is positive velocity or regenerative operation is negative velocity

Diagrams Torque Profile:
The type of profile can be set by "Torque Profile Type" (6088h):

- Value "-1": Immediately
- Value "0": Linear Ramp.



Torque Profile Operation Mode:
In the Profile Torque operation mode, a movement is made with a specified target torque.
To initiate a torque-controlled movement:

- Switch the operation mode to Profile Torque mode by writing 4 to object 6060h.
- Enable operation.
- Start motion by setting the target torque in object 6071h.

Target torque can be changed on-the-fly during motion. The Torque slope can be changed in run time, the others objects must be saved in e²prom.

The motion ends when one of the following conditions is met:

- Target torque is set to 0
- Stop caused by Halt or Quick Stop
- Stop caused by an error

6.13 SinCos Management

Object CAN 3004: SinCos Management (Single/Multi turn)

Sub Index	Name	Attr	Description
1	**Feedback Type**	ro	0 = resolver, 1 = encoder, 2 = SinCos
2	**Pulse/gear**	ro	This object shall indicate the configured rate of change of torque. The value shall be given in units of per thousand of rated torque per second.
3	**Absolute position L (initial) - 16 bit LSB**	ro	Example: pos = 0x297421 value = 0x7421
4	**Absolute position H (initial) - 16 bit MSB**	ro	Example: pos = 0x297421 value = 0x0029
5	**Absolute position L (actual) - 16 bit LSB**	ro	See note (1) – Absolute position is 24 bit for multi turn / 12 bit for single turn
6	**Absolute position H (actual) - 16 bit MSB**	ro	See note (1) – Absolute position is 24 bit for multi turn / 12 bit for single turn
7	**Encoder Type**	ro	(Singleturn = 0x32, Multiturn = 0x37)
8	**Reserved**	ro	
9	**Reserved**	ro	
10	**Encoder Command**	wo	See note (3)
11	**Initial gear number**	ro	(12 bit)
12	**Relative position (initial)**	ro	(12 bit) Example: pos = 0x297421 N° of gear = 0x0421
13	**Reserved**	ro	
14	**Reserved**	ro	
15	**Reserved**	ro	

Note:

1) At the beginning initial and actual position are the same. Actual position is updated only after a read position command (see note 3)
2) In the 8 bit LSB there is internal error code
3) Encoder Command:
    1. READ ENCODER STATUS (encoder status)
    2. READ OUT NAME PLATE (Encoder Type)
    3. Reserved
    4. READ POSITION (actual position)

7 | MODBUS COMMUNICATION

7.1 RS485 - Modbus Communication Settings

WRITE SINGLE HOLDING REGISTER (0x06) / READ HOLDING REGISTERS (0x03)

Physical Address

Variable	Address (WR)	Default Value	Choice
Address	0x0028	1	1 ÷ 247

Baud Rate

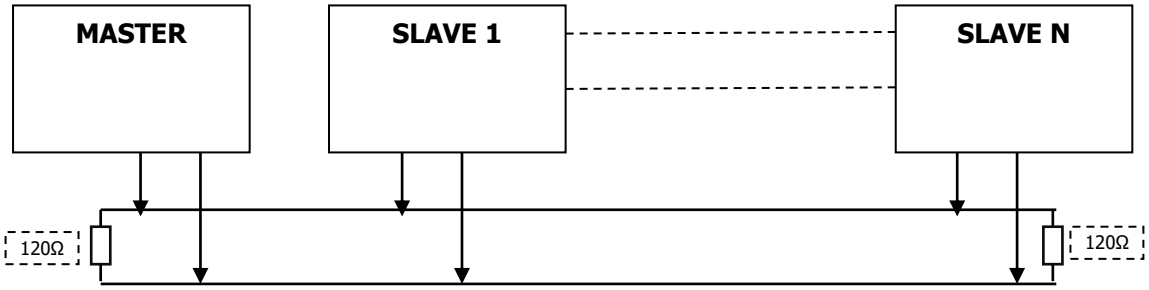
Variable	Address (WR)	Default Value	Choice
BaudRate	0x0035	192 ➔ 19200	96 ➔ 9600
			192➔ 19200
			384 ➔ 38400
			576 ➔ 57600
			1152 ➔ 115200

COM Settings

Variable	Address (WR)	Default Value	Choice
Parity / Stop Bits / Data Bits	0x002B	0 ➔ NO Parity / 2 Stop Bits / 8 Data Bits	0 ➔ NO Parity / 2 Stop Bits / 8 Data Bits
			1 ➔ ODD Parity / 1 Stop Bit / 8 Data Bits
			2 ➔ EVEN Parity / 1 Stop Bit / 8 Data Bits

Info

The Modbus Address is the physical address and depends if there are more devices togheter.
The modifies of Baudrate or Parity can cause communication issues. They depend to Hardware connection
In case of sending different value drive gives the Exception Code 0x03



Picture 23 – Modbus Connection

Warning

Lafert Drive is always set as a slave

Mise en garde

Lafert Drive est toujours défini comme esclave

7.2 List of Read Input Registers List of Read Holding Registers

	READ ONLY (0x03)		UNIT	DEFAULT VALUE
HEX	DEC		[ ]	
0x0001	1	CONTROL WORD	[ ]	0
0x0003	3	FULL SCALE VELOCITY	[RPM]	Depends by motor: • L=3000 • M=4500 • S=4500
0x0028	40	MODBUS ADDRESS	[ ]	1
0x002B	43	COM SETTINGS	[ ]	0
0x0035	53	MODBUS BAUD RATE	[ ]	192
0x0036	54	COMMUNICATION LOSS TIME	[ ]	0
0x003C	60	PID VELOCITY KP	[IU]	Depends by motor
0x003D	61	PID VELOCITY KI	[IU]	Depends by motor
0x003E	62	PID VELOCITY KV	[IU]	Depends by motor
0x003F	63	SPEED RAMP STATE	[ ]	1 : Ramp enabled
0x0040	64	SPEED RAMP UP	[ms]	2000
0x0041	65	SPEED RAMP DOWN	[ms]	2000
0x0043	67	SPEED POLARITY	[ ]	0
0x0044	68	LIMIT TORQUE POSITIVE	[%]	100
0x0045	69	LIMIT TORQUE NEGATIVE	[%]	100
0x0046	70	SLOPE RAMP (TORQUE)	[rated current / (1000 * s)]	1000
0x004E	78	BRAKE MANAGED	[ ]	1
0x004F	79	BRAKE MODE	[ ]	1
0x0050	80	BRAKE TYPE	[ ]	Depends by motor: • Magnetic Brake = 1 • Spring Brake = 2
0X0051	81	MOVE TO STANDBY – CW (PREVIUOUS DYNAMIC STOP)	[ ]	1
0X0053	83	READ CONFIG ANALOG OUTPUT	[ ]	
0X0054	84	AN. OUTPUT VALUE (GEN PURPOSE)	[ ]	
0X0055	85	DYNAMIC STOP STEP RAMP	[rpm*100/sec]	
0X0056	86	SPEED VELOCITY FILTERED	[ ]	
0x0057	87	RESERVED	RESERVED	1
0x0058	88	RESERVED	RESERVED	0
0x0059	89	MOVE TO STANDBY - EMERGENCY	[ ]	1
0x005A	90	MOVE TO FAULT	[ ]	1
0x005B	91	RESERVED	RESERVED	1
0x005C	92	STO OPT CODE	[ ]	0
0x005D	93	SAFETY FSM MODE	[ ]	0
0x005E	94	STATUSWORD CONFIG	[ ]	
0x005F	95	WARNING CONFIG	[ ]	
0x0060	96	FILTER POLO VELOCITY	[ ]	
0x0061	97	DECREMENT STEP S-RAMP	[ ]	
0x0062	98	ANALOG CFG ADC	[ ]	
0x0063	99	ANALOG RUN THRESHOLD	[ ]	
0x0064	100	RESERVED	RESERVED	RESERVED
0x0065	101	RESERVED	RESERVED	RESERVED
0x0066	102	MOTION PROFILE TYPE	[ ]	
0X0080	128	DIGIN 1 CONFIG	[ ]	See User Guide
0X0081	129	DIGIN 2 CONFIG	[ ]	See User Guide

0X0082	130	DIGIN 3 CONFIG	[ ]	See User Guide
0X0083	131	DIGIN 4 CONFIG	[ ]	See User Guide
0X0084	132	DIGOUT 1 CONFIG	[ ]	See User Guide
0X0085	133	DIGOUT 2 CONFIG	[ ]	See User Guide
0X0086	134	DIGOUT 3 CONFIG	[ ]	See User Guide
0X0087	135	DIGOUT 4 CONFIG	[ ]	See User Guide
0X0088	136	DIGIN 1 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0X0089	137	DIGIN 2 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0X008A	138	DIGIN 3 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0X008B	139	DIGIN 4 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0X008C	140	DIGOUT 1 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0X008D	141	DIGOUT 2 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0X008E	142	DIGOUT 3 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0X008F	143	DIGOUT 4 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0x0090	144	WARNING ENABLE USER - LOW		
0x0091	145	WARNING ENABLE USER - HIGH		
0x0092	146	WARNING SINGLE OUT - LOW		
0x0093	147	WARNING SINGLE OUT - HIGH		
0x0120	288	RESERVED	RESERVED	RESERVED
0x0121	289	RESERVED	RESERVED	RESERVED
0x0122	290	RESERVED	RESERVED	RESERVED
0x0123	291	RESERVED	RESERVED	RESERVED
0x0124	292	RESERVED	RESERVED	RESERVED
0x0125	293	RESERVED	RESERVED	RESERVED
0x0126	294	RESERVED	RESERVED	RESERVED
0x0127	295	RESERVED	RESERVED	RESERVED
0x0128	296	RESERVED	RESERVED	RESERVED
0x0129	297	RESERVED	RESERVED	RESERVED
0x012A	298	RESERVED	RESERVED	RESERVED
0x012B	299	RESERVED	RESERVED	RESERVED
0x012C	300	RESERVED	RESERVED	RESERVED
0x012D	301	RESERVED	RESERVED	RESERVED
0x012E	302	RESERVED	RESERVED	RESERVED
0x012F	303	RESERVED	RESERVED	RESERVED
0x0130	304	PROFILE ACCELERATION - LOW	[rpm/sec]	
0x0131	305	PROFILE ACCELERATION - HIGH	[rpm/sec]	
0x0132	306	PROFILE DECELERATION - LOW	[rpm/sec]	
0x0133	307	PROFILE DECELERATION - HIGH	[rpm/sec]	
0x0134	308	MAX ACCELERATION - LOW	[rpm/sec]	
0x0135	309	MAX ACCELERATION - HIGH	[rpm/sec]	
0x0136	310	MAX DECELERATION - LOW	[rpm/sec]	
0x0137	311	MAX DECELERATION - HIGH	[rpm/sec]	
0x01FF	511	FW RELEASE CUSTOMER		Depends by FW release
0x0201	513	HW RELEASE		• 12 if STO • 22 if NO STO
0x0202	514	PARAMETER RELEASE		Depends by parameter release
0x0203	515	MOTOR TYPE		Depends by motor type: • 0 = None, • 1 = B40, • 2 = B63, • 3 = B71, • 100=RESERVED

0x0204	516	STO CHECK		• 1 → STO present • 2 → NO STO
0x0205	517	FEEDBACK		• 0 → Resolver • 1 → Incr Encoder • 2→ SinCos Encoder
0x0207	519	OPERATION MODE		• 1 → Torque mode • 2 → Velocity mode
0x0208	520	READ MOT POLES		Motor poles couple
0x0209	521	MOTOR TEMP SENSOR		
0x020A	522	MAX MOTOR SPEED	[rpm]	

Table 23 – List of Modbus Read Input Registers

7.3 List of Read Holding Registers

	READ ONLY (0x03)		UNIT	DEFAULT VALUE
HEX	DEC		[ ]	
0x0001	1	CONTROL WORD	[ ]	0
0x0003	3	FULL SCALE VELOCITY	[RPM]	Depends by motor: • L=3000 • M=4500 • S=4500
0x0028	40	MODBUS ADDRESS	[ ]	1
0x002B	43	COM SETTINGS	[ ]	0
0x0035	53	MODBUS BAUD RATE	[ ]	192
0x0036	54	COMMUNICATION LOSS TIME	[ ]	0
0x003C	60	PID VELOCITY KP	[IU]	Depends by motor
0x003D	61	PID VELOCITY KI	[IU]	Depends by motor
0x003E	62	PID VELOCITY KV	[IU]	Depends by motor
0x003F	63	SPEED RAMP STATE	[ ]	1 : Ramp enabled
0x0040	64	SPEED RAMP UP	[ms]	2000
0x0041	65	SPEED RAMP DOWN	[ms]	2000
0x0043	67	SPEED POLARITY	[ ]	0
0x0044	68	LIMIT TORQUE POSITIVE	[%]	100
0x0045	69	LIMIT TORQUE NEGATIVE	[%]	100
0x0046	70	SLOPE RAMP (TORQUE)	[rated current / (1000 * s)]	1000
0x004E	78	BRAKE MANAGED	[ ]	1
0x004F	79	BRAKE MODE	[ ]	1
0x0050	80	BRAKE TYPE	[ ]	Depends by motor: • Magnetic Brake = 1 • Spring Brake = 2
0X0051	81	MOVE TO STANDBY – CW (PREVIUOUS DYNAMIC STOP)	[ ]	1
0X0053	83	READ CONFIG ANALOG OUTPUT	[ ]	
0X0054	84	AN. OUTPUT VALUE (GEN PURPOSE)	[ ]	
0X0055	85	DYNAMIC STOP STEP RAMP	[rpm*100/sec]	
0X0056	86	SPEED VELOCITY FILTERED	[ ]	
0x0057	87	RESERVED	RESERVED	1
0x0058	88	RESERVED	RESERVED	0
0x0059	89	MOVE TO STANDBY - EMERGENCY	[ ]	1
0x005A	90	MOVE TO FAULT	[ ]	1
0x005B	91	RESERVED	RESERVED	1
0x005C	92	STO OPT CODE	[ ]	0

0x005D	93	SAFETY FSM MODE	[ ]	0
0x005E	94	STATUSWORD CONFIG	[ ]	
0x005F	95	WARNING CONFIG	[ ]	
0x0060	96	FILTER POLO VELOCITY	[ ]	
0x0061	97	DECREMENT STEP S-RAMP	[ ]	
0x0062	98	ANALOG CFG ADC	[ ]	
0x0063	99	ANALOG RUN THRESHOLD	[ ]	
0x0064	100	RESERVED	RESERVED	RESERVED
0x0065	101	RESERVED	RESERVED	RESERVED
0x0066	102	MOTION PROFILE TYPE	[ ]	
0X0080	128	DIGIN 1 CONFIG	[ ]	See User Guide
0X0081	129	DIGIN 2 CONFIG	[ ]	See User Guide
0X0082	130	DIGIN 3 CONFIG	[ ]	See User Guide
0X0083	131	DIGIN 4 CONFIG	[ ]	See User Guide
0X0084	132	DIGOUT 1 CONFIG	[ ]	See User Guide
0X0085	133	DIGOUT 2 CONFIG	[ ]	See User Guide
0X0086	134	DIGOUT 3 CONFIG	[ ]	See User Guide
0X0087	135	DIGOUT 4 CONFIG	[ ]	See User Guide
0X0088	136	DIGIN 1 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0X0089	137	DIGIN 2 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0X008A	138	DIGIN 3 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0X008B	139	DIGIN 4 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0X008C	140	DIGOUT 1 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0X008D	141	DIGOUT 2 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0X008E	142	DIGOUT 3 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0X008F	143	DIGOUT 4 LEVEL	[ ]	0=POS EDGE / 1=NEG EDGE
0x0090	144	WARNING ENABLE USER - LOW		
0x0091	145	WARNING ENABLE USER - HIGH		
0x0092	146	WARNING SINGLE OUT - LOW		
0x0093	147	WARNING SINGLE OUT - HIGH		
0x0120	288	RESERVED	RESERVED	RESERVED
0x0121	289	RESERVED	RESERVED	RESERVED
0x0122	290	RESERVED	RESERVED	RESERVED
0x0123	291	RESERVED	RESERVED	RESERVED
0x0124	292	RESERVED	RESERVED	RESERVED
0x0125	293	RESERVED	RESERVED	RESERVED
0x0126	294	RESERVED	RESERVED	RESERVED
0x0127	295	RESERVED	RESERVED	RESERVED
0x0128	296	RESERVED	RESERVED	RESERVED
0x0129	297	RESERVED	RESERVED	RESERVED
0x012A	298	RESERVED	RESERVED	RESERVED
0x012B	299	RESERVED	RESERVED	RESERVED
0x012C	300	RESERVED	RESERVED	RESERVED
0x012D	301	RESERVED	RESERVED	RESERVED
0x012E	302	RESERVED	RESERVED	RESERVED
0x012F	303	RESERVED	RESERVED	RESERVED
0x0130	304	PROFILE ACCELERATION - LOW	[rpm/sec]	
0x0131	305	PROFILE ACCELERATION - HIGH	[rpm/sec]	
0x0132	306	PROFILE DECELERATION - LOW	[rpm/sec]	
0x0133	307	PROFILE DECELERATION - HIGH	[rpm/sec]	
0x0134	308	MAX ACCELERATION - LOW	[rpm/sec]	

0x0135	309	MAX ACCELERATION - HIGH	[rpm/sec]	
0x0136	310	MAX DECELERATION - LOW	[rpm/sec]	
0x0137	311	MAX DECELERATION - HIGH	[rpm/sec]	
0x01FF	511	FW RELEASE CUSTOMER		Depends by FW release
0x0201	513	HW RELEASE		• 12 if STO • 22 if NO STO
0x0202	514	PARAMETER RELEASE		Depends by parameter release
0x0203	515	MOTOR TYPE		Depends by motor type: • 0 = None, • 1 = B40, • 2 = B63, • 3 = B71, • 100=RESERVED
0x0204	516	STO CHECK		• 1 → STO present • 2 → NO STO
0x0205	517	FEEDBACK		• 0 → Resolver • 1 → Incr Encoder • 2→ SinCos Encoder
0x0207	519	OPERATION MODE		• 1 → Torque mode • 2 → Velocity mode
0x0208	520	READ MOT POLES		Motor poles couple
0x0209	521	MOTOR TEMP SENSOR		
0x020A	522	MAX MOTOR SPEED	[rpm]	

Table 24 – List of Modbus Read Holding Registers

7.4 List of Write Single Holding Registers

	WRITE PARAMETERS (0x06)		UNIT
HEX	DEC		[ ]
0x0000	0	STORE E2PROM	[ ]
0x0001	1	CONTROL WORD	[ ]
0x0028	40	MODBUS ADDRESS	[ ]
0x002B	43	COM SETTINGS	[ ]
0x0035	53	MODBUS BAUD RATE	[ ]
0x0036	54	COMMUNICATION LOSS TIME	[ms]
0x003C	60	PID VELOCITY KP	[IU]
0x003D	61	PID VELOCITY KI	[IU]
0x003E	62	PID VELOCITY KV	[IU]
0x003F	63	RAMP ENABLE	[ ]
0x0040	64	SPEED RAMP UP TIME	[ms]
0x0041	65	SPEED RAMP DOWN TIME	[ms]
0x0042	66	SPEED SETPOINT	[RPM]
0x0043	67	SPEED POLARITY	[ ]
0x0044	68	LIMIT TORQUE POSITIVE	[%]
0x0045	69	LIMIT TORQUE NEGATIVE	[%]
0x0046	70	SLOPE RAMP (TORQUE)	[Rated current / (1000 * s)]
0x0047	71	CURRENT TORQUE SETPOINT	[Arms / 100]
0x004E	78	BRAKE MANAGED	[ ]
0x004F	79	BRAKE MODE	[ ]
0X0051	81	MOVE TO STANDBY – CW (PREVIOUS NAME: DYNAMIC STOP)	[ ]

0X0052	82	SET CMD REQ FEEDBACK	[ ]
0X0053	83	CONFIG ANALOG OUTPUT	[ ]
0X0054	84	SET ANALOG OUTPUT VALUE (GEN PURPOSE)	[ ]
0X0055	85	DYN STOP STEP RAMP	[ ]
0x0056	86	FILTER POLO VELOCITA'	[ ]
0x0057	87	RESERVED	RESERVED
0x0058	88	RESERVED	RESERVED
0x0059	89	MOVE TO STANDBY - EMERGENCY	[ ]
0x005A	90	MOVE TO FAULT	[ ]
0x005B	91	RESERVED	RESERVED
0x005C	92	STO OPT CODE	[ ]
0x005D	93	SAFETY FSM MODE	[ ]
0x005E	94	STATUSWORD CONFIG	[ ]
0x005F	95	WARNING CONFIG	[ ]
0x0060	96	FILTER POLO VELOCITY	[ ]
0x0061	97	DECREMENT STEP S-RAMP	[ ]
0x0062	98	ANALOG CFG ADC	[ ]
0x0063	99	ANALOG RUN THRESHOLD	[ ]
0x0064	100	RESERVED	RESERVED
0x0065	101	RESERVED	RESERVED
0x0066	102	MOTION PROFILE TYPE	[ ]
0X0080	128	DIGITAL INPUT 1 CFG	[ ]
0X0081	129	DIGITAL INPUT 2 CFG	[ ]
0X0082	130	DIGITAL INPUT 3 CFG	[ ]
0X0083	131	DIGITAL INPUT 4 CFG	[ ]
0X0084	132	DIGITAL OUTPUT 1 CFG	[ ]
0X0085	133	DIGITAL OUTPUT 2 CFG	[ ]
0X0086	134	DIGITAL OUTPUT 3 CFG	[ ]
0X0087	135	DIGITAL OUTPUT 4 CFG	[ ]
0X0088	136	DIGITAL INPUT 1 LEVEL	[ ]
0X0089	137	DIGITAL INPUT 2 LEVEL	[ ]
0X0090	138	DIGITAL INPUT 3 LEVEL	[ ]
0X0091	139	DIGITAL INPUT 4 LEVEL	[ ]
0X0092	140	DIGITAL OUTPUT 1 LEVEL	[ ]
0X0093	141	DIGITAL OUTPUT 2 LEVEL	[ ]
0X0094	142	DIGITAL OUTPUT 3 LEVEL	[ ]
0X0095	143	DIGITAL OUTPUT 4 LEVEL	[ ]
0x0090	144	WARNING ENABLE USER - LOW	
0x0091	145	WARNING ENABLE USER - HIGH	
0x0092	146	WARNING SINGLE OUT - LOW	
0x0093	147	WARNING SINGLE OUT - HIGH	
0x0120	288	RESERVED	RESERVED
0x0121	289	RESERVED	RESERVED
0x0122	290	RESERVED	RESERVED
0x0123	291	RESERVED	RESERVED
0x0124	292	RESERVED	RESERVED
0x0125	293	RESERVED	RESERVED
0x0126	294	RESERVED	RESERVED
0x0127	295	RESERVED	RESERVED
0x0128	296	RESERVED	RESERVED
0x0129	297	RESERVED	RESERVED

0x012A	298	RESERVED	RESERVED
0x012B	299	RESERVED	RESERVED
0x012C	300	RESERVED	RESERVED
0x012D	301	RESERVED	RESERVED
0x012E	302	RESERVED	RESERVED
0x012F	303	RESERVED	RESERVED
0x0130	304	PROFILE ACCELERATION - LOW	[rpm/sec]
0x0131	305	PROFILE ACCELERATION - HIGH	[rpm/sec]
0x0132	306	PROFILE DECELERATION - LOW	[rpm/sec]
0x0133	307	PROFILE DECELERATION - HIGH	[rpm/sec]
0x0134	308	MAX ACCELERATION - LOW	[rpm/sec]
0x0135	309	MAX ACCELERATION - HIGH	[rpm/sec]
0x0136	310	MAX DECELERATION - LOW	[rpm/sec]
0x0137	311	MAX DECELERATION - HIGH	[rpm/sec]
0X0207	519	OPERATION MODE	[ ]
0x5A5A	23130	RESTORE MANUFACTURER DATA	[ ]
0xA5A5	42405	RESET DRIVE	[ ]

Table 25 – List of Modbus Single Write Holding Registers

7.5 List of Exception Code

In Modbus protocol there are some Exception Code for error in Communication values:

	Exception Code on Modbus Communication	
Exception Code	Name	Meaning
0x01	Illegal Function	The function code received in the request is not an authorized action for the slave. The slave may be in the wrong state to process a specific request.
0x02	Illegal Data Address	The data address received by the slave is not an authorized address for the slave.
0x03	Illegal Data Value	The value in the request data field is not an authorized value for the slave.

Table 26 – List of Modbus Exception Code

Info

In this chapter there are only the lists of Modbus Parameters.
To see the descriptions of all parameters and hot to use them see Lafert Modbus Manual

7.6 Run Sequence

1) Switch ON Power Supply [**T0**]
2) Wait **Standby** (*SWITCHED ON*) State [**T1**]
3) Verify Operation Mode by reading [func. 0x03 – addr. 0x0207] Operation Mode:
   - Value equal to 1 → Torque Mode
   - Value equal to 2 → Velocity Mode

Warning

If the customer wants to switch from Torque Mode to velocity Mode or vice-versa he must set it by write to [func.06 – addr.0x0207] Operation Mode.

To make changes effective, the customer must first save to memory with command [func.06 – addr. 0x0000] Store E2PROM Data and then reset drive with command [func.06 – addr.0xA5A5] System Reset.

	Attention
	Si le client souhaite passer du mode couple au mode vitesse ou vice-versa, il doit le définir en écrivant sur [func.06 – addr.0x0207] Mode de fonctionnement. Pour que les modifications soient effectives, le client doit d'abord enregistrer en mémoire avec la commande [func.06 – addr. 0x0000] Stockez les données E2PROM, puis réinitialisez le lecteur avec la commande [func.06 – addr.0xA5A5] Réinitialisation du système.

4) Verify that the Smartris Drive is in SWITCHED ON
5) Set **OPERATION ENABLED** State: write [0x06] Control Word → 0x0001 = 0x0003 [**T2**]
6) Verify LED STATUS ENABLED
   - Verify by read [func. 0x03 - addr.0x0060], that the Smartris Drive is in ENABLED [Drive Status = 0x0001 → RUN)]
   - Verify that the brake is released.
7) If [func. 0x06 - addr. 0x0207] - Operation Mode = 2 – Velocity mode → Write to [func.0x06 – addr. 0x0042] Speed Set Point → **i.e.** 0x03e8 (1000 → 1000 rpm)
   If [func. 0x06 - addr. 0x0207] - Operation Mode = 1 – Torque mode → Write to [func.0x06 – addr. 0x0047] Torque Set Point → **i.e.** 0x03e8 (1000 →10 Arms)
8) Verify if the motor is running.
   - Verify the motor speed (after ramp) by read to [func. 0x04 – addr. 0x0068] Motor Speed
   - Verify the motor current by read to [func. 0x04 – addr. 0x0069] Torque Current
9) Stop the motor with Stop Command → write to [func. 0x06 - addr. 0x0001] - Control Word → 0x0001 [**T4**] – Drive goes immediately in Stop state with MAX torque (it's equal to a QUICK STOP command).
   If you want to Stop the motor with ramp, just write to [func.06 – addr.0x0042] Speed Set Point the value 0 (0 rpm).
   Stop the motor with Standby Command → write to [func. 0x06 - addr. 0x0001] - Control Word → 0x0002 [**T4**] – Drives goes in Standby state.

	Warning
	Broadcast communication it is not implemented

RTU Mode - Bits per Byte

Start Bit	Data Bits	Parity	Stop Bits
1	8 data bits, least significant bit sent first	1 bit for even / odd parity-no bit for no parity	1 stop bit if parity is used-2 bits if no parity

7.7 Examples: Change Modbus Communication Settings

	Warning
	The Modbus doesn't allow more devices with same address To Change Address it is mandatory connect one drive on the time with Master Controller

7.7.1 Change Address Sequence

In case of more devices connected it is necessary to change the address of devices (default value 1).

Variable	Address (WR)	Default Value	Choice
Address	0x0028	1	1 ÷ 247

Example: change address from 1 to 2
In this case connect the Drive where is necessary to change the address (0x0028) from 1 to 2:

Address	Function	Address (WR)		Data		CRC
01	06	00	28	00	02	16 bit

Save to EEProm (0x0000)

Address	Function	Address (WR)		Data		CRC
01	06	00	00	00	01	16 bit

System Reset (0xA5A5)

Address	Function	Address (WR)		Data		CRC
01	06	A5	A5	00	01	16 bit

After this procedure the drive has Modbus Address set at 2

7.7.2 Change Baud Rate Sequence

Example: In case is necessary to change the Baud Rate (0x0035) from 19200 (default) to 9600 (96 = 0x60):

Address	Function	Address (WR)		Data		CRC
01	06	00	35	00	60	16 bit

Save to EEProm (0x0000)

Address	Function	Address (WR)		Data		CRC
01	06	00	00	00	01	16 bit

System Reset (0xA5A5)

Address	Function	Address (WR)		Data		CRC
01	06	A5	A5	00	01	16 bit

After this procedure the drive has Modbus Baud Rate is set at 9600

7.7.3 Change COM Setting Sequence

Example: In case is necessary to change the COM Setting (0x002B) from 0 (default) to 1 (1 ➔ ODD Parity / 1 Stop Bit / 8 Data Bits):

Address	Function	Address (WR)		Data		CRC
01	06	00	2B	00	01	16 bit

Save to EEProm (0x0000)

Address	Function	Address (WR)		Data		CRC
01	06	00	00	00	01	16 bit

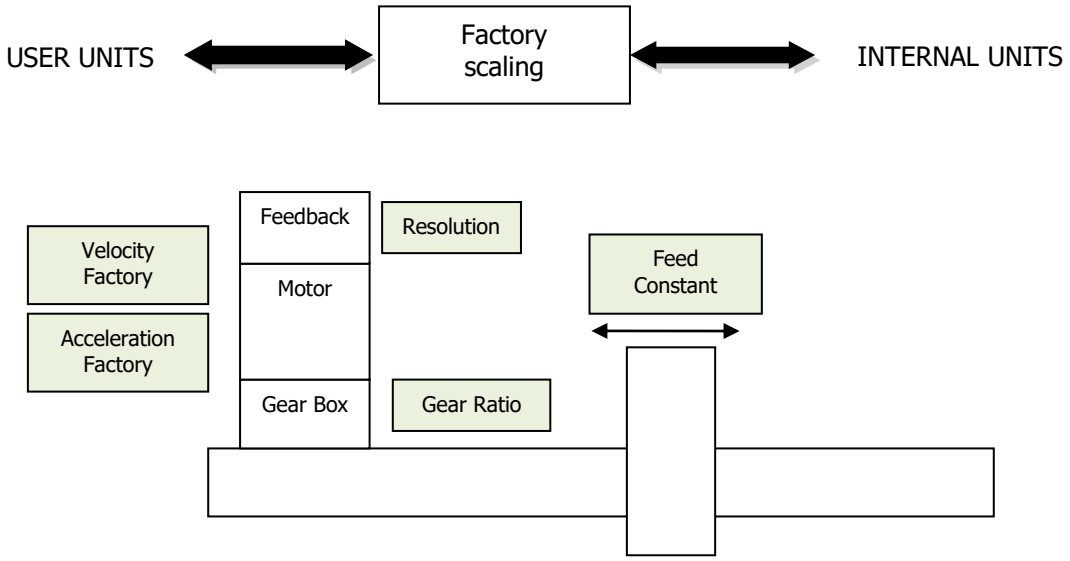
System Reset (0xA5A5)

Address	Function	Address (WR)		Data		CRC
01	06	A5	A5	00	01	16 bit

After this procedure the drive has Modbus COM Setting is set at 1 ➔ ODD Parity / 1 Stop Bit / 8 Data Bits
* depends by COM Settings (0x002B)

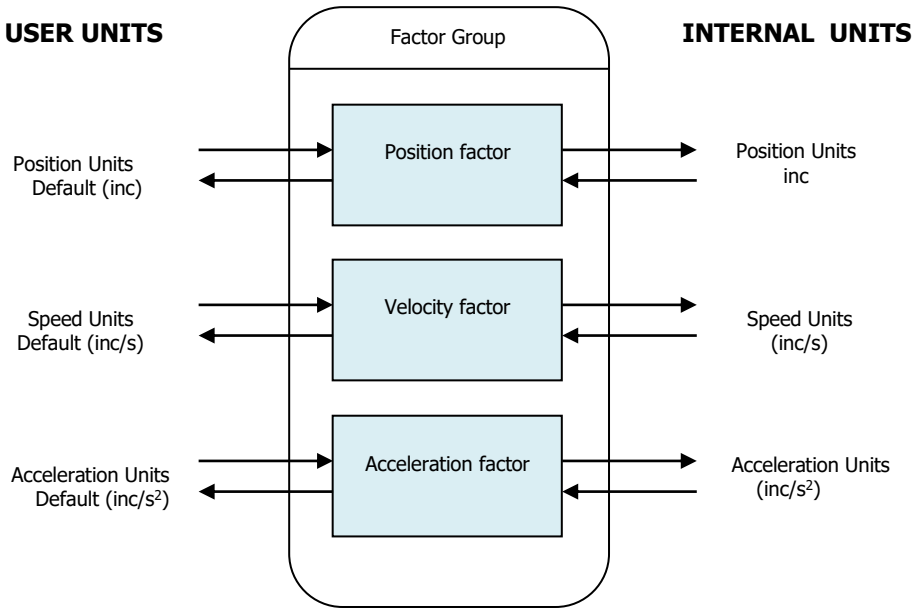
8 | MEASURING UNIT CONVERSION

The drive can be used in different applications. Internal values are entered and calculated in increments; they are dependent on the resolution of the feedback used. The user parameters are defined in increments as default. For setting parameters easily in different applications, it is possible to convert the user unit in other units.



Picture 24 - Factory group

It defines [u.u.] as user unit and [i.u.] as internal units.



Picture 25 - Factory group units

The values of the Velocity Factory Group and Acceleration Factory group are used to convert internal values of speed and acceleration parameters into user-defined units.

The Velocity Factor group is composed by numerator and divisor and it has to be entered separately.

$$Velocity\ Factor\ = \frac{Numerator}{Divisor}$$

The default value of user unit of velocity is [inc/s]: the numerator and the divisor are set "1".

$$Velocity[i.u.] = Velocity[u.u.] \times \left(\frac{Numerator}{Divisor}\right)$$

The Acceleration Factor is composed by numerator and divisor, and it has to be entered separately.

$$Acceleration\ Factor\ = \frac{Numerator}{Divisor}$$

The default value of user unit of acceleration is [inc/s^2]: the numerator and the divisor are set "1".

$$Acceleration[i.u.] = Acceleration[u.u.] \times \left(\frac{Numerator}{Divisor}\right)$$

	**Warning** The drive has as a default unit the increments. If you want to change the units see the procedure. After the units changing It is mandatory modify also some objects (for example profile acceleration/deceleration, max acceleration/deceleration ...)

	**Mise en garde** Le variateur a comme unité par défaut les incréments. Pour changer les unités, voir la procédure. Après le changement des unités, il est obligatoire de modifier également certains objets (p. ex. accélération/décélération du profil, accélération/décélération max., etc.).

8.1 Measuring Unit Conversion Parameters

In CANopen it is possible to change the user unit group using these objects

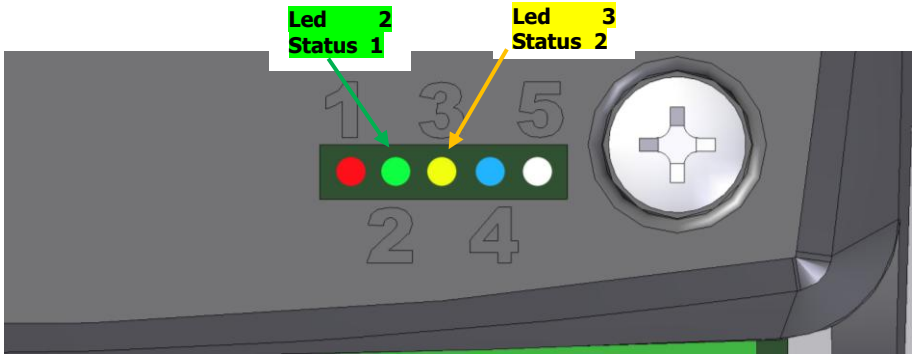
Index	Object	Name	Type	M/O	Attr.	Description
6096$_h$	VAR	Velocity Factor	UINT32	M	rw	This object can be used to match the velocity units to the user-defined velocity units
6097$_h$	VAR	Acceleration Factor	UINT32	M	rw	This object can be used to match the acceleration units to the user-defined acceleration units.

For object's management referring to "Lafert – CANOpen Manual" document.

Table Conversion

FEEDBACK	Velocity Factor		Velocity	Acceleration Factor		Acceleration
Resolution	NUM	DIV	[u.u]	NUM	DIV	[u.u]
4096	1	1	[inc/s]	1	1	[inc/s^2]
	4096	60	[RPM]	4096	60	[RPM/s]
16384	1	1	[inc/s]	1	1	[inc/s^2]
	16384	60	[RPM]	16384	60	[RPM/s]

9 | DIAGNOSTIC



There are 5 leds on Smartris Compact near Power Connector:

LED	**1**	**2**	**3**	**4**	**5**
Meaning	Power (red)	Status1 (green)	Status2 (yellow)	Led Run (blue)	Pulse (white)
Led View	Fixed The Drive is ON	Led Status 1	Led Status 2	Fixed when motor is energized	Rapid Blink (drive alive)

- the **GREEN Led** (Status 1) shows the status 1 of the drive
- the **YELLOW Led** (Status 2) shows the status 2 of the drive

MACRO DRIVE STATE	**CANOpen STATE**	**STATUS 1 LED GREEN**	**STATUS 2 LED YELLOW**	**LED VIEW**
INIT	Not Ready To Switch On	"BLINK" simultaneously	"BLINK" simultaneously	2 simultaneously 3 simultaneously 4 OFF
	Switch On Disabled Ready to Switch On	"BLINK" alternately	"BLINK" alternately	2 alternately 3 alternately 4 OFF
STANDBY	Switched On	"BLINK"	OFF	2 BLINK 50% 3 OFF 4 OFF
FAULT	Fault Fault reaction fault	"BLINK" [x]	"BLINK" [y]	2 see fault 3 chapter 4 OFF
RUN	Operation Enabled	ON	OFF	2 ON 3 OFF 4 ON
STOP	Quick Stop Active	ON	ON	2 ON 3 ON 4 ON
SAFETY	-	OFF	"BLINK"	2 OFF 3 BLINK 4 OFF
COMMUNICATION CAN ERROR	-	OFF	ON	2 OFF 3 ON 4 OFF

Table 27 - LED Status - Diagnostic

To connect drive to laptop by RS232 and read diagnostic or parameter with Lafert Tools use an USB to RS232 interface is needed and one suggested is: - Chipi-X10 Cables (FTDI Manufacturer)

https://www.ftdichip.com/Products/Cables/USBRS232.htm

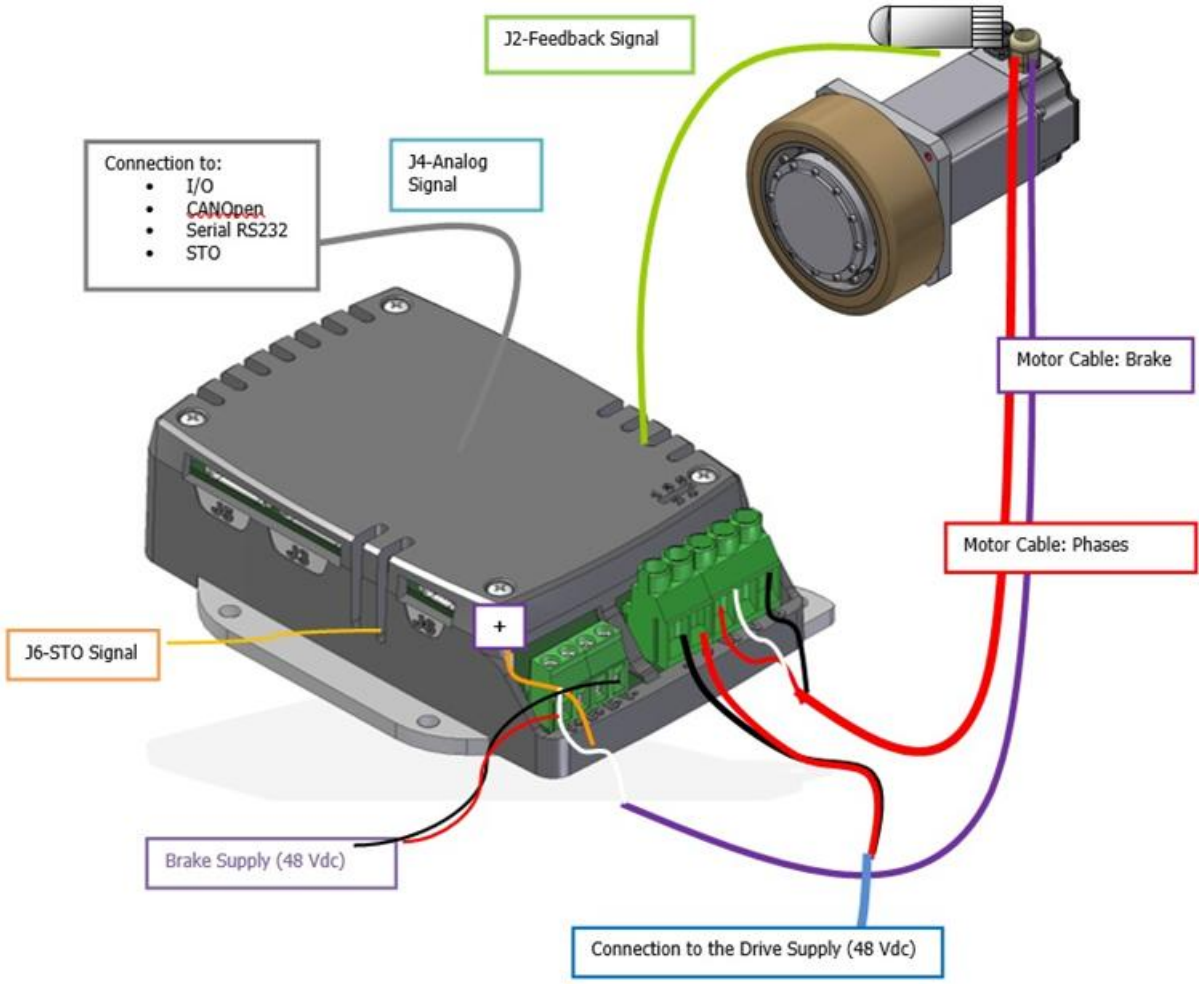
Alarm	STATUS 1 CODE LED GREEN 1st Code	STATUS 2 CODE LED YELLOW 2nd Code	Alarm Description
A Group: (Temperature)			
Motor Over Temperature	**1**	**10**	Motor Temperature over threshold Motor has reached a too high temperature for correct operation. (>140°C)
Heat Sink Over Temperature	**1**	**1**	Heat Sink Temperature over threshold. Heat Sink has reached a too high T for correct operation(>85°C)
Heat Sink Temp Out Of Range	**1**	**3**	Heat Sink Temperature Sensor is out of range. Potential malfunction of the temperature sensor. [1]
Board Over Temperature	**1**	**4**	Internal Board Temperature over threshold. (>75°C) Too high a temperature for correct operation inside the drive.
Board Temp Out Of Range	**1**	**5**	Internal Temperature Sensor out of range. Potential malfunction of the temperature sensor. [1]
Motor Temp Out Of Range	**1**	**6**	Motor Temperature Sensor is out of range. Potential malfunction of the temperature sensor. [1]
B Group: (Feedback)			
Resolver	**2**	**10**	Check resolver connections and wiring of both sides.
Resolver Init	**2**	**4**	Initialization Fault for Resolver Device. [1]
Encoder	**2**	**5**	Incremental Encoder Fault
SinCos Fault	**2**	**6**	SinCos Encoder Fault
Hall	**2**	**7**	Hall Sensors Fault
Distance Hall	**2**	**8**	Hall Sensors Fault
C Group: (Current)			
Offset Current Sensor	**3**	**10**	Offset current sensor is out of range. [1]
Over Current	**3**	**1**	The current absorbed by the motor is beyond the set limit. Check Phase Motor connection and wire. Look for any short circuits.
STO Circuit	**3**	**4**	Reserved [1]
Safety	**3**	**5**	STO occurred (If alarm activated)
D Group: (Voltage)			
Under Voltage	**4**	**1**	DC Bus voltage value lower than the limit threshold. Check mains voltage at terminals +, -.
Over Voltage	**4**	**2**	DC Bus voltage value higher than the limit threshold. Check mains voltage at terminals +, -
E Group: (Functionality)			
Velocity Fault	**5**	**10**	The actual speed differs from the target Speed.
I^2T Overload Protection	**5**	**2**	I2T overload motor protection reached.
Hardware	**5**	**3**	Error Hardware [1]
External HW	**5**	**4**	Error CAN Interface [1]
OverSpeed	**5**	**8**	Overspeed error - CAN
F Group: (Communication and Configuration)			
E^2prom	**6**	**1**	Parameter Fault stored in E2prom.
CanOpen	**6**	**2**	Communication Fault with CANOpen
Sincos Fault	**6**	**3**	Internal Communication Fault [1]
Configuration Parameters	**6**	**4**	Configuration Parameters Fault [1]

Alarm	STATUS 1 CODE LED GREEN 1st Code	STATUS 2 CODE LED YELLOW 2nd Code	Alarm Description
Profile Generic	**6**	**5**	Error Configuration Profile: Mode Of Operation
Torque Profile	**6**	**6**	Error Torque Profile
Velocity Profile	**6**	**7**	Error Velocity Profile
Homing Profile	**6**	**8**	Error Homing Profile
Configuration Parameters			
Program Fault	**7**	**X**	Code Programming Fault [1]
Factory Param	**8**	**1**	Error Programming Factory Parameters[1]
CAN Param	**8**	**2**	Error Programming CAN Parameters[1]
E2prom Function	**8**	**3**	Function Code for EEPROM R/W [1]
Modbus			
Modbus Error	**9**	**1**	Communication Fault with Modbus

Table 28 - Error Code

[1] Contact Manufacturer

10 | CONNECTION SCHEME



Picture 26 - Connection Scheme

For the connection of the different cables see the tables on Chapter 1:

POWER SUPPLY SMARTRIS WIRING			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR (EXAMPLE)**
+	+ VBUS	Connection to + Vbus (+48 Vdc)	Red
-	- VBUS	Connection to - Vbus	Black

Table 29 - Power Supply Wiring Scheme

MOTOR PHASES SMARTRIS WIRING			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
U	PHASE U	Motor Phase U	Black
V	PHASE V	Motor Phase V	White
W	PHASE W	Motor Phase W	Red

Table 30 - Motor Phases Scheme

Brake connector

PIN	SIGNAL	DESCRIPTION	COLOR
1	V+	+V Supply for brake (24/48V) – (default) connect to "+".	
2	B+	Motor Brake +	
3	B-	Motor Brake -	
4	V-	-V Supply for brake (24/48V) – (default) connect to "-".	

Table 31 - Brake Scheme (see Wiring Example Chapter 1)

J2 - Feedback SIGNAL			
PIN	RESOLVER	INC ENC+HALL	SINCOS ENCODER
1	SIN+	A+	SIN
2	SIN-	A-	REFSIN
3	COS+	B+	COS
4	COS-	B-	REFCOS
5	R1	Z+	DATA+
6	R2	Z-	DATA-
7	-	HX	-
8	-	HY	-
9	-	HZ	-
10	-	+5V	+8V
11	-	GND	GND
12	SCH	SCH	SCH
13	NTC1a	NTC1a	NTC1a
14	NTC1b	NTC1b	NTC1b

Table 32 – Feedback Wiring

J5 - Communication SIGNAL			
PIN	SIGNAL	DESCRIPTION	COLOR
1	CAN_H	CAN_H Connection	
2	CAN_L	CAN_L Connection	
3	CAN_T	120 Ω Termination resistance CAN (connect to CAN H)	
4	CAN_GND	GND reference for CAN/RS485	
5	485_A	ModBus RS485+	
6	485_B	ModBus RS485-	
7	485_T	120 Ω Termination resistance Modbus (connect to 485_A)	
8	485_GND	GND reference for RS485	
9	TX232_PC	Tx232 Signal	
10	RX232_PC	Rx232 Signal	
11	GND_232	GND RS232 Serial Communication	

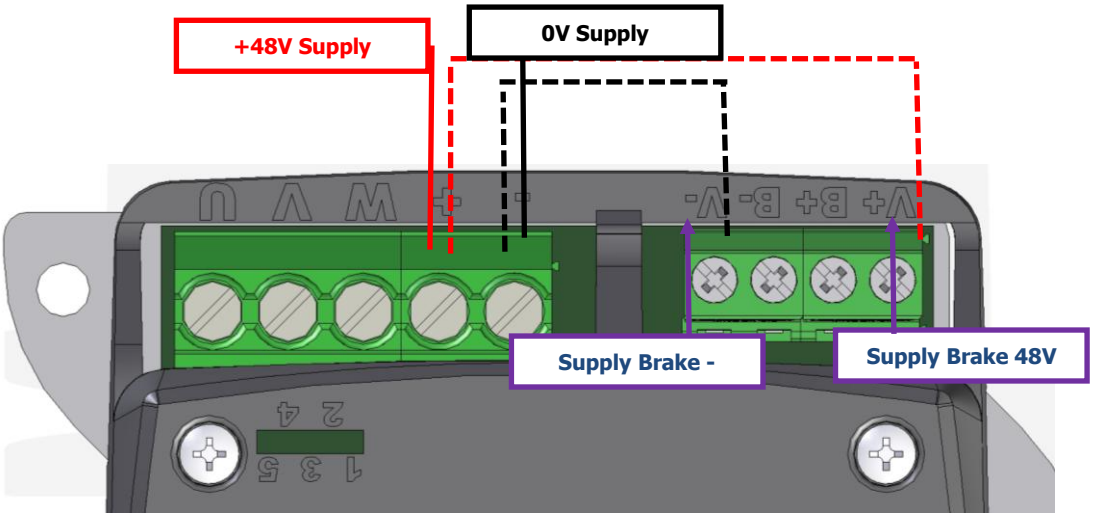
Table 33 - Communication Wiring

J6 – Safety STO SIGNAL			
PIN	SIGNAL	DESCRIPTION	COLOR
1	STO IN 1	Safety Relays STO1	Red
2	STO IN 2	Safety Relays STO2	Black
3	STO IN COM	Common STO1 / STO2	Black
4	NC		Black
5	STO OUT	Safety OUT	Black
6	STO OUT COM	STO Out Common	Black

Table 34 – Safety STO Wiring

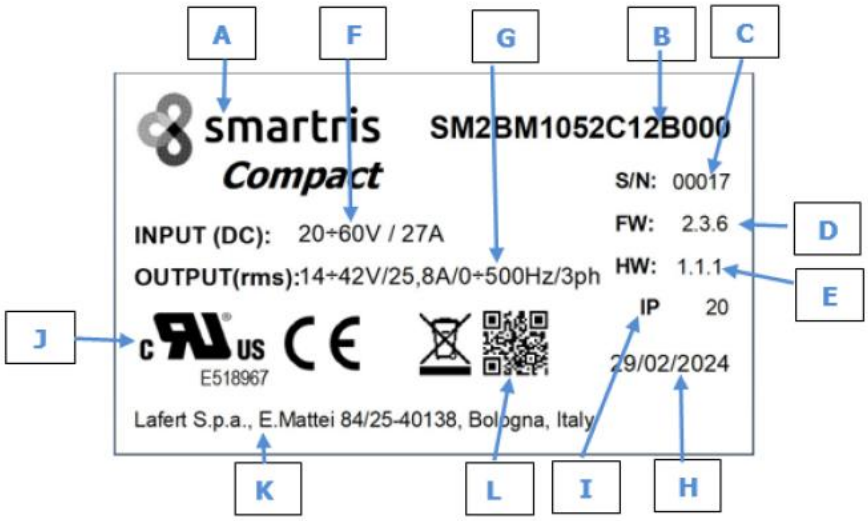
Information

Connect "+V" to "+" and "-V" to "-". For different connection contact manufacturer.



10.1 Label/Code

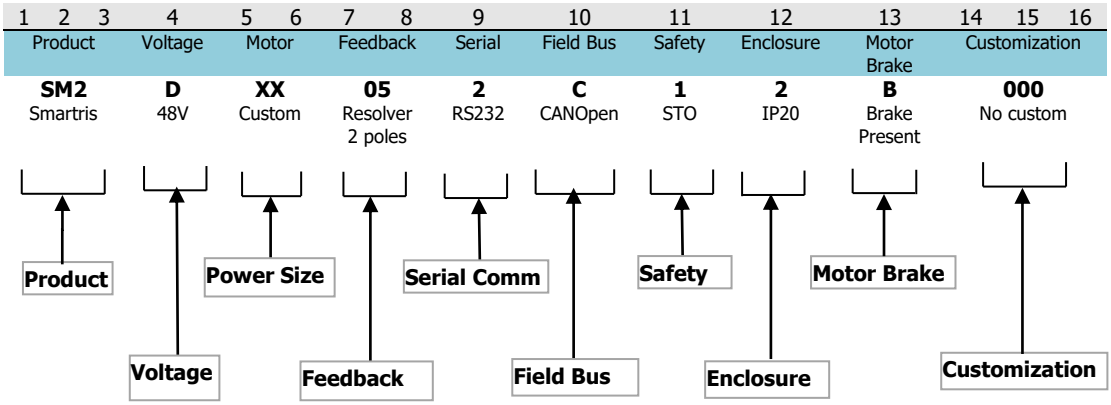
Label



Mark	Description	Mark	Description
A	Manufacturer Logo	**G**	Output Data (Voltage / Current /Frequency)
B	Code	**H**	Production Date
C	Serial Number	**I**	Protection Class
D	FW Release	**K**	Manufacturer Data
E	HW Release	**J**	Certifications
F	Input Data (Voltage / Current)	**L**	Qr Code (PN-SN-FW-HW)

Table 35 - Label Description

Using the following code, the properties of the Smartris can be determined (the code is an example):



Picture 27 - Code Example

PRODUCT	MOTOR PN	SERIAL COMM	SAFETY	MOTOR BRAKE
3 Letters	2 Letters	1 Letters	1 Letters	1 Letters
Pos 1-3	Pos 5-6	Pos 9	Pos 11	Pos 13
SM2	S1 - 600W	2 - RS232	0 - NO STO	B - Brake present
	M1 - 1500 W	4 - RS485	1 - STO	S - Spring Brake
				N - No brake
VOLTAGE	**FEEDBACK**	**FIELDBUS**	**ENCLOSURE**	**CUSTOMIZZATION**
1 Letters	**2 Letters**	**1 Letters**	**1 Letters**	**3 Letters**
Pos 4	**Pos 7-8**	**Pos 10**	**Pos 12**	**Pos 14-16**
B – 24V	05 - Resolver	M - Modbus	5- IP54	000 - Standard
D - 48V	KS - SKS36/SKS36S	C - CANOpen DS402	2 – IP20	R00 - RPM Unit
	KM - SKM36	E – EtherCAT not available	0 - No Enclosure	
	LE - EKM36	N - No fieldbus		
	LF - EKM36			
	KS - SKS36/SKS36S			
	KM - SKM36			
	F9 - INC.2048 Imp/Gear			

Table 36 - Code Description

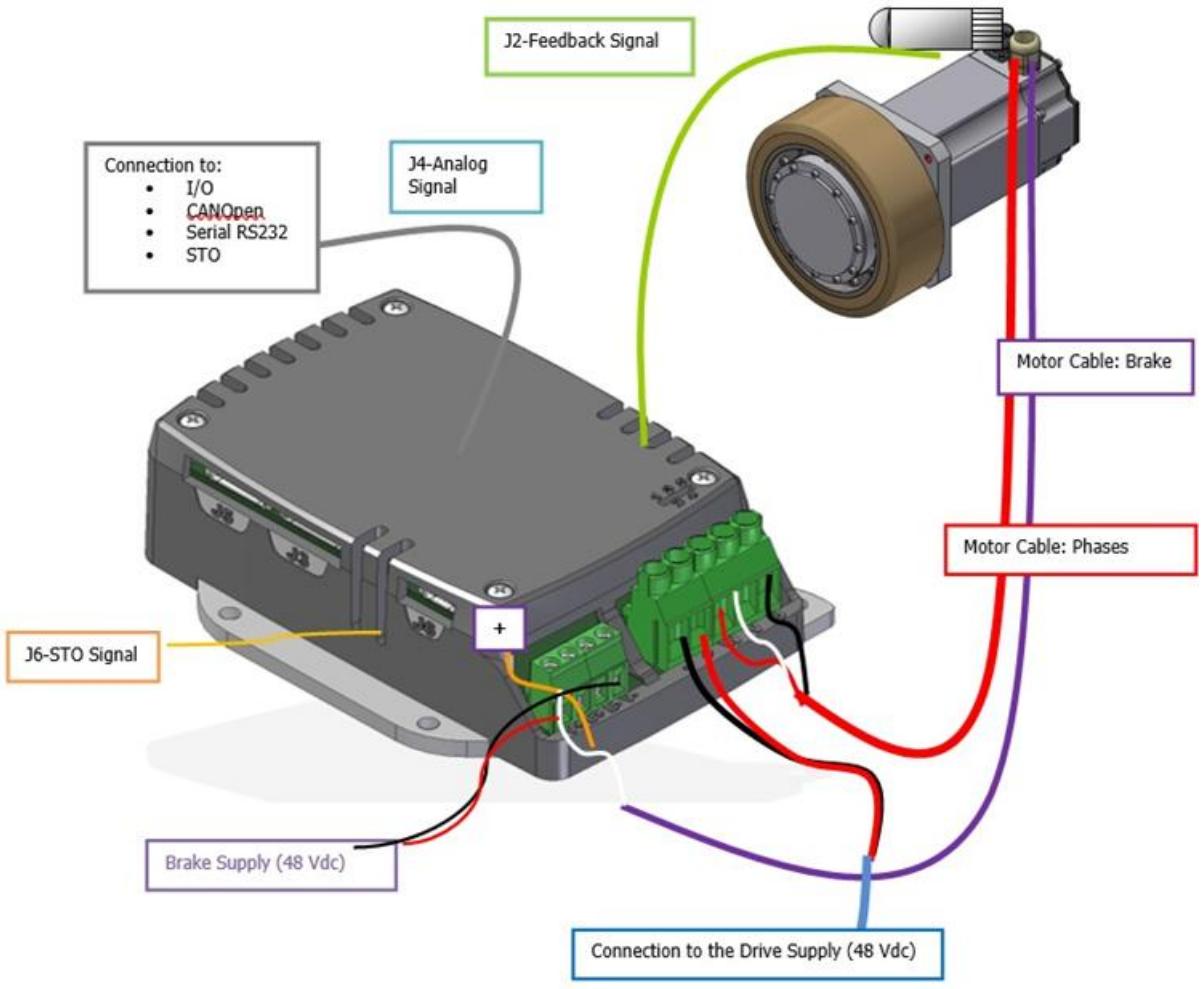
11 | DEBUG TEST MODE

11.1 CANOpen Test "Command Mode"

⚠	**Warning** Read carefully this section to Run Motor with Smartris System and CAN Peak Tools

11.1.1 Setup

1) PCAN-USB (https://www.peak-system.com/PCAN-USB.199.0.html?&L=1)
2) Smartris System (with CANOpen)
3) Laptop with driver for PCA-USB and PcanView SW (https://www.peak-system.com/PCAN-View.242.0.html?&L=1)
4) Terminal resistor (connect between pins 2-7 of DB9 of PCAN-USB or connect pin 3 to pin 1 of J5 on Drive)



Picture 28 - Connection Scheme

For the connection of the different cables see the tables on Chapter 1:

J5 - Communication SIGNAL			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
1	CAN_H	CAN_H Connection	Red
2	CAN_L	CAN_L Connection	Black
3	CAN_T	120 Ω Termination resistance CAN (connect to CAN H)	Black
4	CAN_GND	GND reference for CAN/RS485	Black
5	485_A	ModBus RS485+	Black
6	485_B	ModBus RS485-	Black
7	485_T	120 Ω Termination resistance Modbus (connect to 485_A)	Black
8	485_GND	GND reference for RS485	Black
9	TX232_PC	Tx232 Signal	Black
10	RX232_PC	Rx232 Signal	Black
11	GND_232	GND RS232 Serial Communication	Black

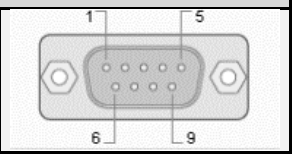
PCANUSB – DB9			
PIN	**SIGNAL**	**DESCRIPTION**	
3	GND CAN/RS485	GND reference for CAN/RS485	
	CAN_T	120 Ω Termination resistance CAN (connect to CAN H-CAN L)	
2	CAN_L	CAN_L Connection	
7	CAN_H	CAN_H Connection	

Table 37 – CAN Connection

SUPPLY/MOTOR CONNECTOR			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
1	- VBUS	Connection to - Vbus	
2	+ VBUS	Connection to + Vbus (+24/48 Vdc)	
3	W	Motor Phase W	
4	V	Motor Phase V	
5	U	Motor Phase U	

Table 38 – Supply/Motor Wiring

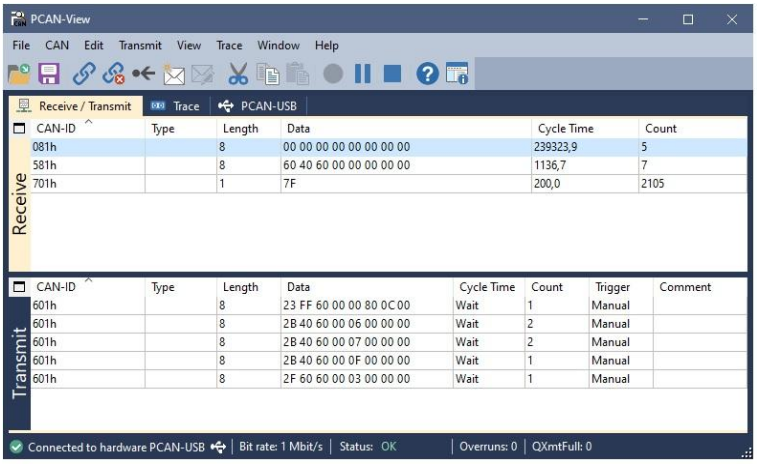
Brake connector			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
1	V+	+V Supply for brake (24/48V) – (default) connect to "+".	
2	B+	Motor Brake+	
3	B-	Motor Brake -	
4	V-	-V Supply for brake (24/48V) – (default) connect to "-".	

Table 39 - Brake Wiring

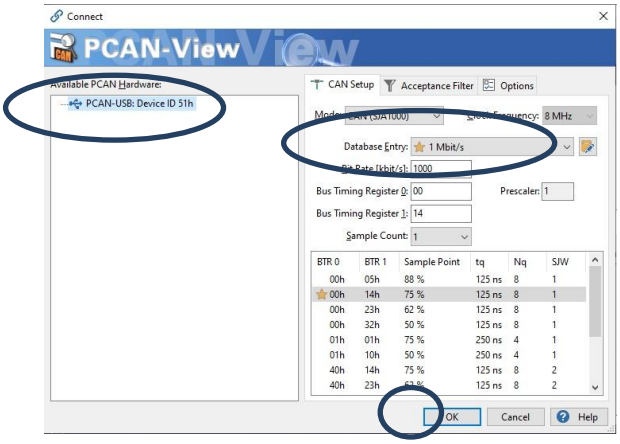
11.1.2 Instructions

Set of instructions

1) Switch ON the Smartris drive
2) Launch PcanView.exe

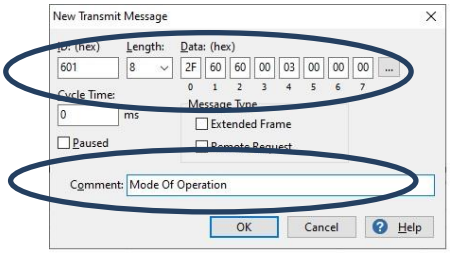


3) Connect and select the interface (51h) and 1 Mbit/s



4) Select New Message

5) Insert 0x6060 – "Mode of Operation" ID (601) Length (8) Data (hex 2F 60 60 00 03 00 00 00)



6) Insert 0x6040 – "Control Word Shutdown" ID (601) Length (8) Data (hex 2B 40 60 00 00 00 00 00)

7) Insert 0x6040 – "Control Word 0x06" ID (601) Length (8) Data (hex 2B 40 60 00 06 00 00 00)

8) Insert 0x6040 – "Control Word 0x07" ID (601) Length (8) Data (hex 2B 40 60 00 07 00 00 00)

9) Insert 0x6040 – "Control Word Enable" ID (601) Length (8) Data (hex 2B 40 60 00 0F 00 00 00)

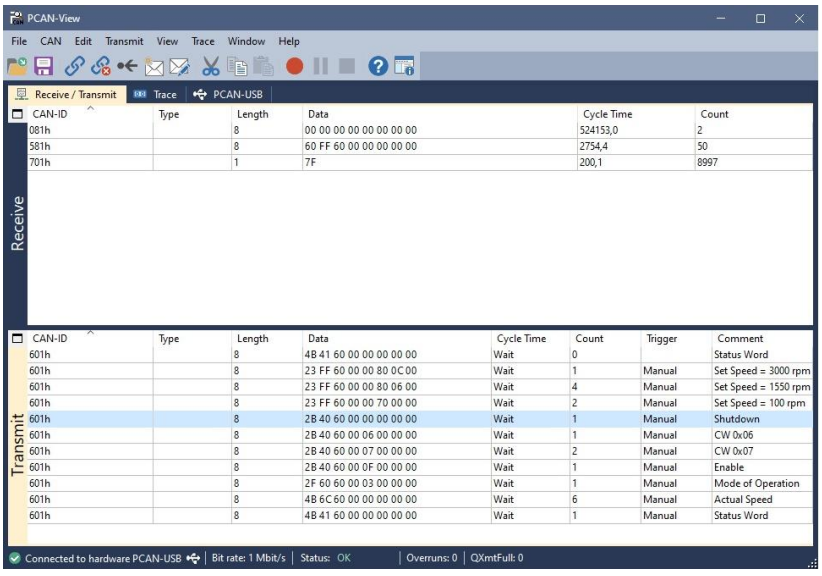
10) Insert 0x60FF – "Set point Speed = 3000 rpm" ID (601) Length (8) Data (hex 23 FF 60 00 00 80 0C 00)

11) Insert 0x60FF – "Set point Speed = 1550 rpm" ID (601) Length (8) Data (hex 23 FF 60 00 00 80 06 00)

12) Insert 0x60FF – "Set point Speed = 100 rpm" ID (601) Length (8) Data (hex 23 FF 60 00 00 70 00 00)

13) Insert 0x606C – "Read Actual Speed" ID (601) Length (8) Data (hex 4B 6C 60 00 00 00 00 00)

14) Insert 0x6041 – "Read Status Word" ID (601) Length (8) Data (hex 23 41 60 00 00 00 00 00)



Run Sequence

1) Switch ON Power Supply
2) Verify LED Status 1/2 in INIT Mode
3) Mode of Operation 0x6060 → 0x03 - double click on:

4) Double Click on "**Shutdown**"
5) Double Click on "**CW 0x06"** (READY TO SWITCH ON 0x6040 = 0x06)
6) Double Click on "**CW 0x07"** (SWITCHED ON 0x6040 = 0x07)
7) Double Click on "**ENABLE"** (Enabled 0x6040 = 0x0F)
8) Verify LED STATUS ENABLED

   Verify that the Smartris Drive is in ENABLED: read Status Word 0x6041 → 0x27

   Verify that the brake is released
9) Double Click on: **"Set point Speed = 100 rpm"** (set 100 rpm)
10) Verify if the motor is running slow
11) Double Click on: **"Read Actual Speed"** to read actual speed
12) Double Click on: **"Set point Speed = 1550 rpm"** (set 1550 rpm)
13) Double Click on: **"Set point Speed = 3000 rpm"** (set 300 rpm)

⚠	**Warning** Following set point are available for all motors. For Size S and M it is possible to set also 4500 rpm: Insert 0x60FF – "**Set point Speed = 4500 rpm**" ID (601) Length (8) Data (hex 23 FF 60 00 D4 BE 12 00)

11.2 CANOpen "Sniffering Mode"

⚠	**Warning** Read carefully this section to Run Motor with Smartris System and CAN Peak Tools

11.2.1 Setup

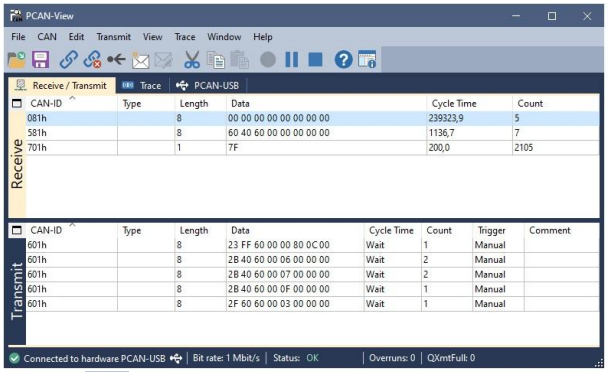
Setup of installation

1) PCAN-USB (https://www.peak-system.com/PCAN-USB.199.0.html?&L=1)
2) Smartris System (with CANOpen)
3) Master Device (PLC, Industrial PC, Specific Electronic)
4) Laptop with driver for PCA-USB and PcanView SW (https://www.peak-system.com/PCAN-View.242.0.html?&L=1)
5) Y Cable to connect Smartris System – Master Device – Peak (laptop)
6) Terminal resistor (connect between pins 2-7 of DB9 of PCAN-USB or connect pin 3 t0 pin 1 of J5 on Drive)

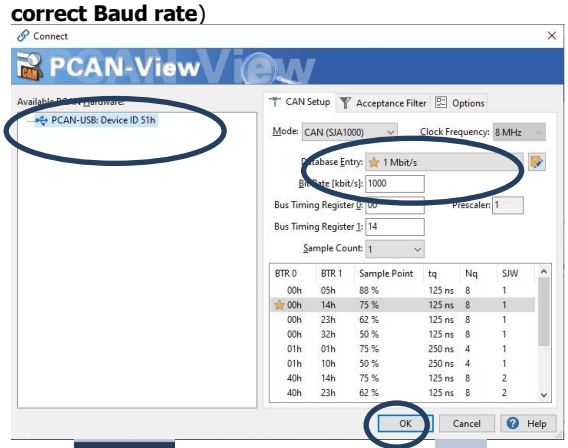
11.2.2 Instructions

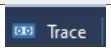
Set of instructions

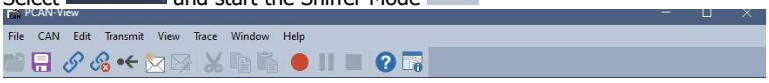
1) Switch ON the Smartris drive
2) Launch PcanView.exe



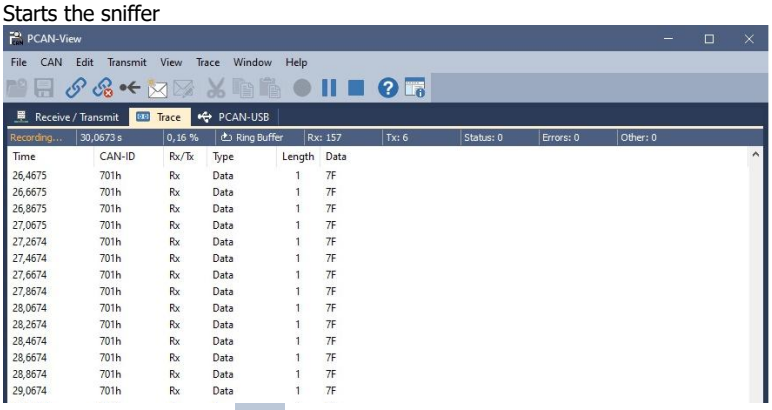
3) Connect  and select the interface (51h) and 1 Mbit/s (**verify the Baud Rate of the final system: if different select correct Baud rate**)



4) Select  and start the Sniffer Mode 



5) Starts the sniffer



6) Save the trace: click ON  → click on Trace → Save and save the file "trc" with trace

11.3 ModBus Test "Command Mode"

	**Warning** Read carefully this section to Run Motor with Smartris System and Smartris Tools

11.3.1 Setup

1) USB-RS485 interface (https://ftdichip.com/products/usb-rs485-we-1800-bt/)

2) Smartris System (with Modbus)
3) Laptop with driver for USB-RS485 and SmartrisTestTool SW
4) Terminal resistor (connect between pin 7 to pin 5 of J5 on Drive)

J5 - Communication SIGNAL			
PIN	**SIGNAL**	**DESCRIPTION**	**COLOR**
5	485_A	ModBus RS485+	
6	485_B	ModBus RS485-	
7	485_T	120 Ω Termination resistance Modbus (connect to 485_A)	
8	485_GND	GND reference for RS485	

Table 40 – Modbus Connection

11.3.2 Instructions

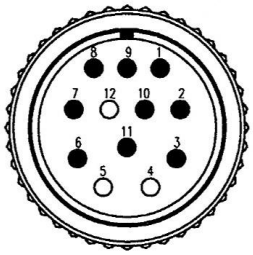
Use the SmartrisTestTool called "SmartrisApp" official version release 3.0.0.0.

APPENDIX A | OPTIONS

Cables for Lafert Standard Motors: XXX the length in m (i.e. XXX=100 means 1 m)

Smartris Compact **Resolver** Wiring: **XKITSMCAB055-Lxxx**

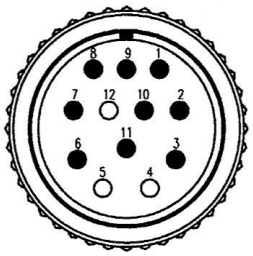
	Description	Color	M23 12 poles
	S2	Blue	1
	S1	*Yellow*	2
	S3	*White*	3
	NC		4
	NC		5
	S4	*White*	6
	R1	*Green*	7
	Shield		8
	NTC1a	*Violet*	9
	NTC1b	*Brown*	10
	R2	*White*	11
	NC		12
Twisted Pair: (White-Brown),(Green-Yellow), (Grey-Pink), (Blue-Red)			



Contact Side View

Smartris Compact **SinCos Encoder** Wiring**: XKITSMCAB054-Lxxx**

	Description	Color	M23 12 poles
	+ SIN	*Blue*	7
	REF SIN	*White*	3
	+ COS	*Yellow*	8
	REF COS	*White*	4
	DATA+	*Green*	5
	DATA-	*White*	6
	+V		1
	GND		2
	NTC1a	*Violet*	9
	NTC1b	*Brown*	10
	SHIELD		N.C.
Twisted Pair: (Green-Brown),(Blue-Violet), (Red-Black),(Grey-Pink), (Brown 0,5 – White 0,5)			



Contact Side View

Signal cable codification

Transducer	*Lenght*	*Code*
SKS36 / SKS36S	xxx cm	XKITSMCAB054-Lxxx
	100 cm	XKITSMCAB054-L100
Resolver	xxx cm	XKITSMCAB055-Lxxx
	100 cm	XKITSMCAB055-L100
Incremental Encoder	xxx cm	XKITSMCAB056-Lxxx
	100 cm	XKITSMCAB056-L100

Table 41 – Signal Cable codification

I/O cable codification

Component	*Lenght*	*Code*
Kit cables PLC-drive WITH STO	40 cm	XKITSMCAB057-L40
Kit cables PLC-drive WITHOUT STO	40 cm	XKITSMCAB058-L40

Table 42 – I/O Cable codification

Power cable with tube terminals included in the motor.

APPENDIX B | DRIVE DISPOSAL

WARNING FOR THE CORRECT DISPOSAL OF THE MOTORS AT THE END OF THEIR LIFE TIME

According to the art. 26 of the Italian law 2014, March 14th n. 49
*" Implementation of the **DIRECTIVE 2012/19/EU** OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4 July 2012, on waste electrical and electronic equipment (WEEE)"*

The above symbol, applied to the equipment or its packaging, means that at the end of its lifetime the motors need to be disposed separately from the other waste materials.
The users must dispose their unused motors on behalf of the national authorized collection centers which have been approved for the electrical and electronic waste.

The right collection for recycling, treatment and disposal will contribute to avoid any potential negative environmental & healthy effect and will help both the reuse and the recycling of the motor's components/materials.

TABLE OF DISPOSAL CODES FOR ELECTRIC MOTORS

CODE OF THE MOTOR (WASTE) DISPOSED IN ALL ITS PARTS	EWC (European Waste Code)	EWC DESCRIPTION
In the event of disposal of the full drive	16.02.14	Discarded equipment
In the event of disposal of a disassembled drive:		
· Aluminum parts: heatsink	12.01.03	Non-ferrous metal filings and turnings
· Steel parts: Cover	12.01.01	Ferrous metal filings and turnings
· Plastic parts: fan, fan cover, terminal box	12.01.05	Plastics shavings and turnings
· Electrical components: switches, capacitors, starters, terminal board, electronic boards, IGBT modules...	16.02.16	Components removed from discarded equipment

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