SISMEDSJ24v2 Firmware description R.Oliva

14.04.2021 →ok en curso

0. INDEX

1. ADVANCES UP TO 20.03.2021

- SJ24 (Mi3 system), programming & description

a) Description (system hard detail, day to day) will continue from last update 8.3.21:
C:\Work_SJ\2021\SISMED_SJ24\SJ24-Upgradesequence_03-2021.docx
(Bootloader working ok) – continue with updates

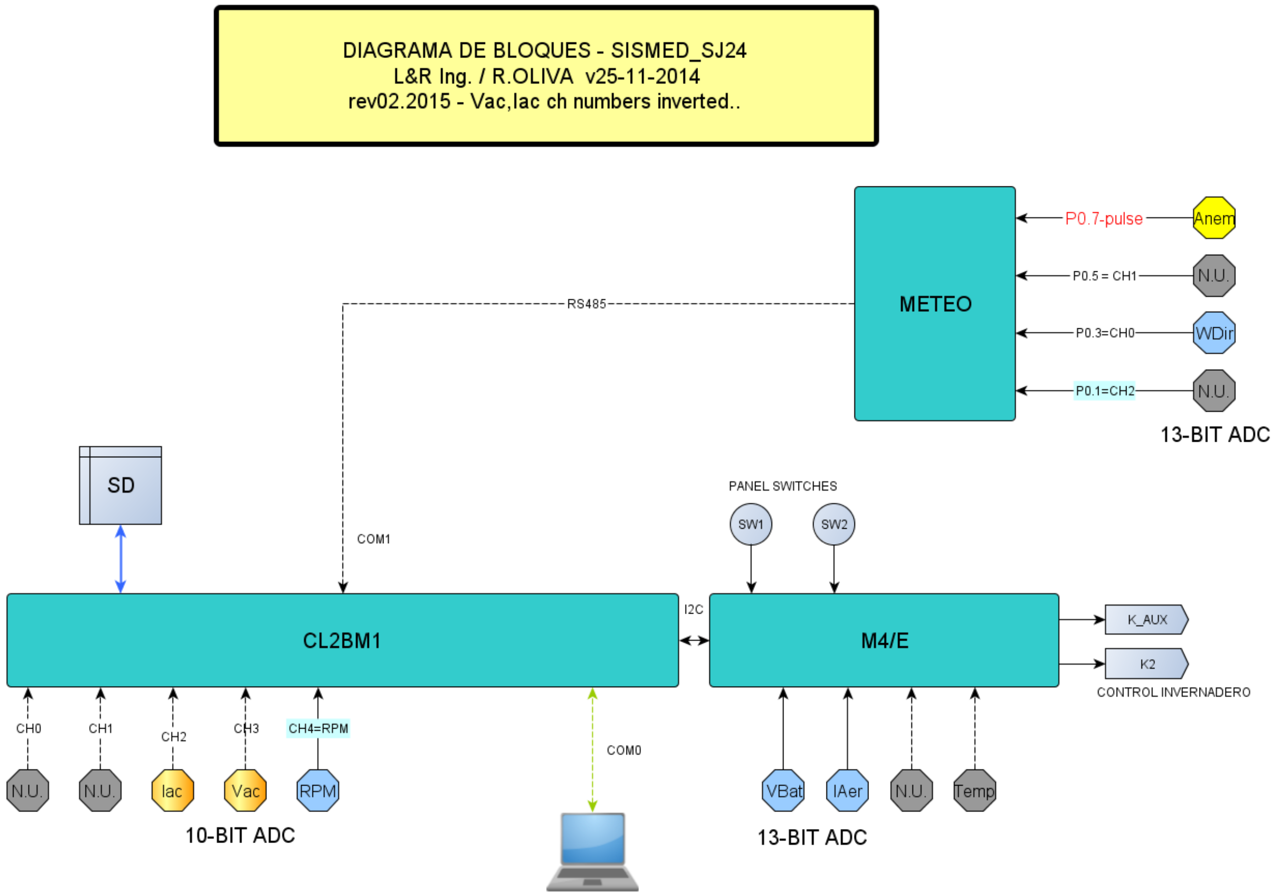
b) Firmware Description (system hard detail, day to day) here in:
C:\cvavr328\Work3\CL2(2021)\SISMEDSJ24v2\DOC\ SISMEDSJ24v2_Firmware_03-2021.docx
Will use C:\cvavr328\Work3\CL2(2021)\DRIVERS, which have their own DOC description in each directory (most from 2018), and a small content DOC in
C:\cvavr328\Work3\CL2(2021)\CL2_Drivers\DriversDOC

2. MAIN DIAGRAMS IN yEd – rev.02.2015

- Diagrams in: C:\Work_Flowcharting\Work\SISMED_SJ24_JFG

2.1. BLOCK DIAGRAM – rev.02.2015

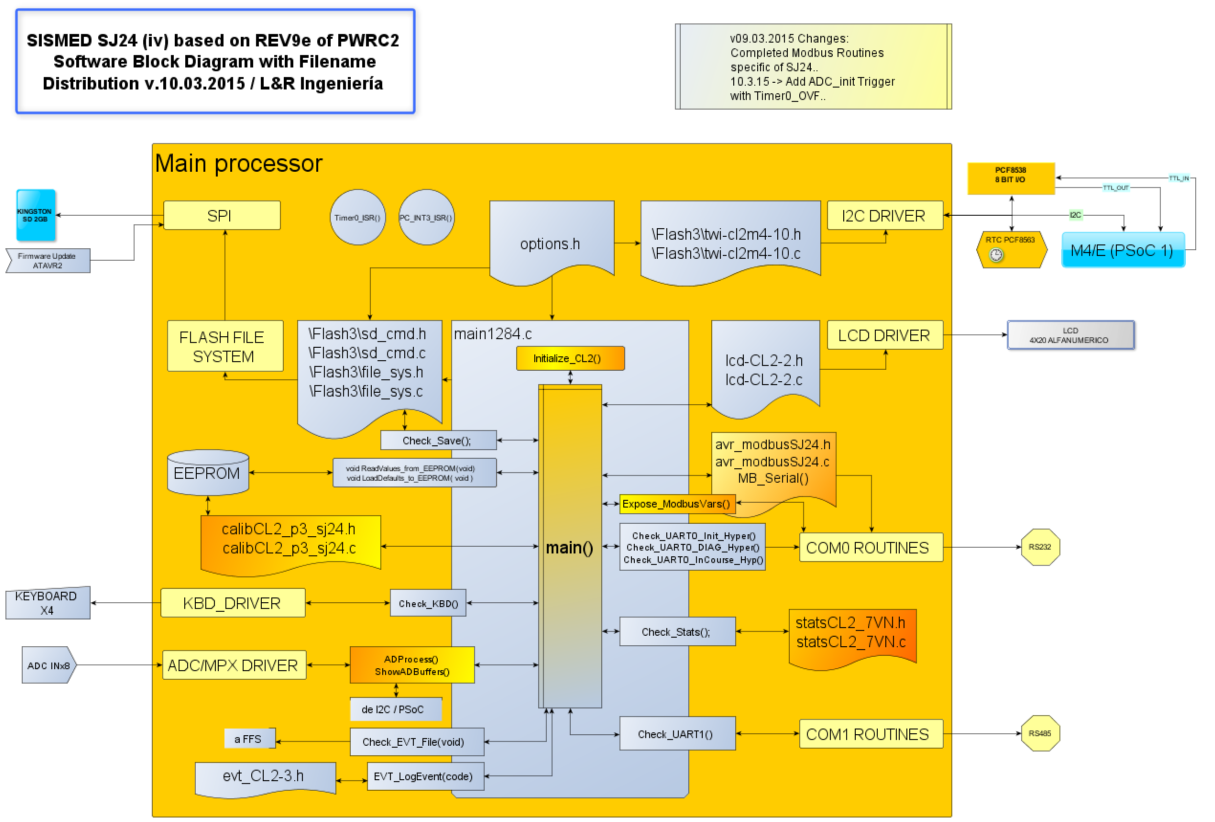
- Printouts PDF in: C:\Work_Flowcharting\Work\SISMED_SJ24_JFG\Printouts
BlockDiagr(ii)SISMED_SJ24_19-02-2015.GRAPHML



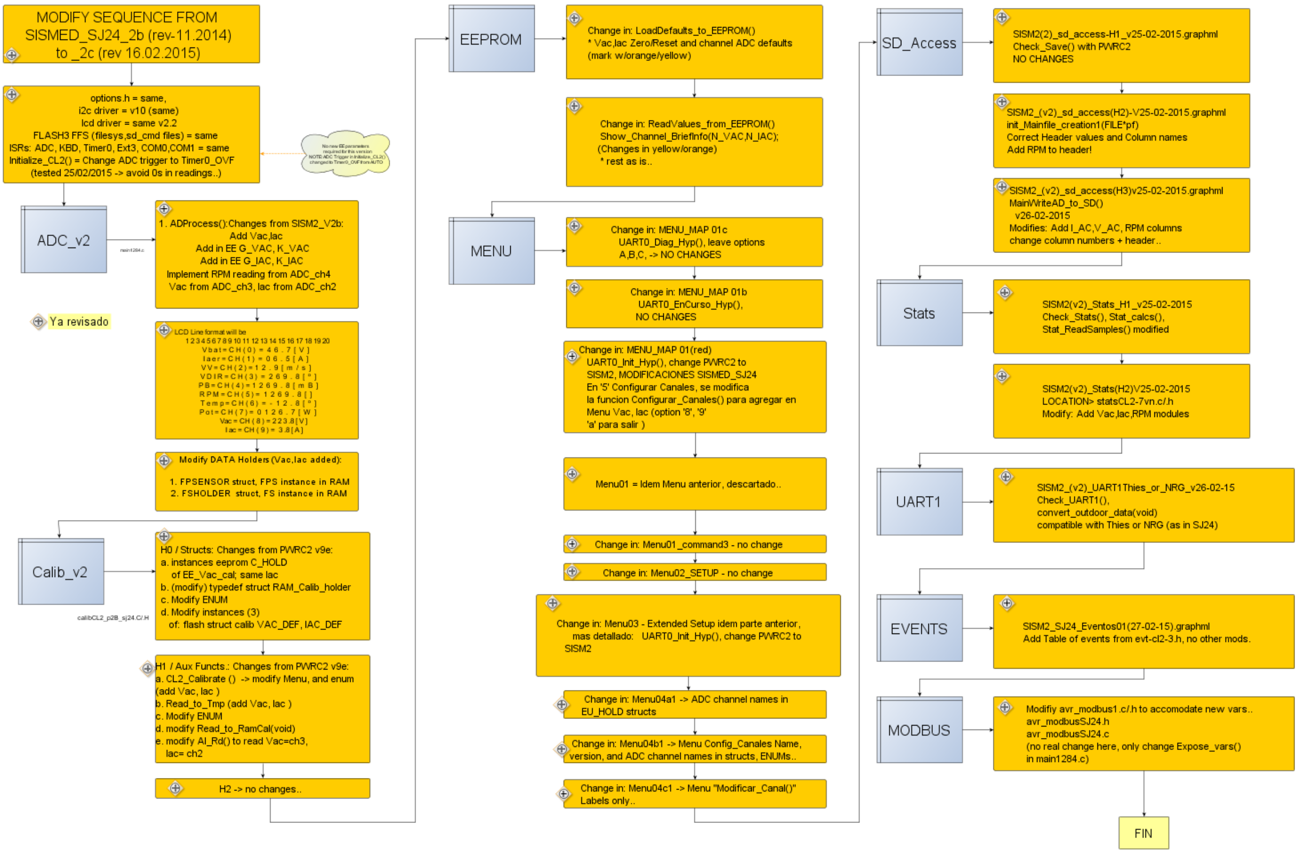
2.2. FIRMWARE DESCRIPTION 04/04/21 (2015 V2)

SoftwareBlockDiagram(iv)SISMED_SJ24_2d(withFilenames)_v09-03-2015.GRAPHML

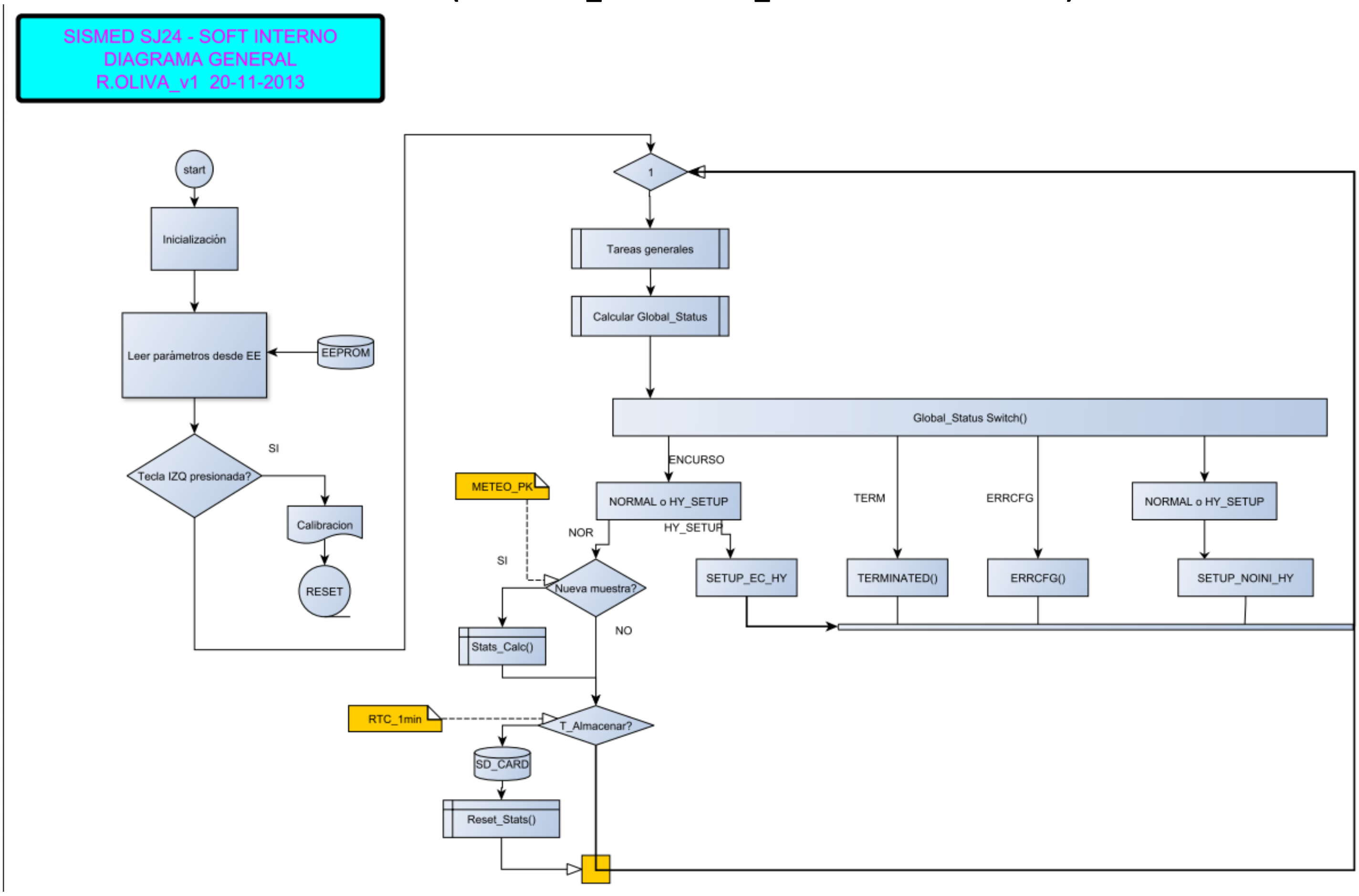
2.2.1- System configuration – last revision from 03-2015:



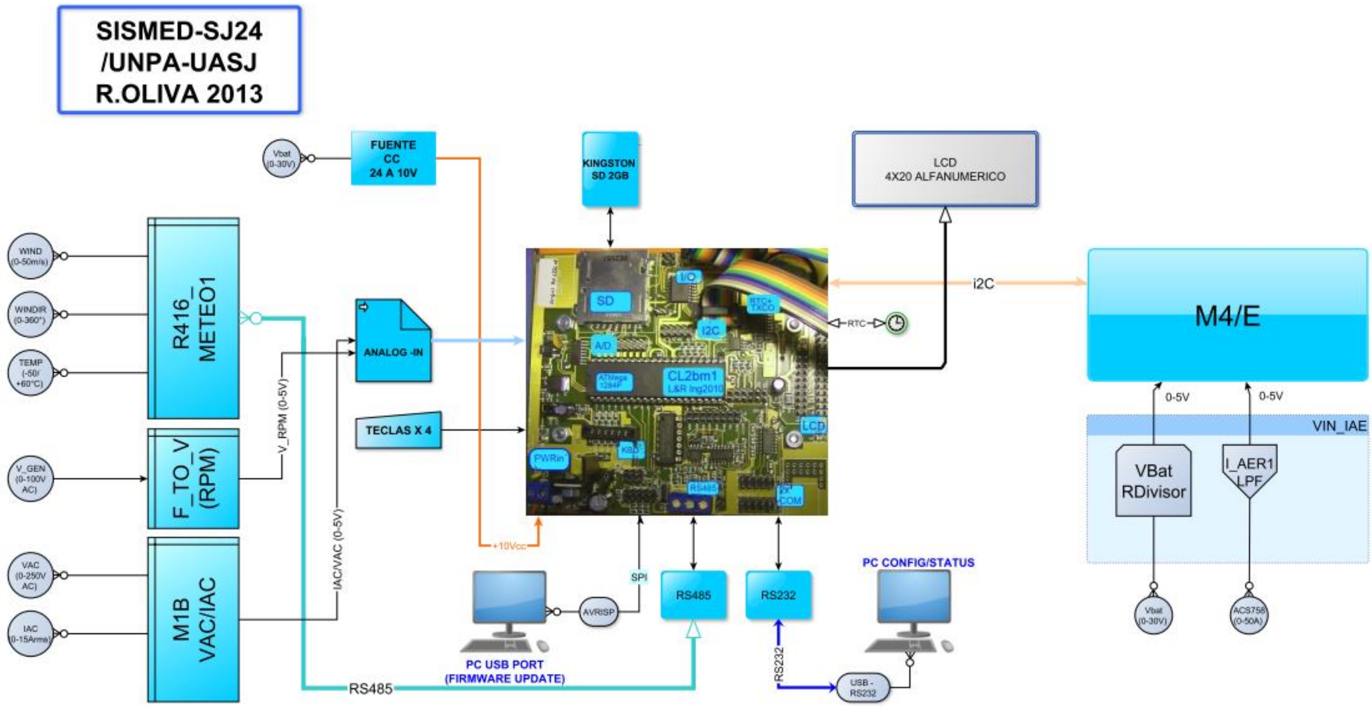
2.2.2- MODIFICATIONS SEQUENCE 03.2015



2.2.3- FIRMWARE FLOW DIAGRAM (MainFlow_SISMEDSJ24_v20-11-2013.GRAPHML)



2.3. BOARD IMPLEMENTATION DIAGRAM – rev.02.2015 (SISMED_SJ24_v1(11-05-2013)B.GRAPHML)



3. FIRMWARE IMPLEMENTATION

3.1- A/D CONVERSION

3.1.1 ADC DIAGRAM:

This section corresponds to on board ADC functions and I2C/PSoC external ADC readings, as shown in Figure AD.1

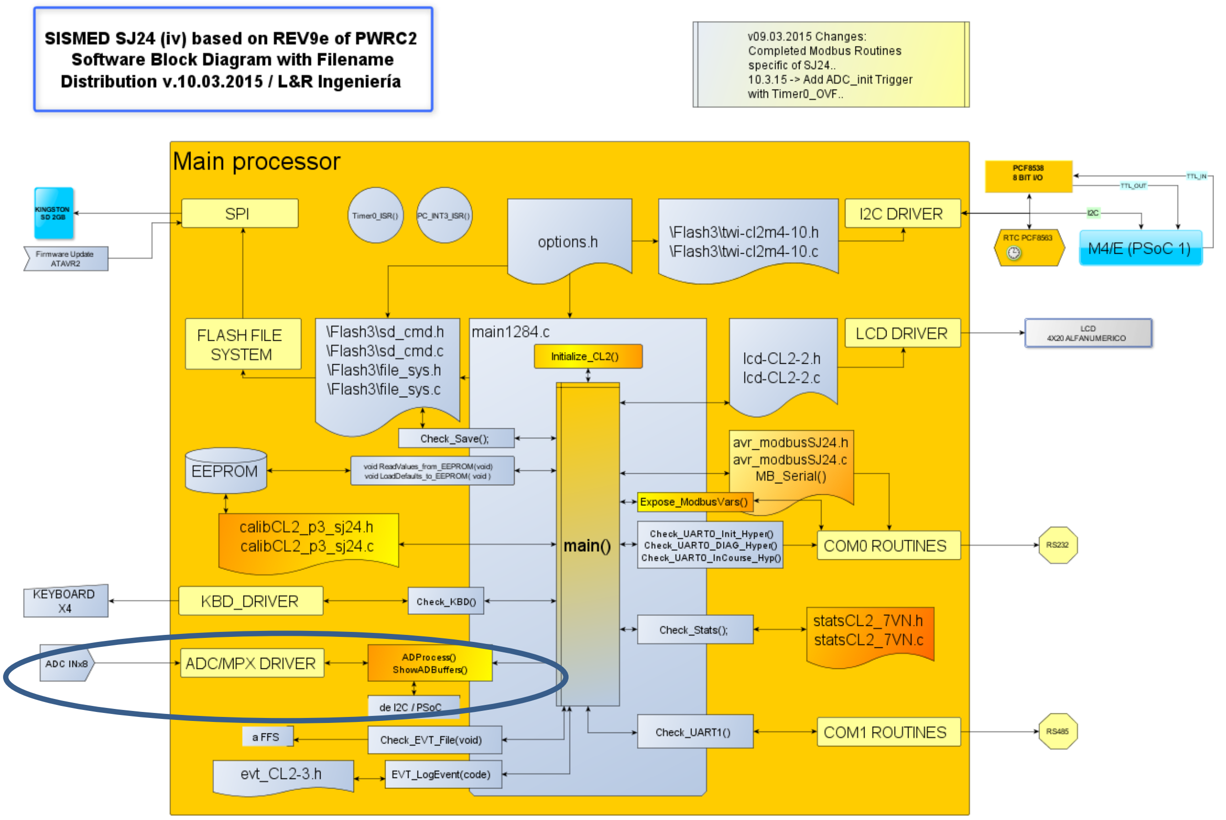


Figure AD.1 –A/D conversión from on chip ADC and off-board PSoC ADC in SJ24 firmware

Figure AD.2 shows the flow the first part of function ADProcess(), which concentrates readings from both sources (internal and external ADC). The second part from point (A) downwards is shown in Figure AD.4.

3.1.2- The ADProcess() function: It performs the treatment of two main sources:

a) External sources: unsigned integer values read through the I^2C interface from the M4/E board (battery voltage and wind turbine current, from a TRIADC 13-bit module in the PSoC controller). This first part is shown in Figure AD.2 up to point (A).

b) Internal sources: unsigned integer values read from the internal 10-bit ADC on the AVR for RPM, V_AC and I_AC (these last two added in the 2015 version, and coloured differently). This is shown in Figure AD.4, from point (A) downwards.

As seen in both diagrams, the integer values are first read into an intermediate local variable Average_Val which is used for calculations. In the case of a) the external TRIADC, the values are copied from the global GVM4E3_i2c data structure, which is periodically updated by the external ReadM4E_Status() function. This is shown in Figure AD.3, which shows the structure contents and interaction with the main program.

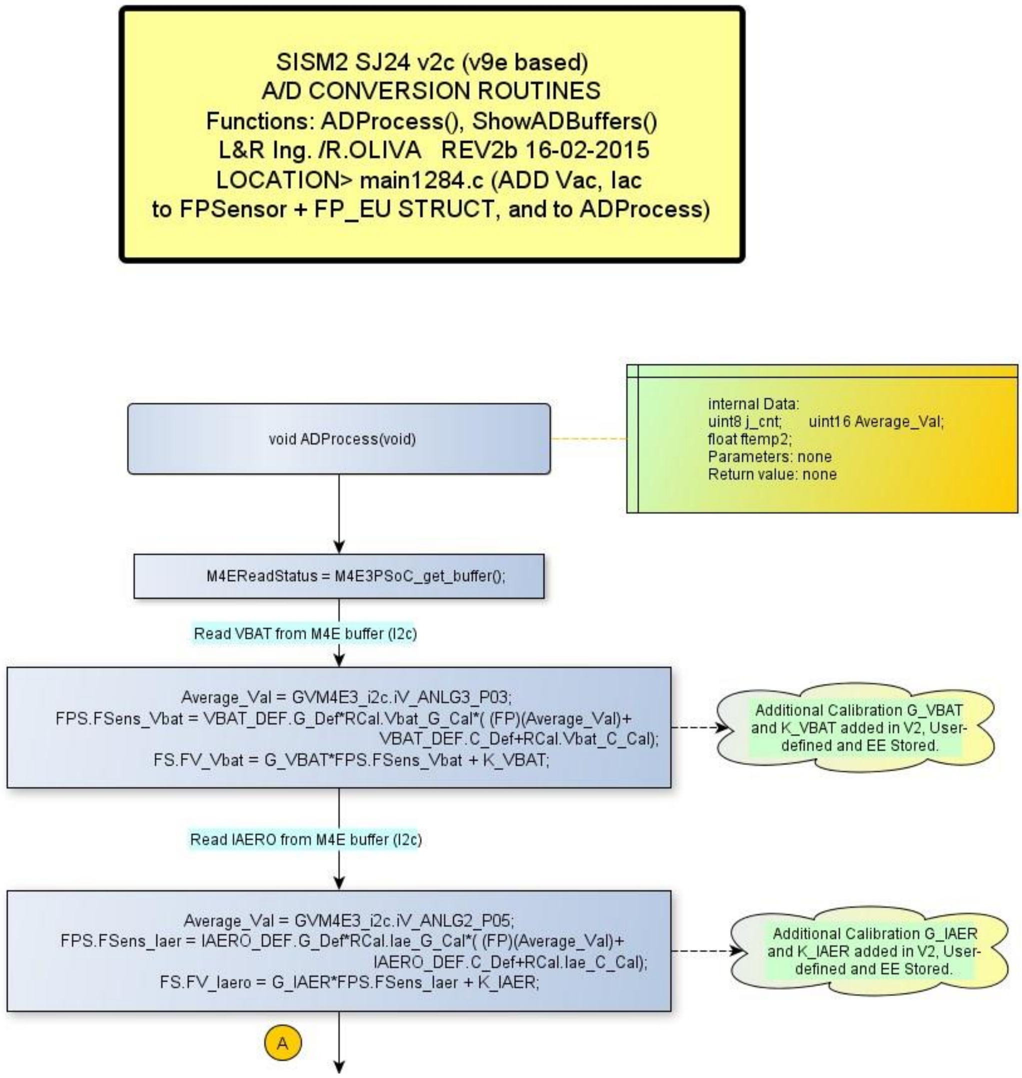


Figura AD.2 – First part of the ADProcess() routine in firmware SJ24

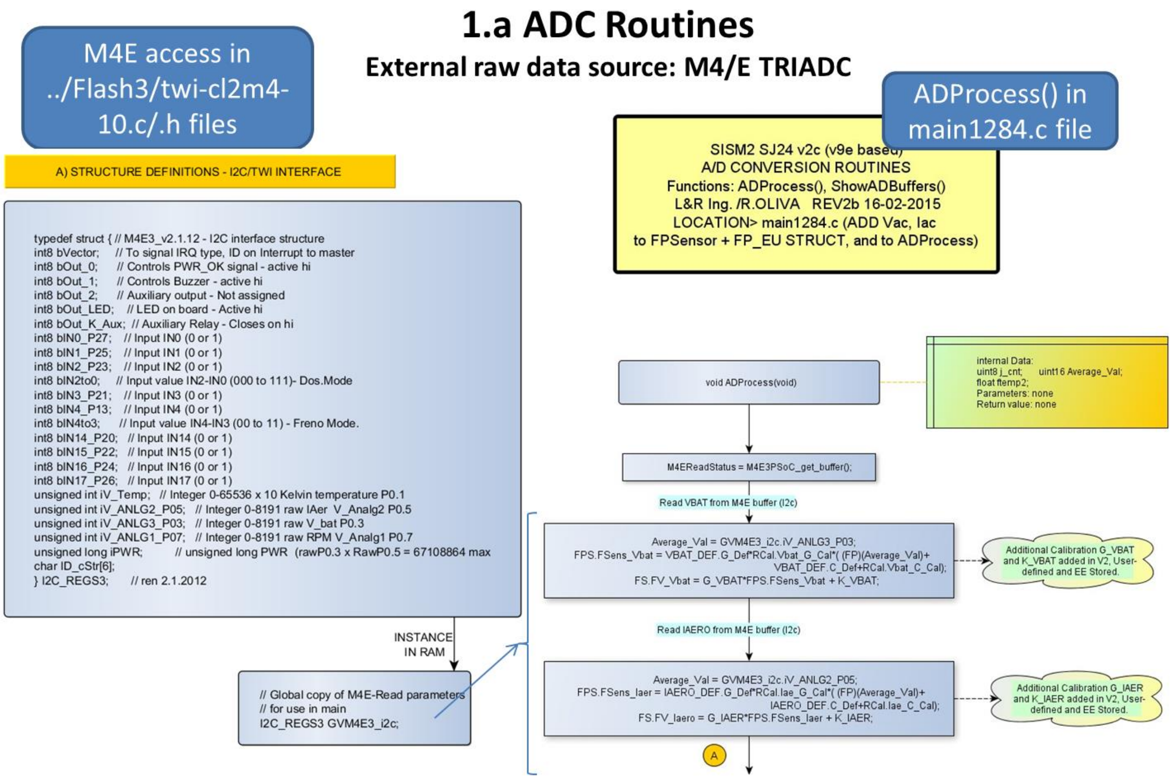


Figura AD.3 –External Raw Data source from I²C/M4E board for ADProcess() routine in firmware SJ24

The raw integer values are first scaled to floating point FPS structure members using low-level two-point calibration coefficients (for the battery voltage channel, this means obtaining the FPS.FSens_Vbat value with a range of 0 to 5 V). This scaling has a default G, K component VBAT_DEF read from permanent (Flash) memory (Figure AD.4) and an RCal G,K low-level calibration component pair (Figure AD.5). The latter is obtained from laboratory or field calibration procedure of the M4E board, using the Calib() functions from the program. The results of this calibration are stored in EEPROM and read into RCal (which resides in SRAM for better speed) during startup or reset procedures. Similarly, the "user coefficient" pair is used to further convert the FPS values into FS values which are expressed in EU or Engineering Units. For example, the FS.FV_Vbat value for the first channel would have a value ranged from 0 to 32.0 V for a 24 V nominal battery bank, and FS.FV_IAero would have a range of 0 to 50.00 A if the current sensor had a capacity of 50 A.

This two-level calibration structure allows an effective separation of the low-level (board) calibration and the user-provided sensor calibration constants. Both calibration sets are kept separate and stored in EEPROM together with timestamps and other relevant information (in the case of user constants, these can be provided by an external manufacturer and the serial number, model and other parameters are stored in non-volatile memory). User parameters as before are read from EEPROM structures into RAM on startup, to speed up the continuous computations of floating point results in program execution.

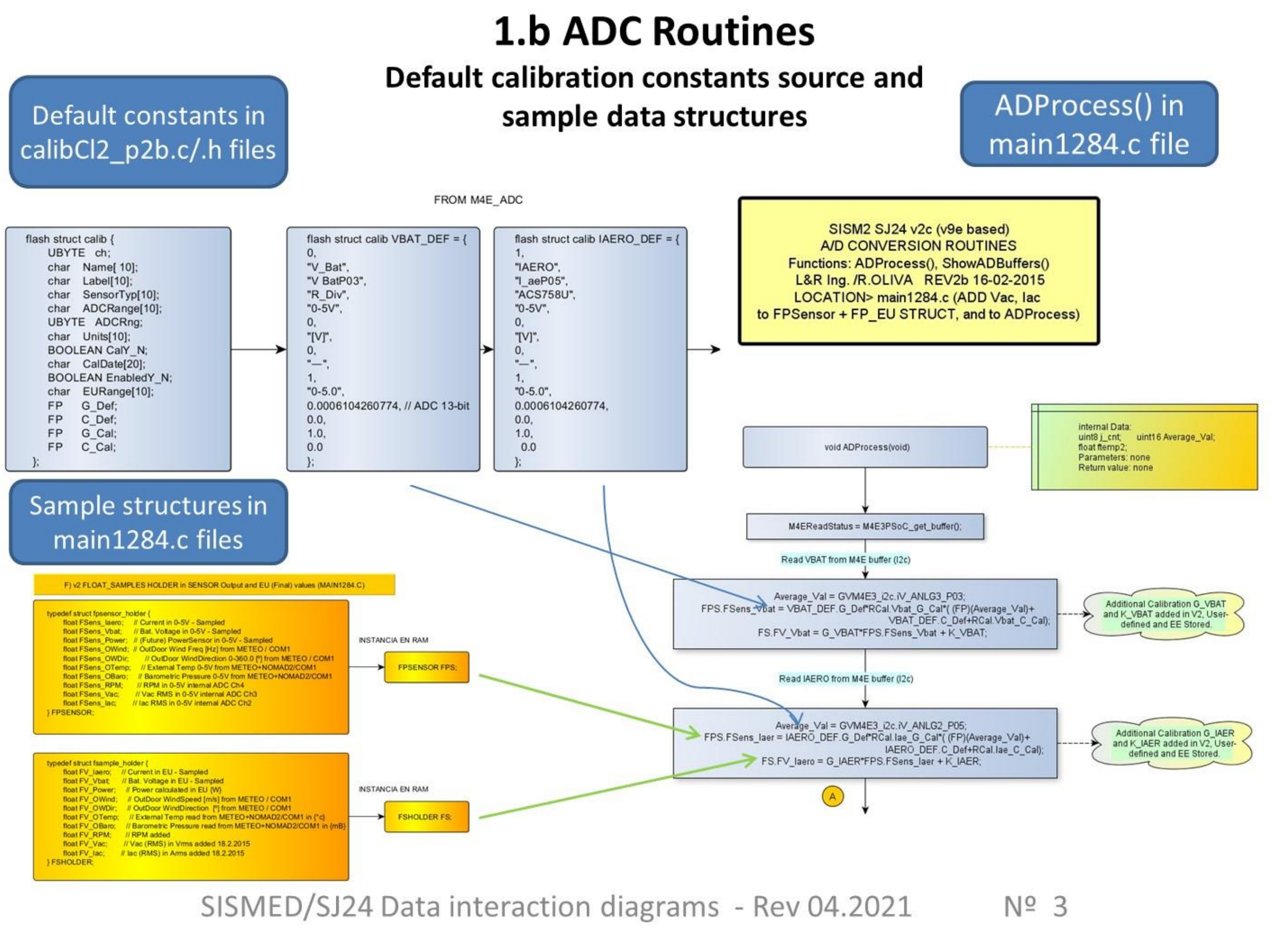


Figure AD.4 –Default Constants and Sample Structures for ADProcess() routine in firmware SJ24

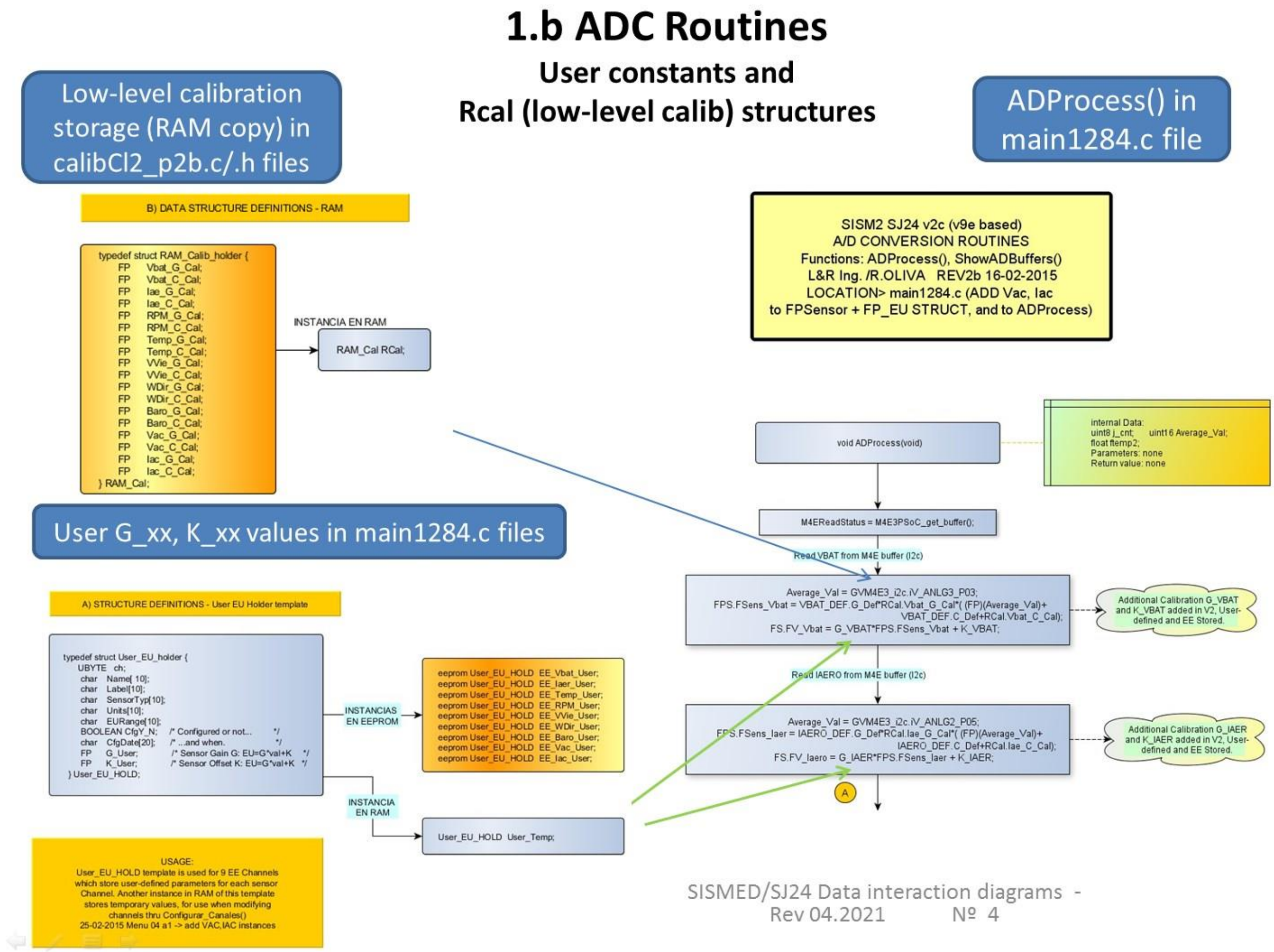


Figure AD.5 –User constants and RCal Structures for ADProcess() routine in firmware SJ24

In the case of ***b) Internal sources,*** values a read from the internal ADC, and copied from the global adc_data[] data structure, which is periodically updated by the ADC conversion function (ISR or timer-triggered). This can be seen in Figure AD.6, where the EU values for FS.FV_RPM, FS.FV_IAC and FS.FV_IAC are computed with an identical scheme as the one shown in Figure AD.2. A special case is the value of FS.FV_Power, which is computed as the product of the EU values of battery bank voltage and the current injected by the wind turbine.

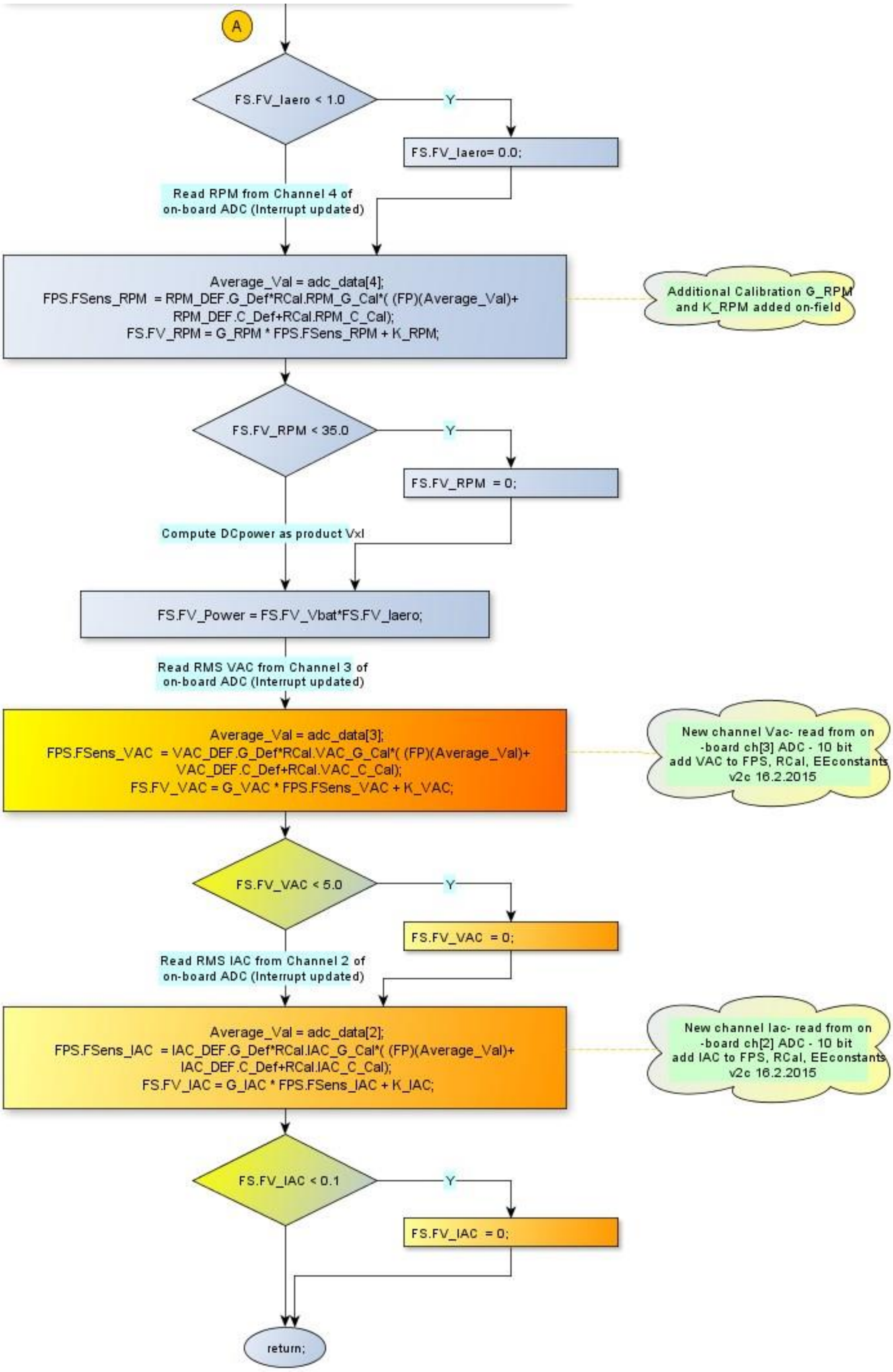


Figura AD.6 – Second part of the ADProcess() routine in firmware SJ24

3.1.3- The Show_ADBuffers() function: This function selects the values to be shown on the display (or thru the terminal) from those obtained by ADProcess(), according to a selected value in variable N_ADC_ch which can be altered by the user from the panel keyboard. The function details are shown in Figure AD.7, where in the lower part the FS, FPS sample structures (also in Figure AD.3) are also present. The EU values are shown by default on the display, but pressing the RIGHT key the "sensor input" values (for example in the range of 0-5V) can be seen on display during 10 seconds.

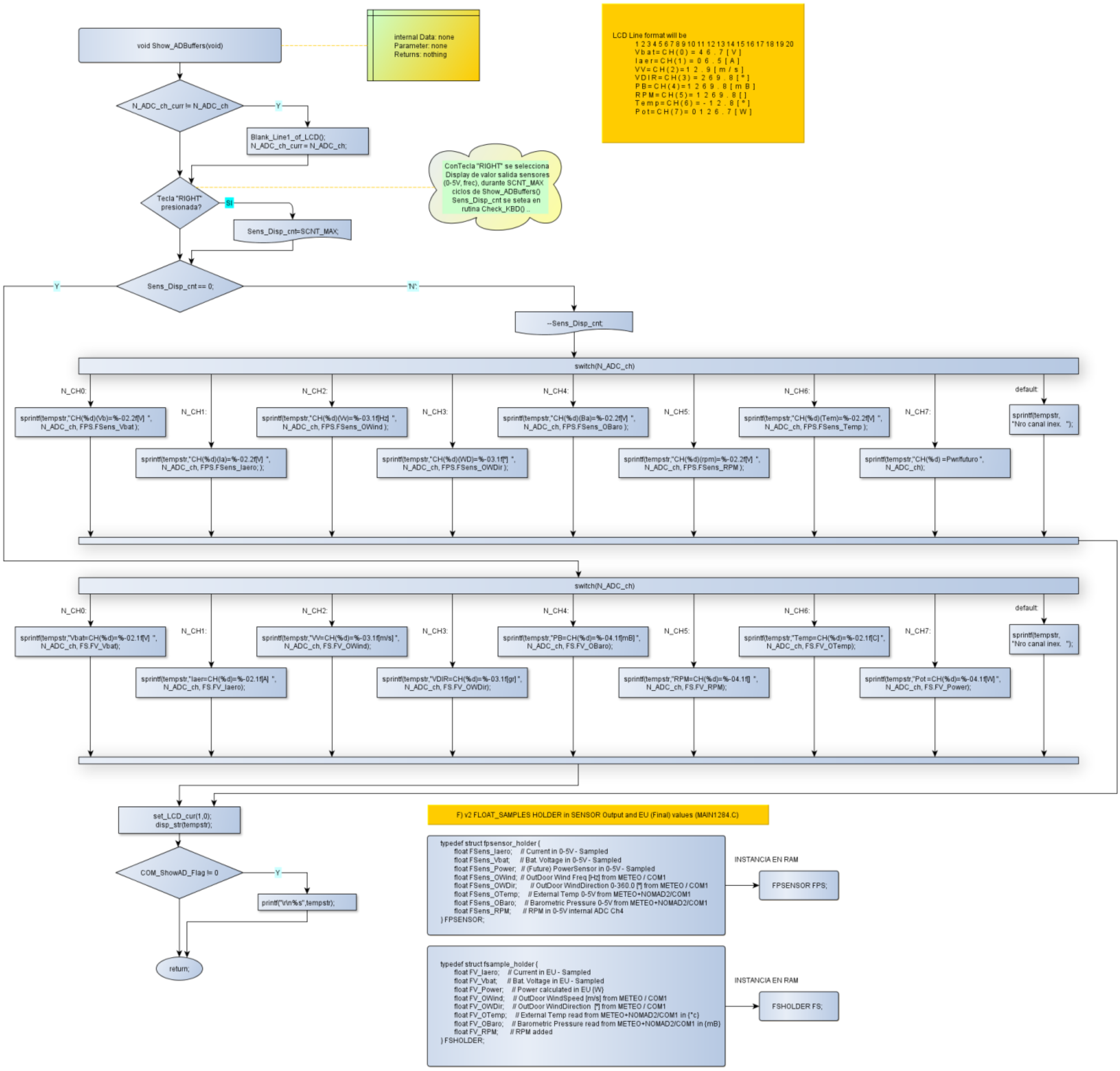


Figure AD.7 – Show_ADBuffers() selects what values from ADProcess() are shown on display.

3.2 – LOW-LEVEL CALIBRATION (INTI-Rept 01-16):

3.2.1- Context:

Previous versions of the PWRC2 firmware required simultaneous calibration of the sensor module and PWRC2 input conditioning. Newer (>v9e) firmware versions require a low-level calibration to be performed as in Figure CL.1, and then separately calibrate the sensors or input the manufacturer-provided constants.

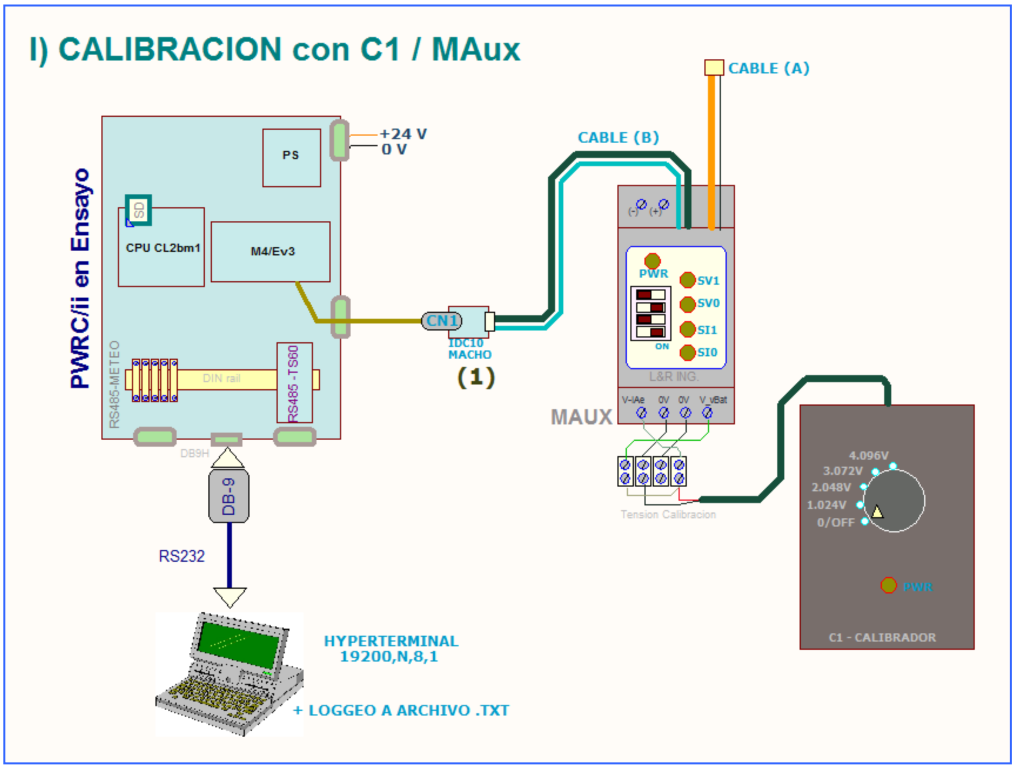


Figura CL.1 – Low level PWRC2 calibration using auxiliary MA module and C1 Calibrator

On Figure CL.2 the low level calibration functions in the global firmware diagram are shown.

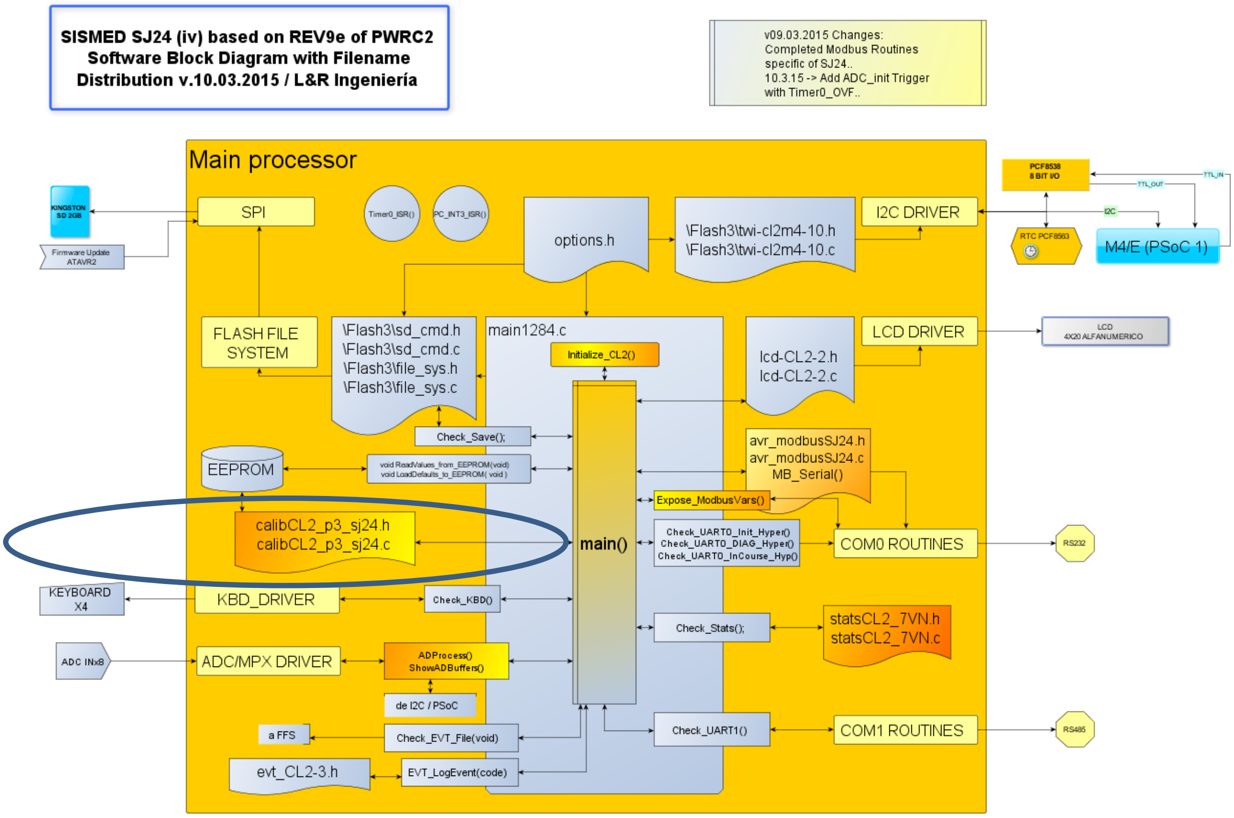


Figura CL.2 – Low level calibration functions on the SJ24 firmware

3.2.2- Routine layout for low-level calibration:

In Figure CL.3 the first part of the calibration functions is shown. The function *CL2B_Calibrate()* is the main menu where the selected channel is chosen for low-level calibration. This function highlights the addition of two channels developed in 2015, I_AC and V_AC, but lacks the newer I_FV to read the power from Photovoltaic subsystem added in later versions. The distribution is similar.

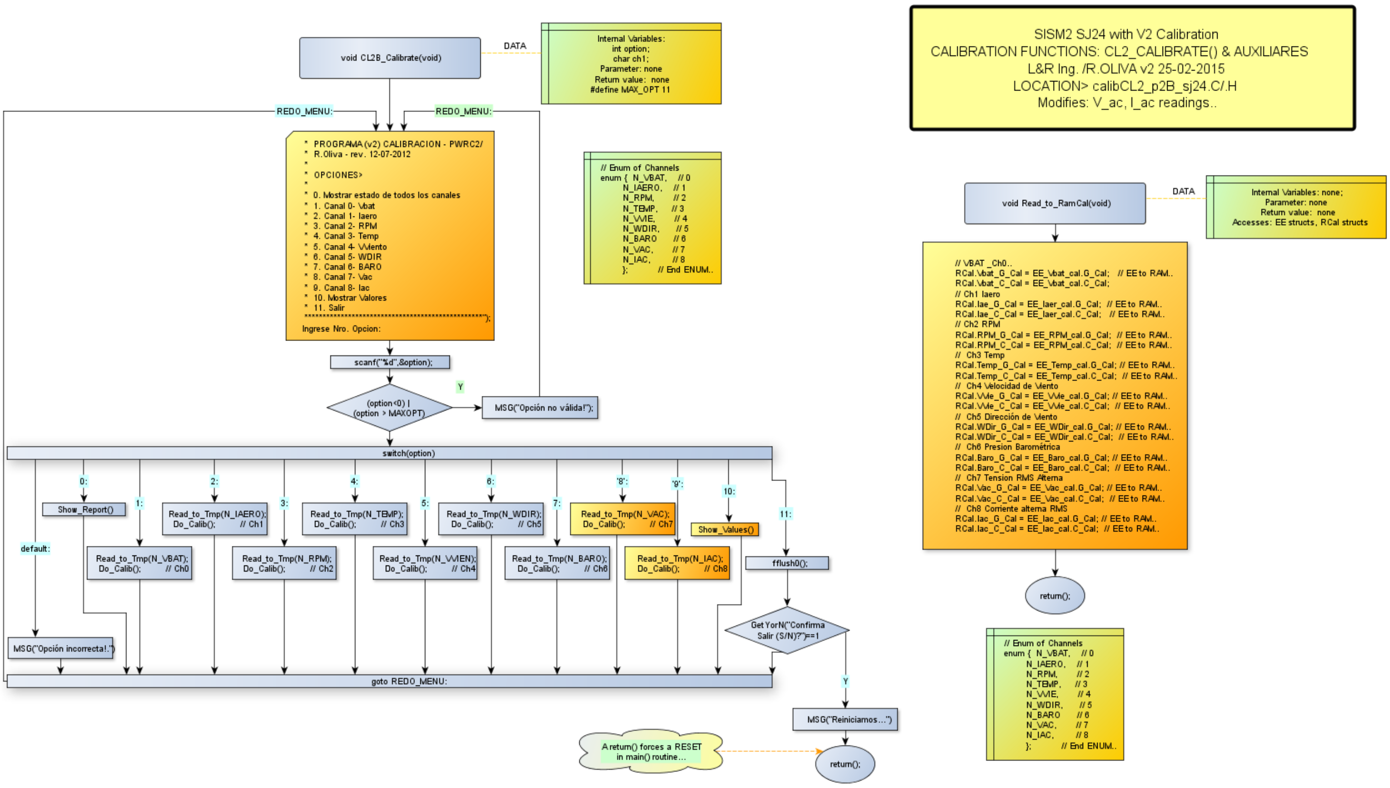


Figure CL.3 – CL2B_Calibrate() function, main menu selection for the low-level calibration sequence.

(Cont)Básicamente, documenta la acción de la función CL2_Calibrate() que es la de mas alto nivel, y utiliza las otras subrutinas documentadas en la hoja (y en HOJA CL.2 , en revisión) para ejecutar la acción de seleccionar un canal para calibrar, copiar la información actual de calibración (si es que se realizó antes) y proceder a la calibración de dos puntos (Ref 1) a efectos de linealizar la medición y obtener los coeficientes de la recta de ajuste, utilizando un instrumento de referencia de baja incertidumbre.

3.2.3- Contenidos de diagrama HOJA CL.2: La HOJA CL.2 documenta la acción de la función Do_Calib() que es la que realiza las acciones de solicitud de ambos valores de referencia, y procede a la calibración por el método de dos puntos (Ref 1) a efectos de linealizar la medición y obtener los coeficientes de la recta de ajuste, utilizando un instrumento de referencia de baja incertidumbre.

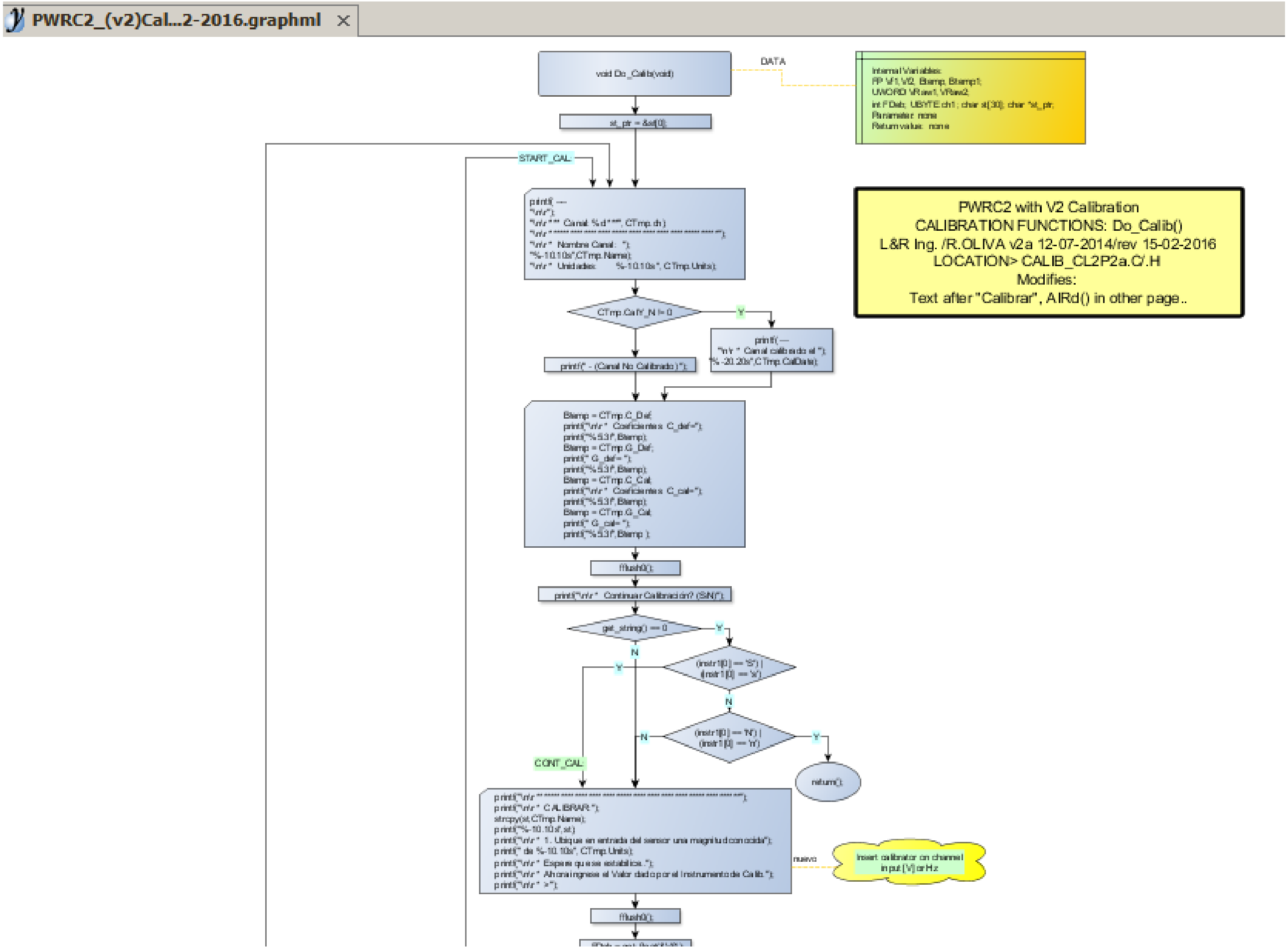


Figura CL.5 – Detalle de HOJA2 de funciones de calibración dentro del firmware PWRC2 v9e (ver PDF adjunto)

3.2.3 Contenidos de diagrama DATA_STRUCTURE: Dicho diagrama documenta gráficamente las dependencias y contenidos de las estructuras de calibración utilizadas por las rutinas de HOJA CL.1 y HOJA CL.2. Una parte de dichas estructuras se muestra en la Figura CL.6. Al igual que el caso de HOJA CL.2, el diagrama completo se incluye como adjunto de este informe en formato PDF, listo para ser impreso en una hoja tamaño A3 para poder observar adecuadamente el detalle.

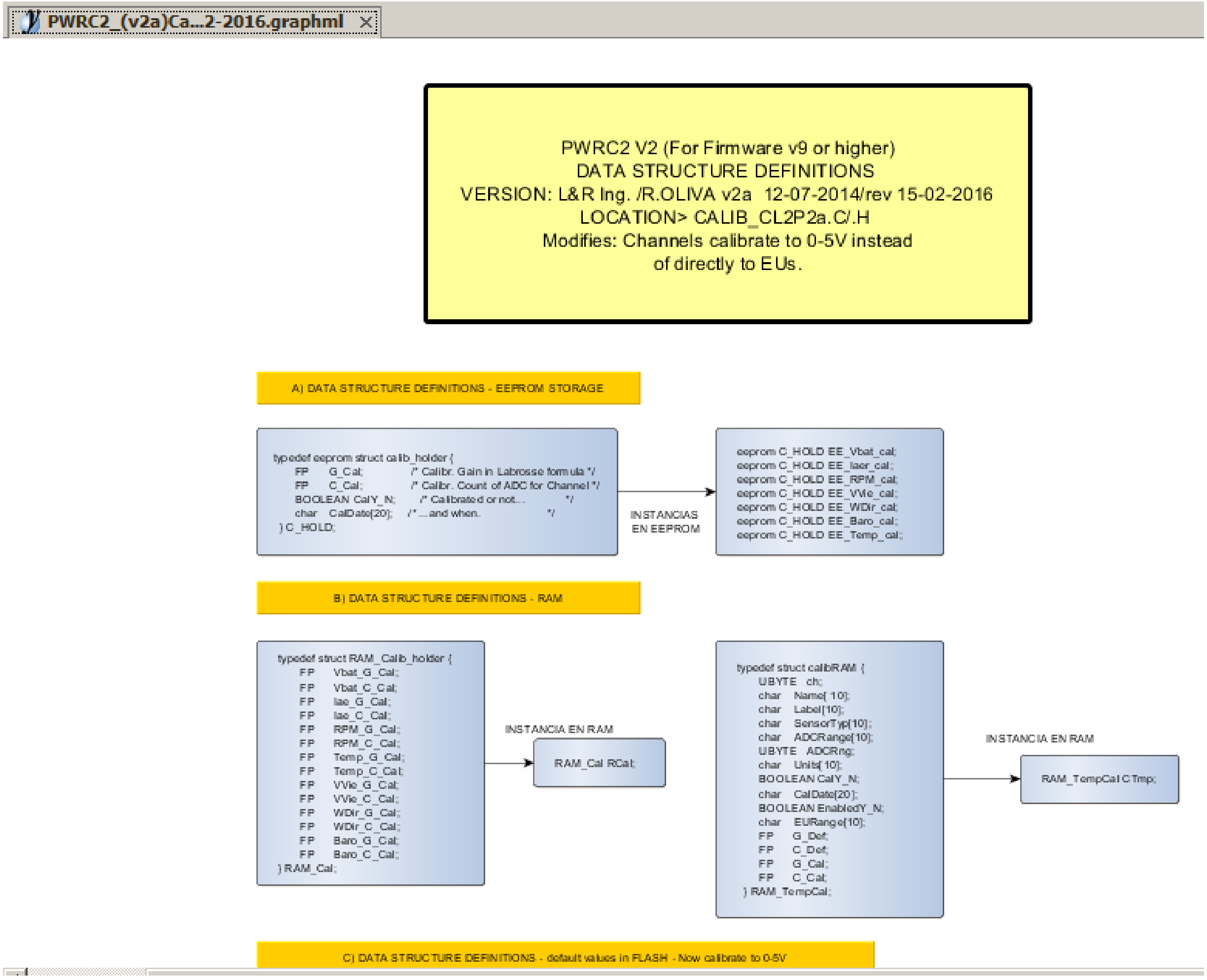
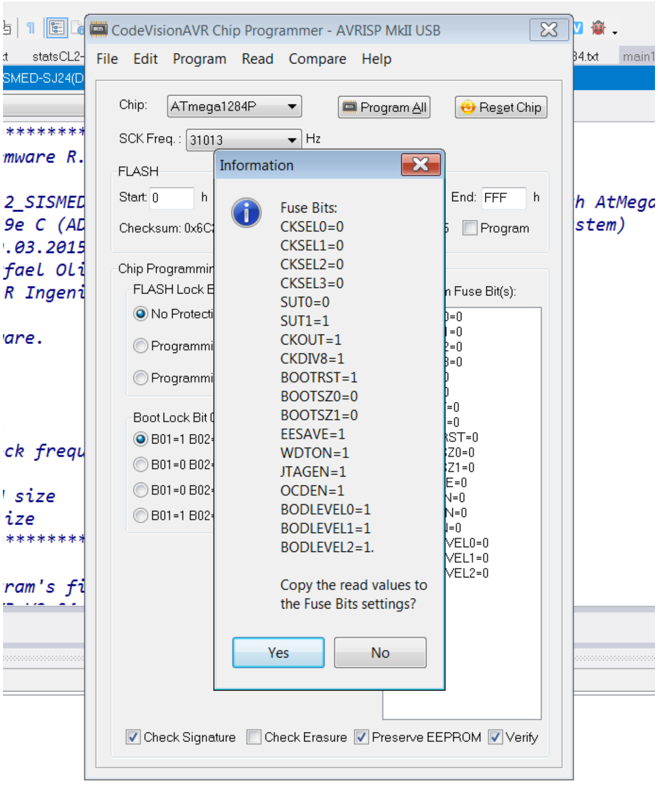
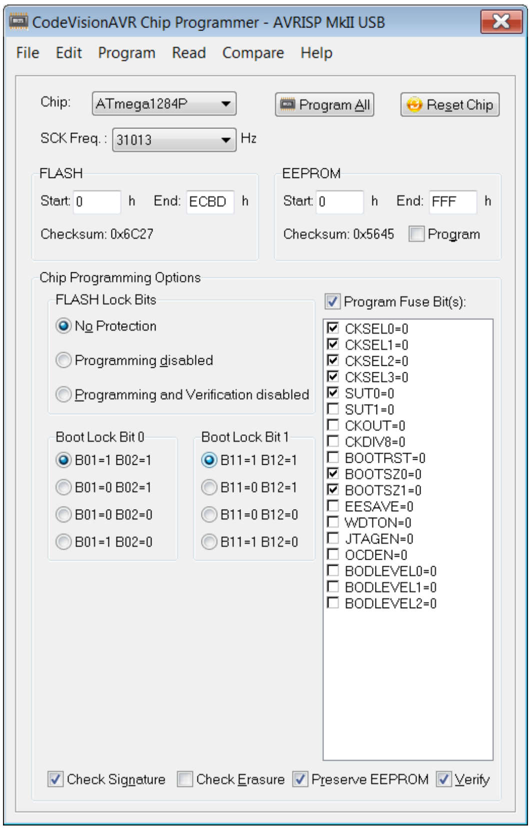


Figura CL.6 – Detalle de DATA_STRUCTURE para calibración dentro del firmware PWRC2 v9e (ver PDF adjunto)

APPENDIX – BOOTLOADER / Started 6.3.21

Bootloader OK on SISMED-SJ24 CL2 board





Bootloader programmed with Arduino IDE… OK 7.3.21 – Requires .hex generated by CVAVR en SISMED SJ24, tested with older version. →ok ✅ 08-03-21 - See document in. C:\Work_SJ\2021\SISMED_SJ24\SISMED_SJ24_070321\BurnBootloader_onSISMED_SJ24(7-3-21).docx