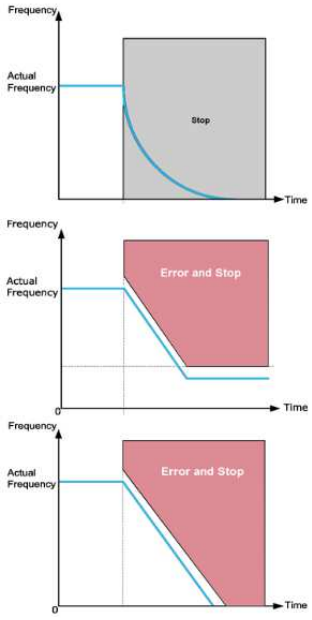
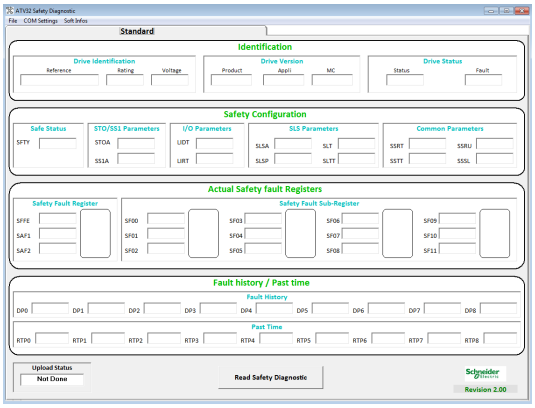
Drives CCC Expert

ATV32 / ATV320 SAFF fault diagnostic





1. ATV32 Safety evolution

V1.5ie08

Correction on SAFF fault due to interruption of internal communication

V1.8ie11

Add SLS Type 4 function
Add new parameter (STFR filtered) to be able to check safety speed.
All safety fault register are now accessible inside graphic keypad
All safety fault registered are now save in fault history area. The values are visible on keypad and can be read via communication (or dedicated tool).
Duplicate Safety configuration to another Drive

V2.1ie15

Add SLS type 5 and 6 function
Remove filter on STFR to be able to check safety speed.

V2.5ie22

Add SMS and GDL function

2. General information on ATV32 safety

There are many roots for a SAFF. It can be just due to drive configuration, due to instability on 24Vdc (connected to STO) or due to bad internal component.

On the ATV32, the safety kernel is always present with safety configured or not.
It's mean that the safety, check always if there is no issue on the safety channel.
For example the safety kernel, check always if there is no issue on the internal serial link (even if no safety are configured by SoMove)
It can explain SAFF even if the customer does not configure Safety with SoMove.

How to diagnose the SAFF fault

In function of Drive version, it will have several way to check internal data about safety fault is order to identify SAFF root cause.
Major evolution about the SAFF diagnostic in the Drive was made since ATV32 version V1.8ie11.
This document will separate the diagnostic in 2 parts.

- Diagnostic of SAFF fault for drive up to version V1.5ie08
- Diagnostic of SAFF fault for drive since version V1.8ie11

3. SAFF on Drive power ON with ATV32 version before V1.5ie08

On Drive version before V1.5ie08, we can have SAFF fault without any safety configured in Drive. This SAFF was due to interruption of the internal communication

Interruption of the internal communication

- Check the ATV32 fault history (with keypad)

If you see in this fault history the sequence INF3, SAFF, INF3, SAFF … then there is a possibility to be in this case.

- To be sure you need to read the SAF1 register (access only by communication at the address 15350 (or 16#207B/33 for CANopen)

If SAF1 = 0x0100 we are in this case.

Detail about the Interruption of the internal communication.

The SAFF origin can be due to an internal communication interruption (between the application and motor control). This interruption is due to a general reset of microcontroller cause by a fall down of internal supply when the STO input is connecting.
In other word when we Power ON the drive, without the STO connected and then we connect this STO input. On this step there is a fall down of internal supply which cause the reset and so the SAFF.
Today for this point, it's possible to reflash the ATV32 with lastest version (available on M&D TIP).

The V1.5ie08 corrects this particular case with interruption of internal communication.
There is always possibility to have SAFF fault for other reason and here it necessary to diagnose the root in using the provided tools.

4. SAFF with SAF1 = 0x0001 – pulse on STO

Even without Safety configured with SoMove, the STO input is always present.
In case of instability (or rebound) on this STO input, it's possible to detect this SAFF with SAF1 register 0x0001 (Bit0 = 1 : PWRM consistency fault).
This can appear in case of :

- Instability detected (around 10,5V) on the STO input.
- Pulse (like relay rebound) on the STO input

SAF1 bit 0 = 1 means PWRM consistency fault.
With SAF1 bit 0 = 1, we could be in a case of instability or the Pulse on STO.

To describe how it's works:

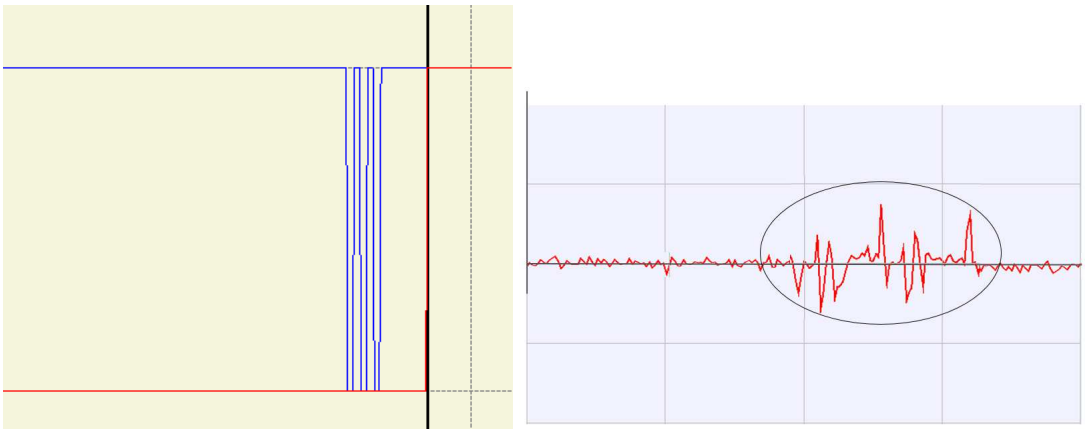
Even if physically you only have 1 wire connected to the STO, the Application processor gets 2 "STO values":

- The physical signal STO
- The feedback state of the STO input read by the Motor Control

For its safety functionality the Application processor compares both. If the drive detects inconsistency between the both signals, you will have SAFF fault with SAF1 bit 0 = 1.

So like I explained before, you can have this type of SAFF related to the signal quality send on STO

For example if you have instability (or rebound): see here pulse which can generate SAFF fault (with SAF1 = 1). Blue are the pulse on STO and Red is the detection of SAFF.



Way to check if you are in these case for the instability or the Pulse on STO

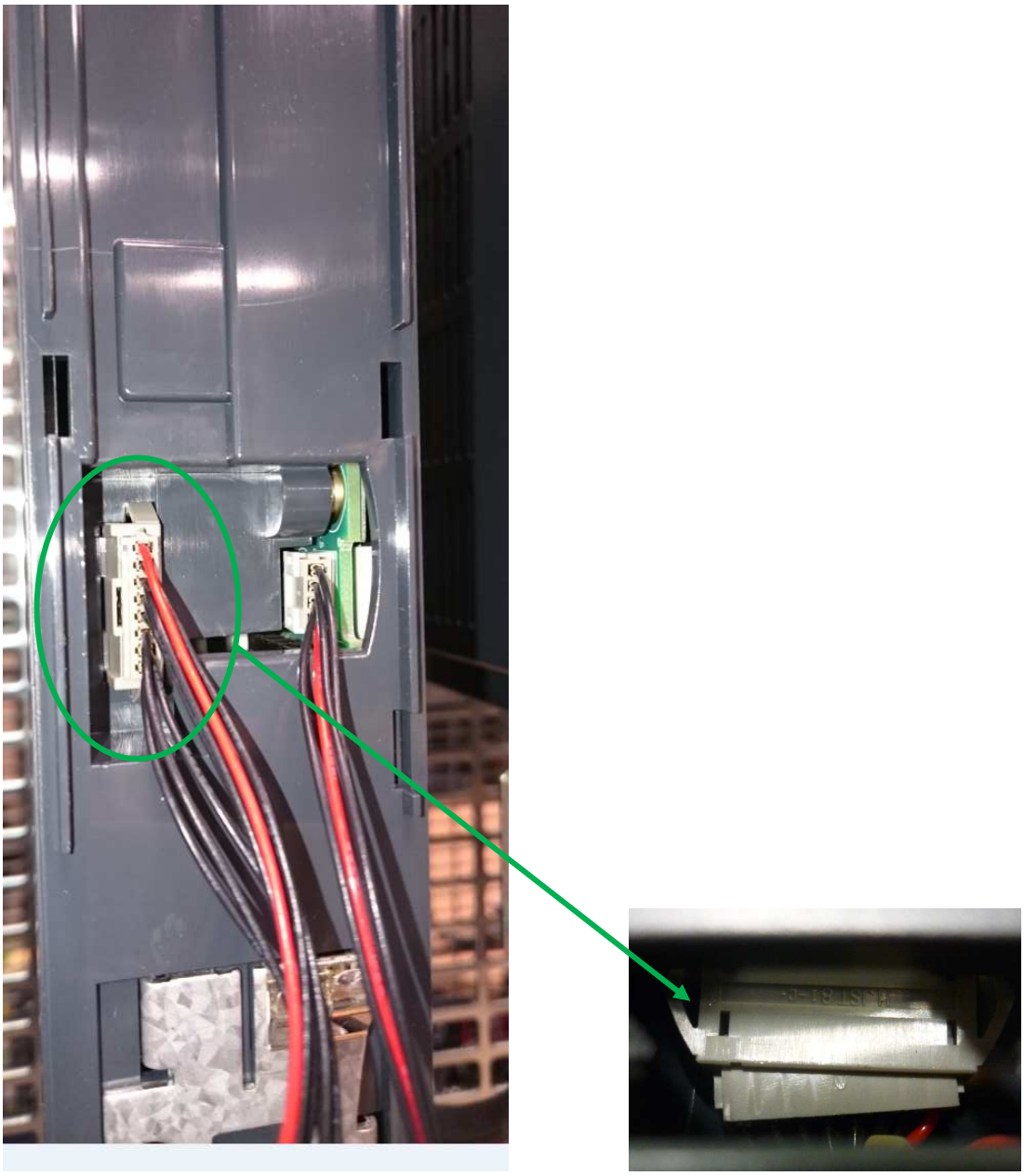
- Check the SAF1 register (access only by communication at the address 15350 (or 16#207B/33 for CANopen)

If SAF1 = 0x0001 we are in one if these case. Then you need to check with oscilloscope the STO input when the SAFF appear.

Those instabilities or pulse on STO are always present on all drive version. This is not drive issue but link to signal send to STO input.
If you are in one of those case, the action must be on wiring in order to remove the pulse and stabilized the 24Vdc.

5. SAFF with SAF1 = 0x0001 – Bad internal connection

Here you have the same fault code as STO link to pulse, but the origin is different.
It could also occur, if some internal connection (between application and motor control) are on the limit or badly connected. In this case you will have this type of SAFF bit 0 = 1.

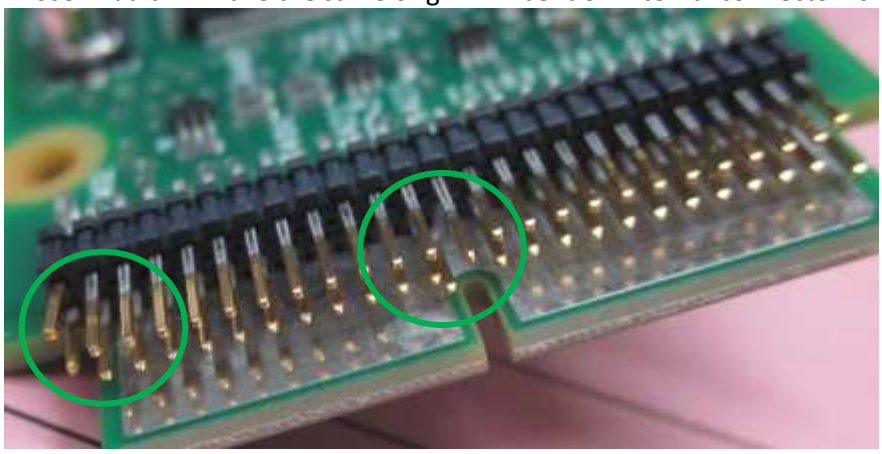


If this connector is not correctly connected, this will generate bad signal between application and motor control and can generate this SAF1 = 0x0001

6. SAFF – INF6

If option card was connected to the drive, it's possible to see sometime SAFF fault or INF6 fault.

Those 2 fault will have the same origin: Pin bent on internal connector for option card



In the fault history you will find both fault for exemple like this :

DP1 = SAFF = Safety function
DP2 = INF6 = Unknown or incompatible option board
DP3 = SAFF = Safety function
DP4 = INF6 = Unknown or incompatible option board
DP5 = SAFF = Safety function
DP6 = INF6 = Unknown or incompatible option board
DP7 = SAFF = Safety function
DP8 = INF6 = Unknown or incompatible option board

In case of successive SAFF – INF6 in fault history, check that the drive connector for option card do not have bin bent.
In case of pin bent exchange the product.

7. SAF1 = 0x80 - SAF2 = 0x204 and SF08 = 0x8

This fault will appear only on drive version from ATV32 V2.5 and higher or with ATV320.
This SAF2 = 0x200 (so bit 9) is link to GDL function. Even if GDL function is not configured, this SAFF can be detected.

To describe how it's works:

GDL function manage information coming from IGBT. This information go to application part through the interial serial link. In case of data corrupt in this internal serial link the GDL information could be missing and so safety detect the SAFF.

The fault register could be like that :

SAF1_details	16#80		
SAF2_details	16#204	SF08_details	16#8

The point to check will be on the internal connector : like before on part 5 of this document. The information on internal serial link gors through this connector. So bad connection can lead also to this SAFF.

8. SAF1 = 0x80 and SAF2 = 0x200

This fault will appear only on drive version from ATV32 V2.5 and higher or with ATV320. This SAF2 = 0x200 (so bit 9) is link to GDL function. Even if GDL function is not configured, this SAFF can be detected.

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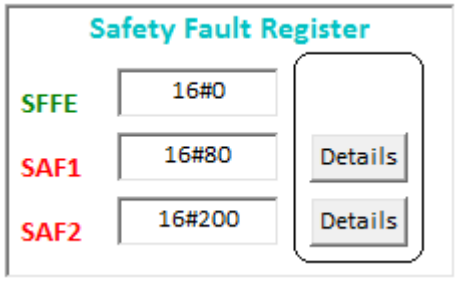
The fault register could be like that :



This issue appear mainly when drive is used close to 0Hz (or with high number or Start / stop order). On speed area close to 0, IGBT state checking between Application part and motor control are not synchronized. So drive detect incoherence of signal because they are not synchronize.

We corrected IGBT check function since the ATV320 version V2.9IE35.

The solution here will be to update the drive with ATV320 version V2.9ie35 or higher.

9. Tools and methods to diagnose the SAFF fault.

To diagnose the root of SAFF it's mandatory to check the safety register when the SAFF fault is present on the drive.

In function of Drive version, the safety fault register will be accessible through different way

Drive Version up to V1.5ie08

- **We have a safety fault register visible in SoMove → parameter SFFE.**

When an error is detected by the safety function, the drive displays [Safety function fault] (SAFF). This detected error can only be reset after powering the drive OFF/ON. For more information, you can access to the registers to find out the possible reasons for triggering. These registers can be displayed using the commissioning software

SFFE	Safety fault register	0000.0000.0000.0001

SFFE **[Safety Function Fault Error Register]**

Bit	Description
Bit0=1	Logic inputs debounce time-out (verify value of debounce time LIDT according to the application)
Bit1	Reserved
Bit2=1	Motor speed sign has changed during SS1 ramp
Bit3=1	Motor speed has reached the frequency limit threshold during SS1 ramp.
Bit4	Reserved
Bit5	Reserved
Bit6=1	Motor speed sign has changed during SLS limitation
Bit7=1	Motor speed has reached the frequency limit threshold during SS1 ramp.
Bit8	Reserved
Bit9	Reserved
Bit10	Reserved
Bit11	Reserved
Bit12	Reserved
Bit13=1	Not possible to measure the motor speed (verify the motor wiring connection)
Bit14=1	Motor ground short-circuit detected (verify the motor wiring connection)
Bit15=1	Motor phase to phase short-circuit detected (verify the motor wiring connection)

This register is reset after powering OFF/ON.

This register can also be accessed from **[DRIVE MENU]** --> **[MONITORING]** --> **[MONIT. SAFETY]**

The SFFE is the first level of SAFF fault diagnostic, but in some case (especially if SAFF occur when no safety is configured), the SFFE parameters will stay 0.

For this reason, inside the Drive we also have internal fault code for safety but with only access by communication (for version up to V1.5ie08)

To easily have access to the mandatory safety register, we develop a software tool (ATV32 safety diagnostic tool). This software will check the safety fault register inside the drive when the SAFF fault is present.

This software is available on AutomationWiki

Category: altivar Drive

Sub category: Application Notes

Altivar Drives

News | Low Voltage Drives and Drive Systems | General Drives Information | WebEx Community | Spare Part | Application Note | FAQ - Inquira Information Center | Demo WebServer

ATV32/320	ATV32/320 Safety Diagnostic Tool	This application Note describe the steps to check when SAFF fault is present on ATV32/ATV320. There is also tool in order to check internal Safety fault registers.

Drive Version since V1.8ie11

- **We have a safety fault register visible in Keypad and SoMove → parameter SFFE.**

When an error is detected by the safety function, the drive displays [Safety function fault] (SAFF). This detected error can only be reset after powering the drive OFF/ON. For more information, you can access to the registers to find out the possible reasons for triggering. These registers can be displayed using the graphic display terminal or the commissioning software: **[DRIVE MENU] --> [MONITORING] --> [DIAGNOSTICS] --> [MORE FAULT INFO]**

SFFE	Safety fault register	0000.0000.0000.0001

SFFE [Safety Function Fault Error Register]

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The SFFE is the first level of SAFF fault diagnostic, but in some case (especially if SAFF occur when no safety is configured), the SFFE parameters will stay 0.

- **We have all internal safety fault register visible in Keypad and SoMove → parameter SAF1, SAF2, SF00 to SF11.**

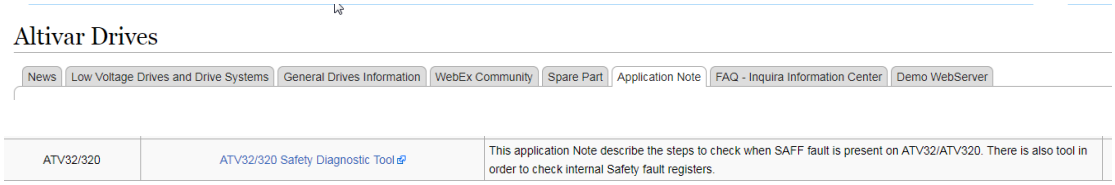
These registers can be displayed using the graphic display terminal or the commissioning software: **[DRIVE MENU] --> [MONITORING] --> [DIAGNOSTICS] --> [MORE FAULT INFO]**

SAF1	Safety fault Reg1	0000.0010.0000.0000
SAF2	Safety fault Reg2	0000.0000.0000.0000
SFFE	Safety fault register	0000.0000.0000.0001
SF00	SAFF Subcode 0	0000.0000.0000.0000
SF01	SAFF Subcode 1	0000.0000.0000.0000
SF02	SAFF Subcode 2	0000.0000.0000.0000
SF03	SAFF Subcode 3	0000.0000.0000.0001
SF04	SAFF Subcode 4	0000.0000.0000.0000
SF05	SAFF Subcode 5	0000.0000.0000.0000
SF06	SAFF Subcode 6	0000.0000.0000.0000
SF07	SAFF Subcode 7	0000.0000.0000.0000
SF08	SAFF Subcode 8	0000.0000.0000.0000
SF09	SAFF Subcode 9	0000.0000.0000.0000
SF10	SAFF Subcode 10	0000.0000.0000.0000
SF11	SAFF Subcode 11	0000.0000.0000.0000

See the SoMove online Help, to have meaning of each bit.

If also possible to use internal software tool (ATV32 safety diagnostic tool). This software will check the safety fault register inside the drive when the SAFF fault is present. It will also allow seeing that past fault history with safety sub fault code registered.

This software is available on AutomationWiki
Category: altivar Drive
Sub category: Application Notes



❖ **New parameter STFR allow to check drive internal speed (Stator frequency)**

To understand the need of this parameter, it's mandatory to know how the motor is driven by the ATV32.

On Asynchronous motor, the rotor speed correspond (in simplified way) to the frequency of magnetic field - slip.

On the drive we have several parameter to display the output speed of motor (RFR and RFRD) but those parameter display the rotor frequency.

Inside the safety kernel, the safety threshold or limit work with stator speed (not the rotor speed). For this reason it's not possible to compare RFR (or RFRD) to safety threshold.

To have good comparison, we have to compare stator frequency (STFR) to safety threshold.

Example

FRO (Green) show the frequency reference after ramp calculated by the drive

RFR (Red) is the output frequency (rotor frequency): stator frequency – slip

STFR (Blue) is the output frequency (stator frequency): rotor frequency + slip

Like you see Rotor frequency (RFR) and Stator Frequency (STFR) are different. We have the slip between both values.

With safety threshold configured, it's important to check the STFR parameters and not the RFR.

STFR is available in SoMove slow scope.

❖ **The safety fault register are also memorized in fault history.**

This feature allows knowing if the root cause is always the same in case of several SAFF on a Drive.

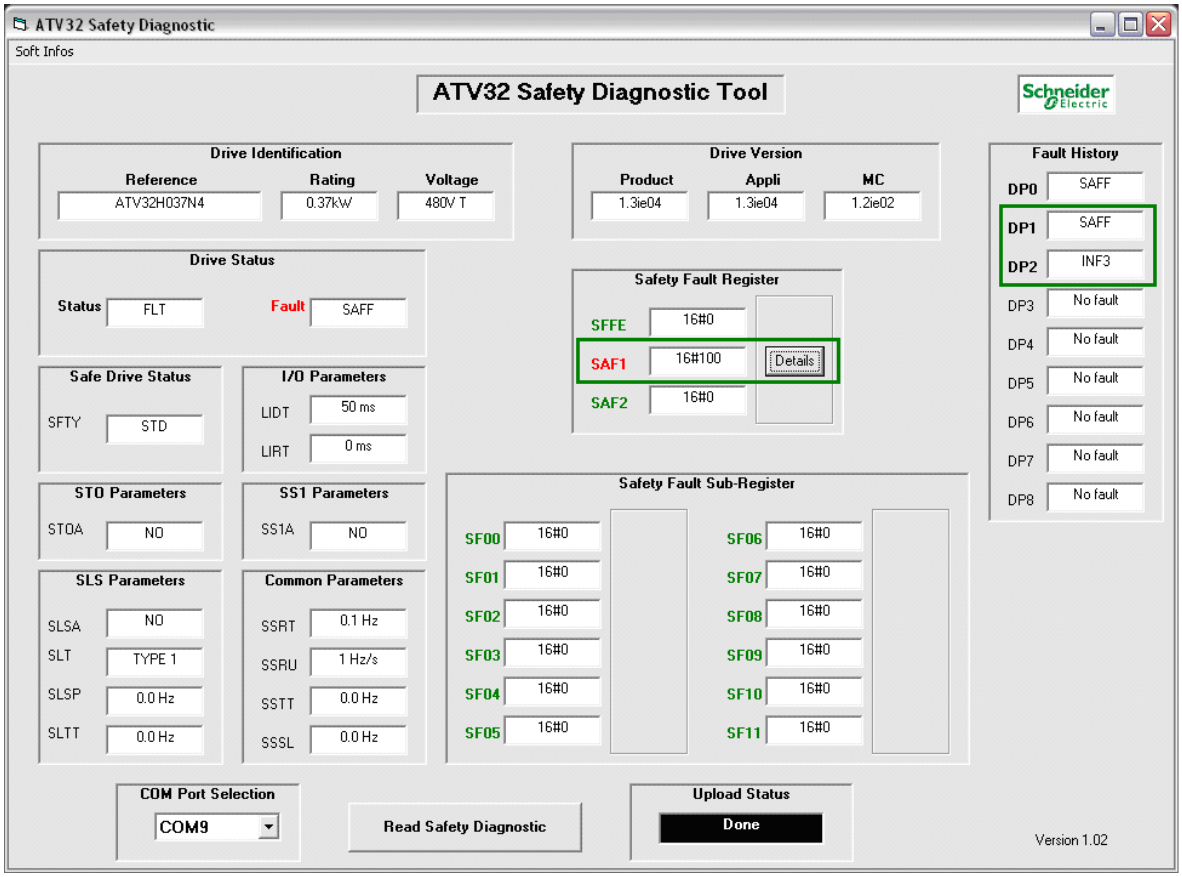
These registers can be displayed using the graphic display terminal or the commissioning software: **[DRIVE MENU] --> [MONITORING] --> [DIAGNOSTICS] --> [FAULT HISTORY]**

For each SAFF fault registered in the fault history, you can see inside the keypad the value of safety fault registers.
Those registers are also available via ATV32 safety Diagnostic tool.

10. Example of SAFF on ATV32 without safety configured.

SAFF fault trip when the STO is connected to 24Vdc after a long time in power OFF.

Screenshot of ATV32 safety diagnostic tool



Note : This screenshot was made with old version of ATV32 safety diagnostic tool. On tool V2.00, the look and feel is different but the register value will be the same.

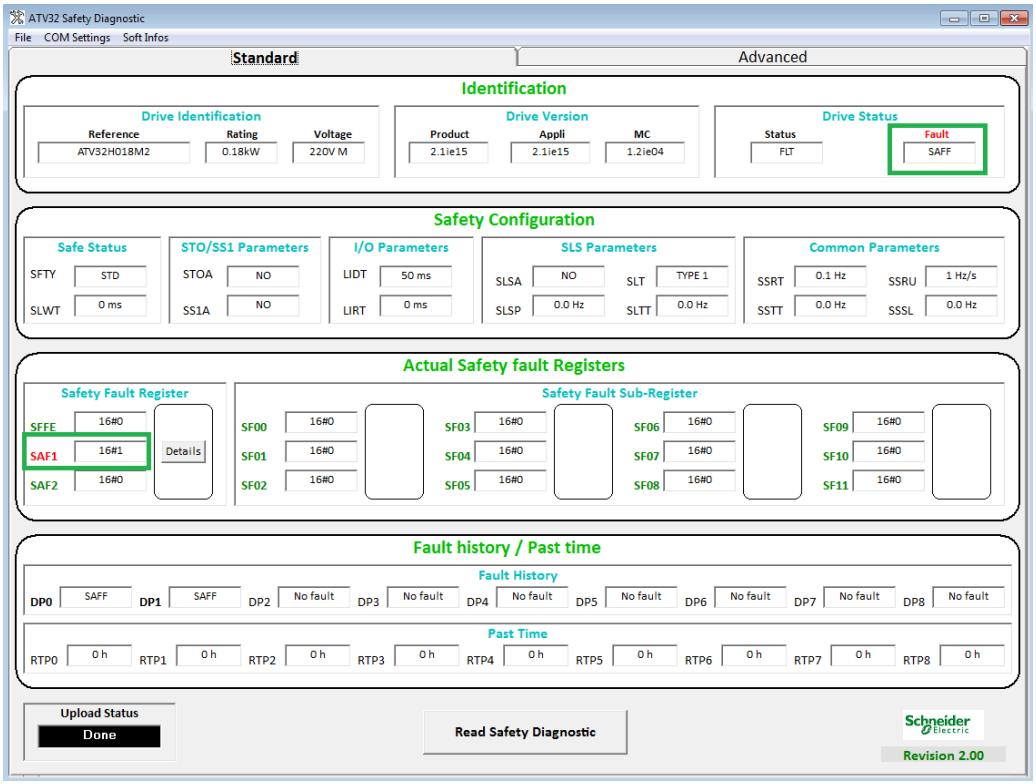
The SAF1 = 16#100 and in the fault history we can see fault SAFF – INF3

Result: in this particular case the SAFF root was due to interruption of internal communication.
The solution is to update the product with version V1.5ie08 or higher

SAFF fault trip randomly

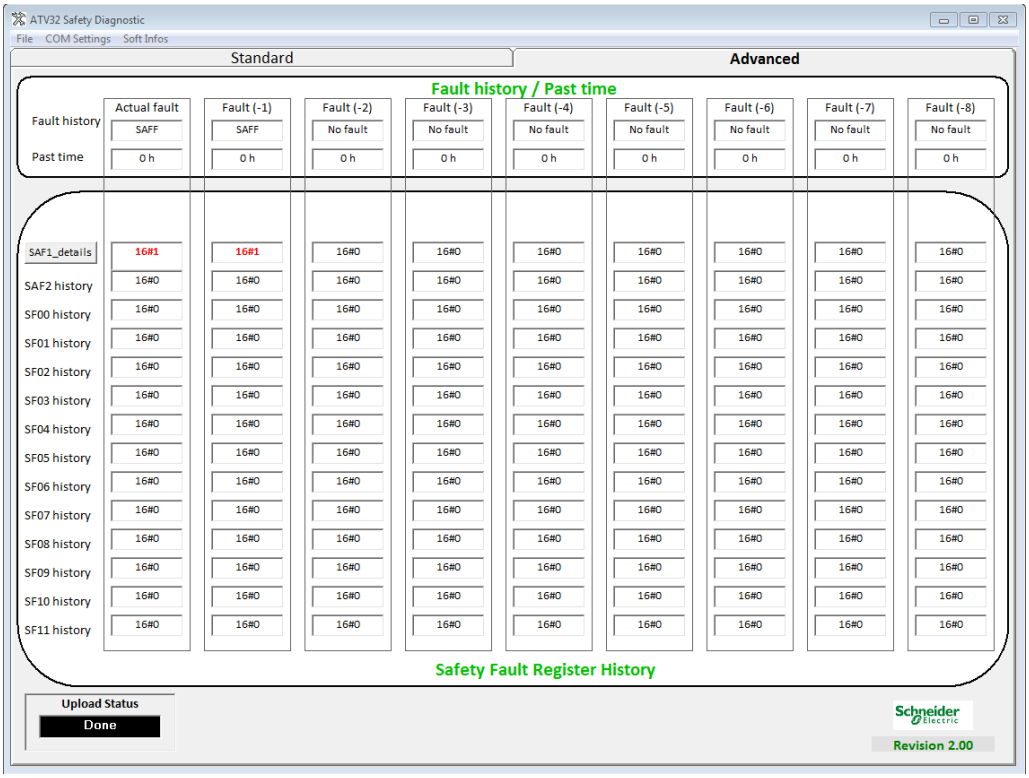
Screenshot of ATV32 safety diagnostic tool

Standard tab with safety fault register



The SAF1 = 16#0001.

Advanced tab with past fault registers and safety sub fault code register



Result:

In this case the SAFF root is on the STO consistency check. I can come from instability of STO input or pulse on this STO input.
To check this you need to spy with oscilloscope the STO input and check if you see instability or pulse.

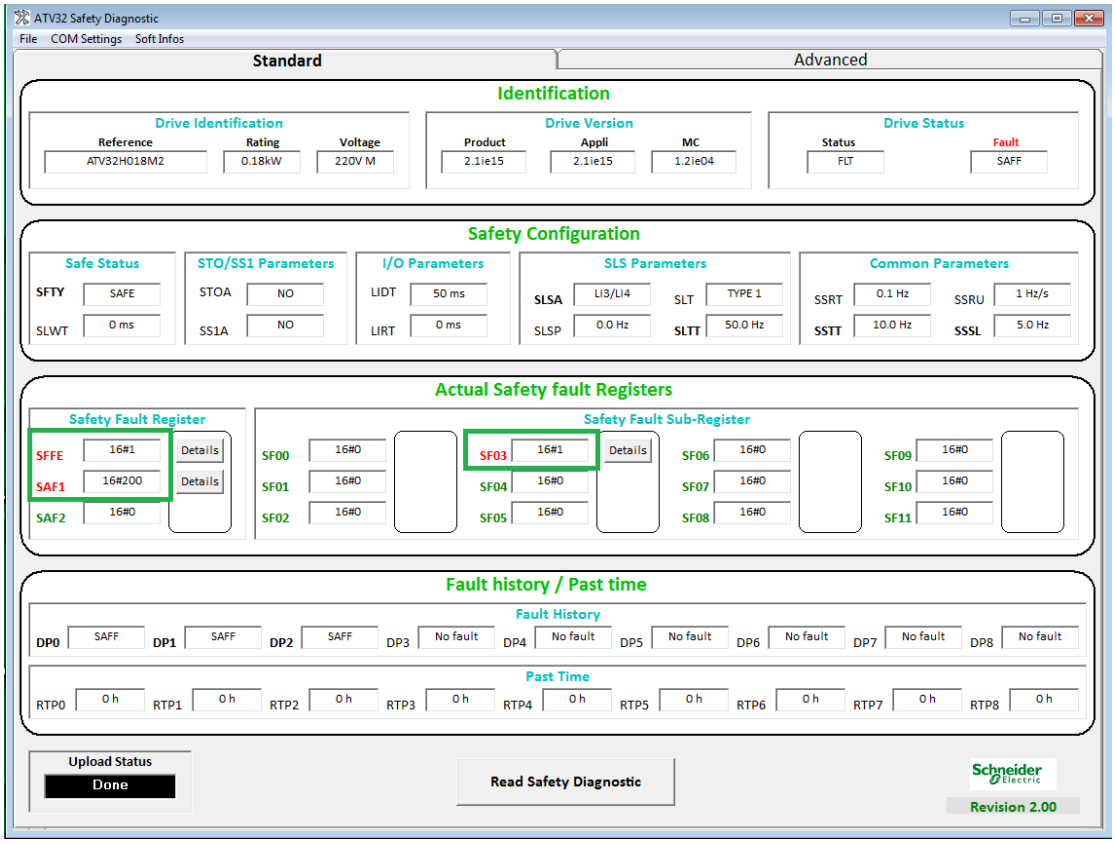
This type of SAFF with SAF1 = 16#0001 could also come from bad internal connexion between the control bloc and the Power card. For this Expertise of product is needed (TEX)

See exemple before (part 4 and 5 of this document)

11. Example of SAFF on ATV32 with safety configured.

SAFF fault trip on safety sensor activation

Screenshot of ATV32 safety diagnostic tool



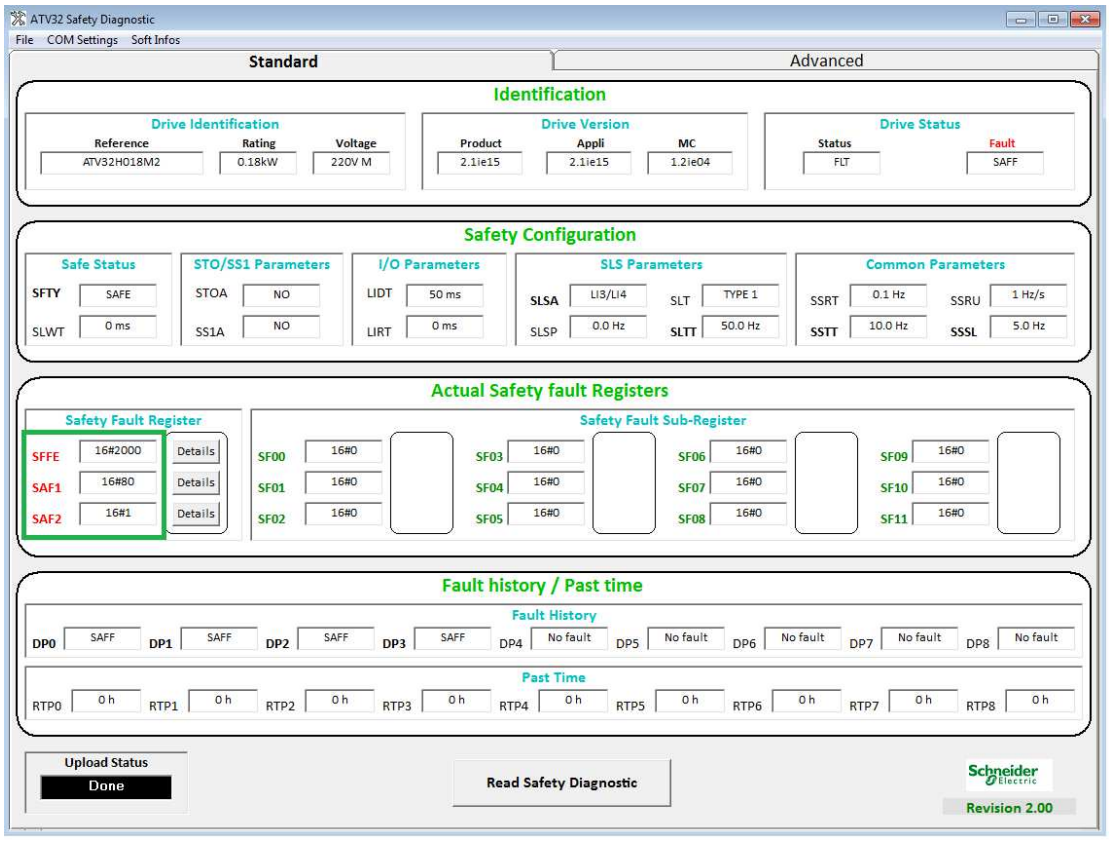
The SFFE = 16#1, SAF1 = 16#200, SF03 = 16#1

Result: In this case the SAFF root is the bad synchronization of safety input.
This can be solving with the configuration of LIDT parameter.

L Idt	**[LI debounce time]**	1 to 2000 ms	50
	In most of the case, both LI of a safe LI couple (LI3 and LI4, LI5 and LI6) will not be 100% synchronized. They will not change of state in the same time. There is a small delta between both LI transition. L Idt is the parameter used to set this delta. If both LI change states with a delta in time smaller than L Idt it is considered as a simultaneous transition of the LI. If delta in time is greater than L Idt, drive considers that LI are no more synchronized and a Safe detected fault is triggered.		

SAFF fault trip randomly

Screenshot of ATV32 safety diagnostic tool



The SFFE = 16#2000, SAF1 = 16#80, SAF2 = 16#1

Result: In this case the SAFF root is bad connexion of motor (output phase loss).So in this case it's needed to check the motor connexion.

12. Recommendations / Mandatory information

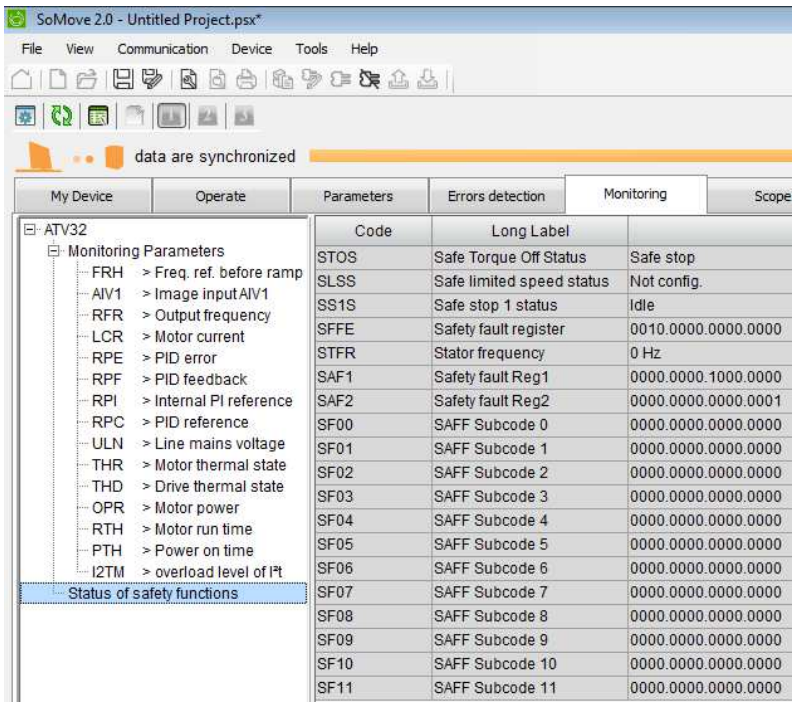
Inside the ATV32, there are 15 safety fault registers.
Each bit of these words corresponds to a possible SAFF root cause. The examples describe before, are just a part of possible SAFF fault on ATV32.

You can see that even if you see SAFF display on product, the root can be completely different between 2 SAFF.

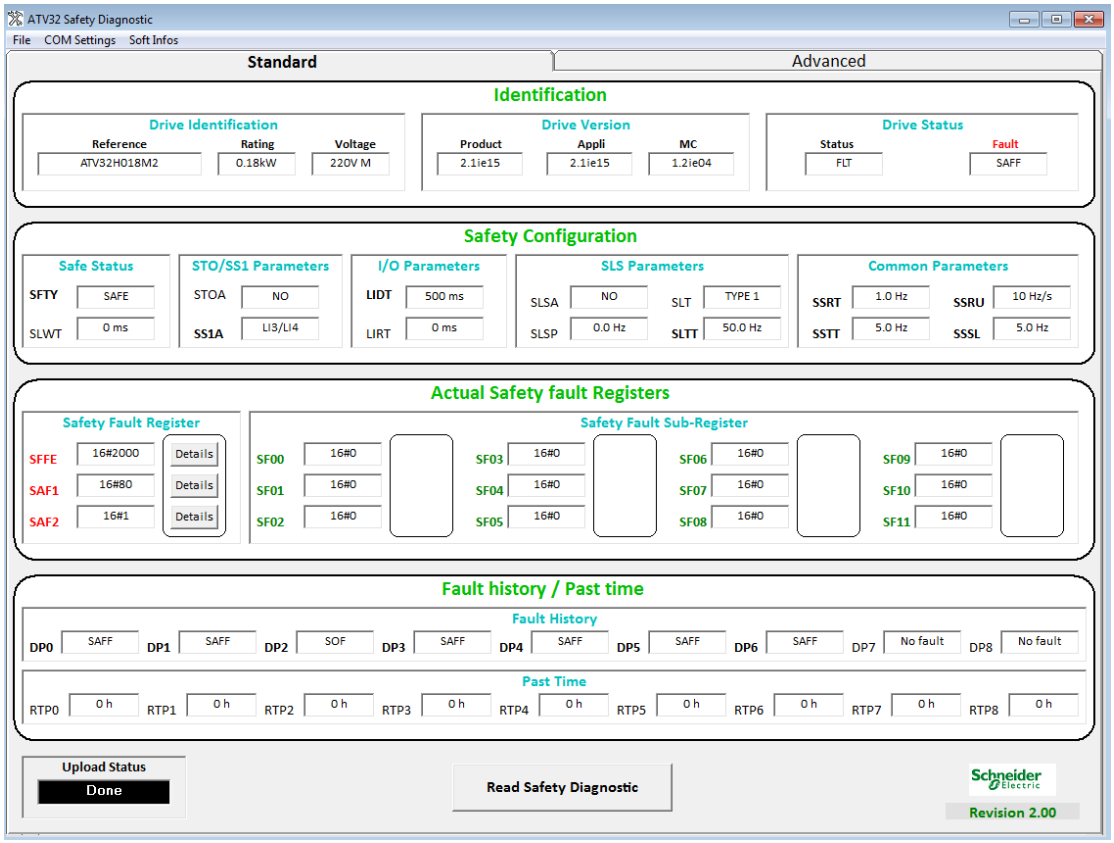
With ATV32 version V1.5ie08 and before, we can only see safety fault register value with safety diagnostic tool AND only when SAFF fault is present.
Now since version V1.8ie11 and higher, we can have access to those register in keypad, in SoMove and in ATV32 safety diagnostic tool.

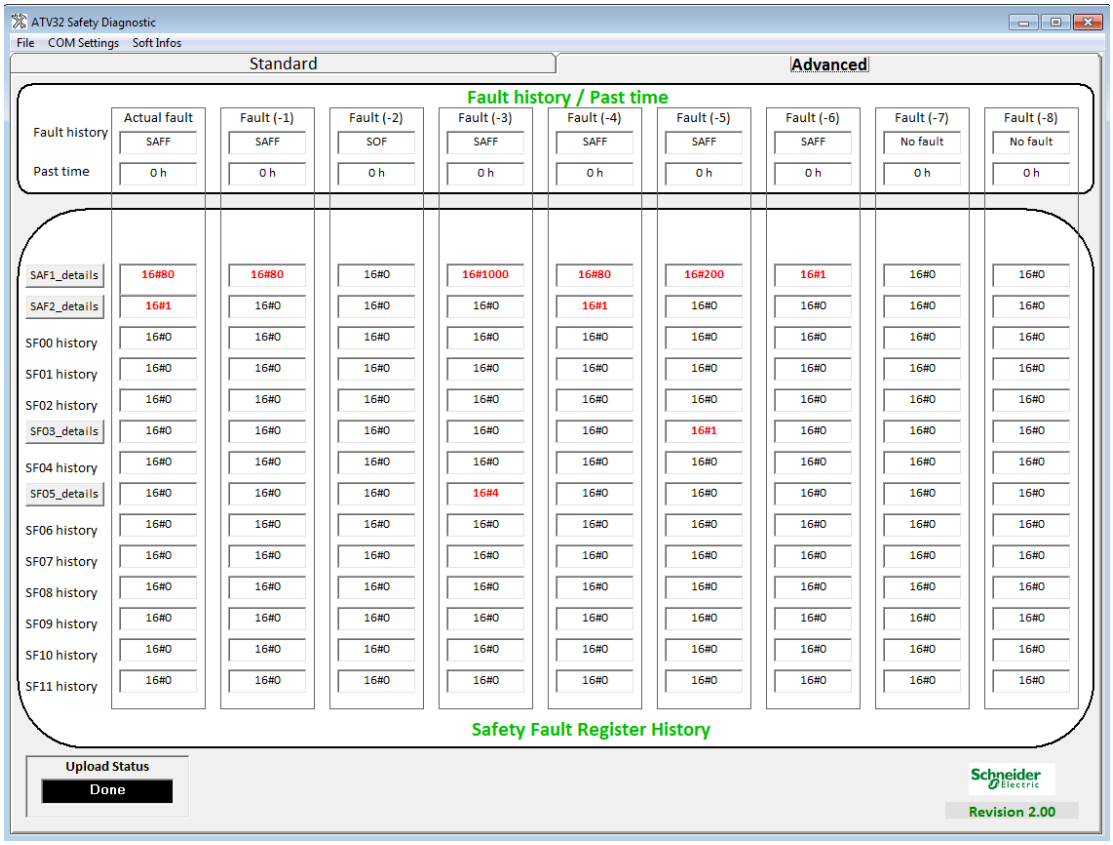
Keypad access

SoMove access



ATV32 safety diagnostic tool





Checks the safety fault register in the Drive fault history allow checking if SAFF origin is always the same.

For SAFF fault diagnostic, we need to have detailed information on:

- The ATV32 version
- The SAFF trip (on power on, when the STO input is connected, randomly during normal working…)
- The screenshot of safety diagnostic tool, SoMove or Keypad with safety fault registers
- It's also good to measure (with oscilloscope) the value of 24Vdc connected on STO input. (The goal is to check the stability and/or if there are pulse on STO input)
- Be sure that there is no pin bent on internal connector for option card
- Be sure that connector between control block and power if correctly connected.
- Electrical schematic to know how are connected the ATV32 safety inputs.
- In some case the SAFF origin can be due to product, so in this case Product Expertise (TEX) could be mandatory.