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**SVI FF**

**Firmware 3.1.0.0 Technical Release Notes**

# Revision History

The table below describes the revision history of this document.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Rev. | Date | Revised By | Checked By | Approved  By | Brief Description |
| **1.0** | 11/8/2022 | Ark Khasin |  |  | The first revision. |
| **1.1** | 1/20/2023 | Ark Khasin |  |  | Updated comments, known issues, test coverage |
|  |  |  |  |  |  |

# Target Firmware

|  |  |
| --- | --- |
| **Firmware Part Number** |  |
| **Firmware Image** | **ALLFF\_Rel\_C97277\_F010403\_30193\_A010403\_34167.ffd** |
| **Firmware Image for R2 field upgrade** | **ALLFF\_Rel\_C97277\_F010403\_30193\_A010403\_34167.Upgrade.ffd** |
| **Firmware Version** | **3.1.0.0** |
| **Firmware Build** | **C97277** |
| **Firmware Build Date** | **1/15/2023** |
| **NVM Factory Default Document** | **CES-421 Revision E** |
| **DD at release time** | **030101.cff, DD4: 0301.ffo, 0301.sym DD5: 0301.ff5, 0301.sy5** |
| **Production DD target** | **030101.cff, DD4: 0302.ffo, 0302.sym DD5: 0302.ff5, 0302.sy5** |

# Overview

Firmware revision 3.1.0.0 is a major firmware revision. Compared to the previous revision 2.1.0.0, It sports many important new features, major improvements of existing features, better compliance to FF specifications, as well as corrections of all previously identified defects. Additionally, the firmware is outfitted with testing/troubleshooting interfaces to assist with development and testing. An expanded yet still brief description is presented [below](#R3vsR2). See also [Appendix A. Internal improvements](#_Appendix_A._Internal).

A few [Known issues](#_Known_issues) comprise device limitation. There are no other known firmware defects at this time.

The firmware runs on the original SVI FF hardware 1.0.0.17.

SVI FF 2.1.0.0 can be upgraded to this 3.1.0.0 in the field. Note though that [Manufacturer’s Id has changed](#_Manufacturer’s_Id_change).

# Compatibility

Technically, 3.1.1.0 is not compatible to any device, just because of [Manufacturer’s Id change](#_Manufacturer’s_Id_change), not to mention parameter changes.

However, a device with firmware 2.1.0.0 can be upgraded to 3.1.0.0 in the field using any FF “common software download” host while preserving calibration parameters and everything else related to the positioner proper. All FF configuration, from node address to function block application to TB parameters access rights. See also [here](#upgrade).

Upgrade can also be done using [Comm. DTM](#CommDTM), or indeed any host that supports FF “Common software download”.

# State of Firmware Testing

All changes in firmware have been made against TFS work items which all have been resolved and verified. (See, however, [Known issues](#_Known_issues).) This includes newly introduced requirements or defects, as well as carryover defects from R2.

Firmware V&V is prepared. For firmware defects verification and requirements testing, see TFS folder $/FW SVI FF Releases/Release3/Docs/TestDocs. Some of the testing recommendations are in TFS folder $/FW SVI FF Releases/Release3/Docs/DesignEtc.

DD V&V is prepared. The report is in TFS,

Overall functionality has been exercised in multiple firmware updates, running DTM and DD development and targeted testing.

## Targeted Testing

Several key features key features can only be tested dynamically, with the whole device running under normal or specially induced conditions.

FF spec compliance tested with ITK 6.3.1 and 6.4.0

Control performance has been tested. See IR22-030 “Auto Tune and Control Performance Comparison between SVI FF R2 and SVI FF R3” Q:\inst-dev\Test Reports\IR22-030 where Q: is mapped to [\\tnwp18877.ent.bhicorp.com\shared01](file:///\\tnwp18877.ent.bhicorp.com\shared01). Also, on OneDrive at <https://bakerhughes-my.sharepoint.com/:w:/p/acacia_melzer/EUop9ntmyQdPhtO2uwcO5ogBYcFVXx9QIoUxba8ELBYK8A?e=4%3AG1cOF9&at=9&CID=38BBAC2F-C37E-43FC-AFF6-E286F31F47A9&wdLOR=c6212DF60-12B6-4A3B-A5DE-FFC595911056>

Ramp test has been regression- and performance-tested. Report: <https://bakerhughes-my.sharepoint.com/:w:/r/personal/acacia_melzer_bakerhughes_com/_layouts/15/Doc.aspx?sourcedoc=%7B965598DE-83C9-4091-9794-F2D0EEB1A644%7D&file=SVI%20FF%20R2%20v%20R3%20Ramp%20Test.docx&action=default&mobileredirect=true>

New open-loop signature algorithm has been tested. Report: <https://bakerhughes-my.sharepoint.com/personal/acacia_melzer_bakerhughes_com/_layouts/15/onedrive.aspx?FolderCTID=0x012000787FF0D64544DE4E86BD3739D1E35401&id=%2Fpersonal%2Facacia%5Fmelzer%5Fbakerhughes%5Fcom%2FDocuments%2FDocuments%2FProjects%2FSignature%20Test>

PST and data collection have been exhaustively tested during DTM development and integration. The report is in TFS $/SVI Software Releases/DTMs/SVIFF/Trunk/Documents/Releases

## Early testing

Some early testing of functionality and robustness were performed by MANRO. Failures detected there are due to incorrect test setup or no longer applicable. They are included for completeness in TFS   
$/FW SVI FF Releases/Release3/Docs/Testing-Manro.

# Supporting Software Tools

* FMA – SVI FF electronics manufacturing assistant (factory only)
  + Must support CES-421 Re. E or later
* TBD – Manufacturing software for positioner assembly and final testing
  + Must support CES-421 Re. E or later
* Smarts Assistant 3.24.5 or later (lab only – for diagnosing/troubleshooting)
* Masoneilan NI-FBUS-H1 Comm. DTM ver. 4.0 or later
* SVI FF DTM ver. 2.0.0.0 or later
* ValVue 3.6.1 or later

SVI FF differences between Rev. 3 and 2

([Back to Overview](#_Overview))

# New features

## Manufacturer’s Id change

Changed from 0x004745 (GE) to Baker Hughes (0x445644). Provided framework for FF live firmware download between R2 and R3 accounting for different manufacturer’s ids.

## Partial Stroke Test

Implemented [PST](#_Partial_Stroke_Test) to run in AUTO or MAN mode of TB with various process-related abort conditions and several patterns of setpoint excitation (26097) in order to minimize the process impact.

* User value: Important feature for the valve applications where valve stays in place for a long time

## Data Collection

Diagnostic data collection can be triggered to start by various conditions (26398) including setpoint, position, and/or pressure deviation (50671) and TB alerts. It comes with a presampling feature to include data before the trigger. Data can be collected with 15 ms or 60 ms sample rate.

## New diagnostic process interface

PST and data collection can now start automatically based on trigger events. Because of that, a guard is implemented to avoid clobbering the diagnostic buffer.

Lock the buffer semaphore to preserve the content of the buffer, override the lock.

Added data collection state monitor for testing (70176-70178) and add info to the buffer header (80586, 80599)

* User value: Data consistency; ability to trace events with optional [presampling](#presample).

## Physical Analog Input

Analog input is now a TB parameter and a new channel in AI FB (27101)

* User value: Feature enhancement

## DO Function Block Channel FAULT and TB\_FSTATE\_STATUS

Now DO FB can cause fault state in TB to [enhance device application](#_Extension_of_XD_FSTATE) (25082, 27391, 27869)

## Firmware download

TB factory defaults used to be lost on firmware upgrade. Now, current settings are automatically set as new factory defaults (26713)

* User value: Feature enhancement

## DD features

“Replace stops” is now supported (67696)

* User value: Support of device replacement operations

## Write lock

[Write lock](#_RB_write_lock) behavior re-implemented to comply with new FF spec (67721)

* User value: improved interoperability

# Major improvements

## Network parameters

Tighter network parameters are allowed. Max response delay can be 3 (down from 5 in Rev.2), allowing SVI FF to replace FVP (26918). However, at tighter parameters, “geometry” (MRD\*slot\_time >=24) considerations should be made. E.g. MRD=3 won’t work with slot time <8.

* User value: SVI FF R3 can replace FVP/YVP in any DCS environment

## Field Diagnostics

TB alerts are now mapped to RB.FD\_SIMULATE.DIAGNOSTIC\_VALUE thus enhancing the functionality (27333)

* User value: flexibility of routing alert reporting via FD or BLOCK\_ERR

## Inter-CPU communications

Inter-CPU communications (IPC) made faster and more robust (29544, 31252).  
This improvement made [Network parameters](#_Network_parameters)  improvement possible.

* User value: Control performance improvement esp. with short macrocycles

Failure of IPC no longer break FF communications. On the contrary, RB.RESTART=Processor may be attempted to kick-start IPC (29544)

* User value: This rare failure mode does not require power cycling and can be remedied remotely

HART over FF now admits all commands that HART over ISP does (54110). This enables, but doesn’t require, manufacturing process with less wiring.

## Signature Test

Open loop signature now works consistently on double-acting valves (83015, 80882, 86840)

* User value: Now it is possible to rely on open loop signature on DA valves just as it is possible on single-acting valves. In particular, it is possible to segregate valve behavior from control algorithm artifacts

## Bumpless operation

Now, like in HART products, open stop adjustment change, ATO/ATC change, characterization change, switch mode out of Setup/Local override, and such, are bumpless, i.e., do not change physical valve position (88339)

* User value: No unexpected/counterintuitive valve movement during configuration

## DD major redesign

FD alerts redesign (60733)

Support of Trex handheld (67658-67694)

Intermediate displays no longer disappear instantly (70142)

TRANSDUCER\_DIRECTORY parameter removed from menus (70171) to avoid some DD hosts confusion

Autotune method uses correct pressure units (70172)

Corrected detection of running process (70173)

Optimized menu structure and methods implementation (70175-70176)

## Local UI

Button lock added to DD (61923)

UI password added to DD (61924)

# Interoperability improvements

## Ease of operation / User experience

The critical ADVANCED key is no longer lost in any RB operations (25006, 52797)

* User value: UX, ease of operation

RB restart defaults or factory no longer induce fault “find stops failed” to require new find stops. That’s because stops no longer restored (27309)

* User value: UX, ease of operation

TB now allows to enter AUTO mode even if FINAL\_VALUE is not GOOD. In this case, it will reinitialize the value with the current valve position (25305)

* User value: UX, ease of operation

Added RB RESTART option “Quick Defaults” to make sensible defaults across FB, such as e.g. CHANNEL (53057), as a countermeasure to [FF requirements](#ITKpass).

## Compliance with FF specification

### CS FB

Non-volatile memory use is brought up to the spec

### Block modes

RB and TB block mode parameters are now standard. This resolves interoperability with Honeywell (41985)

* User value: Honeywell interoperability (no more special DD)

RB target mode no longer changes programmatically (if APP is in failed state) (41808)

* User value: Compliance and quality

### XD\_ERROR

A XD\_ERROR bit is set if and only if BLOK\_ERR “Other” bit is set (41895)

* User value: UX and compliance

All XD\_ERROR parameters now have underlying type “unisigned 8” (41983)

* Consistency

### Field Diagnostics

Field Diagnostics recommended action could be set without FD alert and mismatched against xd\_error (41896)

* User value: UX, consistency (bug fix)

### RB write lock behavior

The code has been rewritten to comply with FF spec (42541, 43408). In particular, handover protocol between Soft and Hard lock is now correct. The lock now works correctly on both CPUs.

* User value: Compliance and interoperability

### Block Errors

Block errors originating from TB alerts are by default apportioned between TB and RB without duplication. Old option (TB only and copy all to RB) are still available for special purposes (42604)

“Power up” block error bit is now reserved and is not set ever (45379)

* User value: Compliance and interoperability

### ITK

Firmware defaults are now sufficient to pass the tests (53056). Implemented [usability countermeasure](#QuickDef).

# Other improvements

## Non-volatile memory management and recovery

NV memory objects are now small and the writes to the larger of them is delegated. This avoids spikes in block execution times. (25535, 26325)

* User value: Performance of a function block application

TB FINAL\_VALUE\_D and \_DINT are no longer saved in NV memory, just like the analog FINAL\_VALUE. That improves timing (26226)

* User value: Performance of a function block application

We don’t attempt to rescue Rev.2 NV memory, but going forward, FFP CPU [firmware up/downgrade](#_Firmware_download) will preserve all settings transparently to the user (26431, 28833)

It is now possible to completely reinitialize FFP CPU NV memory by writing RB.RESTART=169 (26933)

* User value: Field personnel can try to fix heavily misconfigured or misbehaving unit

Restore TB to factory now handles TB STATIC\_REV consistently: if APP CPU succeeds, increment by 1, if FFP CPU, by 2, so overall success is indicated by ST\_REV incremented by 3 (27310)

* User value: clear indication of success or failure of the operation

## Control and Autotune

~~Corrected multiple Autotune bugs by bringing over ESD fixes and extending check for stability (28298)~~Rolled back because couldn’t achieve comparable performance. Maybe, future.

Eliminated iterative artificial control windup due to multiple resets (42245, 42247)

Eliminated possible division by 0 and possible positive feedback (42246)

Removed bias reduction on startup for ATC (42248)

Corrected bias initialization sequence (was always to 0 deg.C) (42249)

Minimized the possibility of saving wrong bias, including but not limited to numeric overflow (32844, 32715, 42250, 42261)

Implemented consistent reinitialization of state variables on entering closed-loop control (42251, 42252)

Corrected evaluation of “bias out of range” fault (42262)

* User value: Quality improvement

## Local UI

Manual and automatic “find stops” now consistently display raw position (25204)

* User value: UX

On Autotune failure, LCD displayed “FAILURE” which confused a lot of people. Now it displays “TUNE ERR” (28185)

* User value: UX

It is now possible to write LCD temperature calibrations, as a factory operation (44277)

* User value: Manufacturing can adjust to different LCD components

SIMULATN menu on entry didn't show the actual "jumper" state (53769)

* User value: User now knows the current state of simulation enabled

## Robustness

Flash bank written to during [FW download](#_Firmware_download) is no longer left open between commands (25239)

Watchdog now monitors event-driven tasks in both CPUs (26424, 26453)

Watchdog in FFP CPU now exclusively follows a stringent tickle policy like APP (29102)

[NV memory management](#_Non-volatile_memory_management) now tests and repairs the last write before unexpected reset in both CPUs. That protects against repeated resets. (26312)

## Firmware download

Firmware download is now about twice as fast as in R2 (29609)

Firmware download/activation state machine brought to FF compliance to the extent possible without Softing and made robust against power loss at various phases of activation (43858, 54031, 54032)

## Testability and troubleshooting

Function blocks’ execution time can now be monitored (25348)

It is now possible to monitor performance of interprocessor communications on each CPU (26926, 29245, 29247, 29544)

Propagation of failed state to APP CPU is now indicated in TB COMPLETE\_STATUS (29250)

“HART pass-through” interface now supports all commands to APP, as well as intercepts for FFP (42259)

“HART pass-through” commands to FFP that change device behavior now require factory mode (43410)

“HART pass-through” can now connect to the device even if IPC is not operational (43474)

“Firmware Info” command now returns the APP build changeset instead of month/day (43597)

CPU traps now point to the instruction just past the offending instruction, making it useful for debugging (43954)

Added sufficient interfaces to run ITK tests remotely (52857)

Added SPC-42 (FF chip) lockup monitoring using base.a provided by Markus Bachmann in 2016 (54066)

Added task statistic access via hart (54112)

## Physical DI

Digital input toggling may take a long time over long wires, and can be missed if changed rapidly. Like in ESD where the effect was first discovered, power to DI is no longer switched (26635, 27928)

* User value: Interoperability

## Processes/Methods

A process leaving data in the diagnostic buffer no longer auto-terminates. Instead, it indicates completion by 200% complete to allow the data upload and prevent [data collection](#_Data_Collection) from overwriting the buffer (50612)

## TB trends, histograms, and alerts

Deviation alert is no longer calculated in CUTOFF on either side (53774)

Near-close alert is no longer calculated in CUTOFF\_LO (53774)

Implemented consistent design of trends (53206). In particular, RB.RESTART = Defaults or = TB Factory Defaults shall not change the trends. They can be separately reset individually. Implemented methods to reset trends, working time, and histograms (53085, 53701)

## Miscellaneous

Lifetime min/max temperatures are added to TB TEMPERATURE\_EXTREMES (52485)

Brought TB defaults in conformance to ITK test (52729, 52826, 52857, 53056)

# Corrections and bug fixes

## Serious issues

In some cases, writing to NV memory could fail without any indication (25006, 25012, 25044)

DO FB back calculations limit status don’t account for reverse action (25418)

Fail Open/Close did the exact opposite for ATC configuration (28722)

Mismatch of Softing GW script definitions with DD and firmware is corrected by [automation](#_Build_automation). The user-facing effect was unclear but could be memory overwrite due to size mismatch (26238)

Incorrect fix-up (in restore factory) of what is enabled per “Advanced” key is corrected (27832)

Parameter read filter may corrupt live TB parameter causing incorrect function block application behavior. This has been corrected (27808)

DO FB, BLOCK\_ERR bit READBACK\_CHECK\_FAILED could be overwritten (41910)

When TB is in MAN mode, setpoint delivery to APP CPU was ignored. That caused incorrect behavior for APP-only resets and XD\_FSTATE failover interface (42282)

Incorrect handling of TB alerts with RB restart defaults has been fixed (53074)

TB Alerts with time-to-wait were to spontaneously disappear in ~49 days. This has been fixed (53084)

Many TB alerts + failed state time would overflow in ~45 days yielding incorrect results (53610)

RB.RESTART=Resource now clears sources of BLOCK\_ERROR (81555)

## Less serious issues

TB.XD\_FSTATE configuration limits are corrected (25464)

A mix-up in noise calculation between raw position and position in % range is corrected (26170)

Incorrect changing of TB static revision (e.g. in working time alert/working times) is fixed (26349)

Not all alerts make it to alerts log. This has been corrected (27389)

final\_position\_value was filled with uncharacterized position if readback\_select == READBACK\_SELECT\_WORKINGPOS. This has been corrected (53062)

TB trends’ current values may jump unexpectedly on RB restart defaults (53197)

Travel accumulation trend missed increments <1%/s (53247)

Trends values were unchanged when travel unit changed (53197)

Setpoint timeout alert didn’t clear current and history state when disabled (53608)

Near-closed alert didn’t clear history state when disabled (53608)

Ranges of pressure parameters didn't change when pressure units change (53611)

Position error histogram calculations could overflow (53772)

# Partial Stroke Test

As an incidental improvement, allowed setpoint range limits are widened (26855)

PST data can be read out while PST is still running (26867)

# Extension of XD\_FSTATE functionality

1.      XD\_FSTATE controls fallback to a setpoint as configured (full closed, full open, stay in position, fixed setpoint) on the following conditions:

a.      Controlling output block, according to TB.SETPOINT\_SOURCE has FINAL\_VALUE\_x.STATUS BAD or substatus “Initiate failed state”.

                                                    i.     In this case, the time is counted and when it reaches FSTATE\_TIME\_1, the fallback setpoint is used

                                                   ii.     When TB changes actual mode to AUTO, the time counter is reset

b.      A DO FB has CHANNEL=CH\_DO\_FAULT and its output is GOOD and TRUE

                                                    i.     In this case, the fallback setpoint is used immediately

                                                   ii.     The DO FB request is latched until changed to GOOD and FALSE

                                                  iii.      When the DO FB output is not GOOD, the last GOOD request is latched, in particular, when the DO FB is stopped (such as OOS).

1.      This is so even if the FB is no longer scheduled

2.      To cancel a stale DO FB request, the user can:

a.      change the CHANNEL of the DO FB to something else, or

b.      write 0 to FSTATE\_STATUS.REQUEST (see below)

2.      At most one DO FB may have CHANNEL=CH\_DO\_FAULT

3.      When the fallback setpoint is used, it is indicated in SETPOINT.STATUS substatus “Initiate failed state”.

4.      FSTATE\_STATUS parameter (new) indicates

a.      Flag of active fallback due to DO FB or user request

                                                    i.     Writing a 0 will cancel DO FB request, whether stale or not. If not stale, next execution of the DO FB will refresh it.

**ii.     Writing a 1 will have the same effect as DO FB request, whether or not there is a DO FB that could make such a request**

b.      Flag of active fallback due to FINAL\_VALUE\_x, read-only

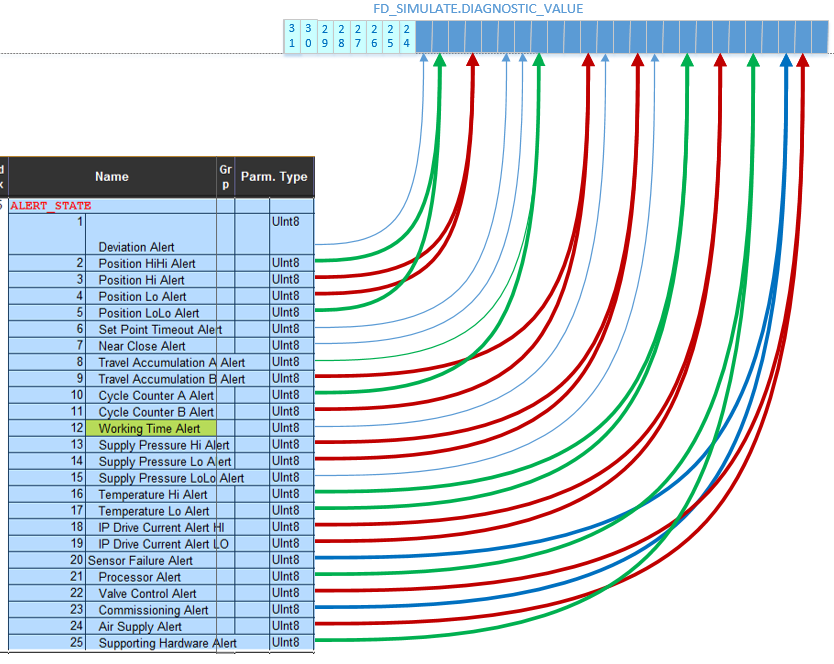
c.      Time until activation of fallback due to FINAL\_VALUE\_x, read-only

5.      On reset/power-up, TB doesn’t preserve any old DO FB requests and starts with fresh XD\_FSTATE internal state, just as it does w.r.t. FINAL\_VALUE\_x.

(28831)

# FD Diagnostics

In complement to R2 limited FD alerts, the following mapping is in R3:



(27333)

# Known issues

It is not possible to upgrade directly from SVI FF Rev.1 to Rev.3, or downgrade from Rev.3 to Rev.1. A workaround is to use an intermediate up/downgrade to Rev.2.

On upgrade from R2 to R3 or on downgrade from R3 to R2, FFP will lose all configuration (APP will preserve its). This is a carryover issue from R1<->R2 update.

MAI FB doesn’t have a channel to connect to physical analog input. A workaround is to use an AI FB instead.

Some range values in DD are not documented and not enforced (62389).

Consistency between local UI configuration parameters (TB) and the actual names shown on LCD can be improved (89241).

[Factory only] Creating “TB factory defaults” by RB.RESTART=42 require that TB be in OOS, with no indication of failure (89596).

Creating “Quick Defaults” do not automatically enable pressure and accumulation alerts in TB (89595).

New firmware activation may fail if PST is running at the time of activation (89542). A workaround is to disable PST and repeat FW download procedure.

# Appendix A. Internal improvements

## Build automation

While still work in progress, some automation is in place to allow for guaranteed match of definitions in DD, Softing GW script, and C (26227).

At that, RB parameters can and partially are automated, too (27334). Custom parameters and channels are now documented automatically.

## Quality

Conceptually common features between CPUs now use common API and common code, when possible (26425), esp. i2c (28676)

One-time recalculation of parameters on change units are removed in favor of internal representation (27381, 27390)

Thread-unsafe code has been corrected (multiple)

DD HLP strings match FD enumeration label by automation (60733)

1. 54067 54070
2. 62390
3. Etc.