Eval Kit Manual

AS3701B

Standard Board

AS3701B-WL-ES_EK_ST

Table of Contents

1 Introduction

This document describes the AS3701 Evaluation Kit.

The AS3701 is a small compact PMU for small size and low power applications.

AS3701 features one 500mA DCDC buck converter operating from 1MHz up to 4MHz, two 200mA LDOs, two 40mA current sinks and offers additional GPIO functions. Further, the device contains an integrated linear battery charger with constant current and constant voltage operation. The wide charging current range going from 11mA up to 500mA and the integrated battery temperature monitoring with selectable NTC beta values make this device suitable for a great variety of applications.

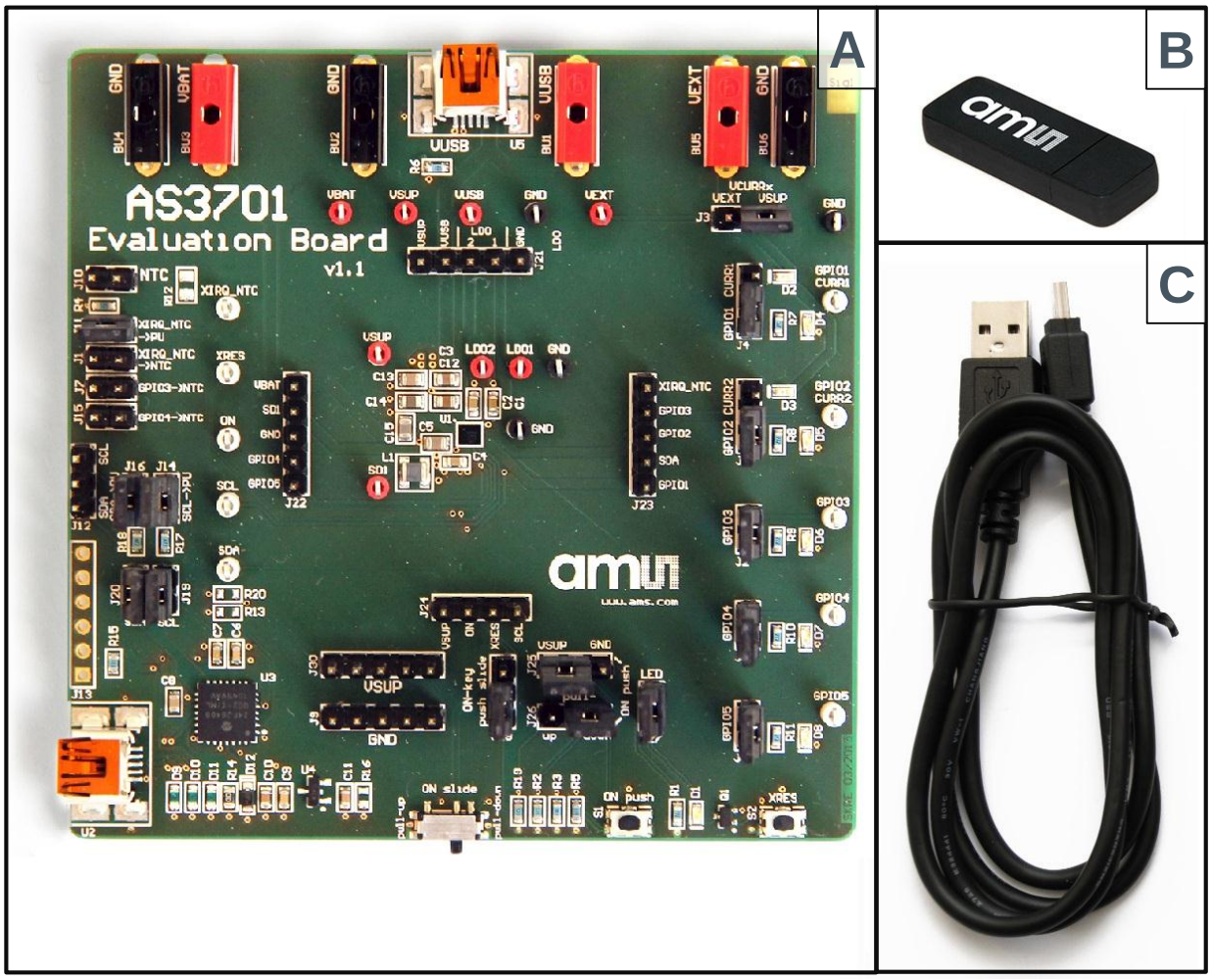
The single supply voltage may vary from 2.7V to 5.5V and all functionalities of AS3701 can be controlled via the I2C interface.

The Evaluation Kit has to be externally supplied. The graphical user interface (GUI) runs on PC running Windows 7 and allows the user to control the AS3701. Use the enclosed USB cable to connect the PC with the Evaluation board.

1.1 Kit Content

The AS3701 Evaluation Kit includes all items listed in **Figure 1: Kit Content**.

Figure 1: Kit Content



Label	Item	Comment
A	Evaluation Board	AS3701B Micro-PMIC
B	USB flash drive	Includes Eval Kit Manual and Software
C	USB connection cable	-

2 Getting Started

Drive the AS3701 Eval Kit only with the recommended settings and values as described in the datasheet. (Please check www.ams.com for the latest version.)

For a detailed description of the Kit please read carefully sections 3-5 of this document.

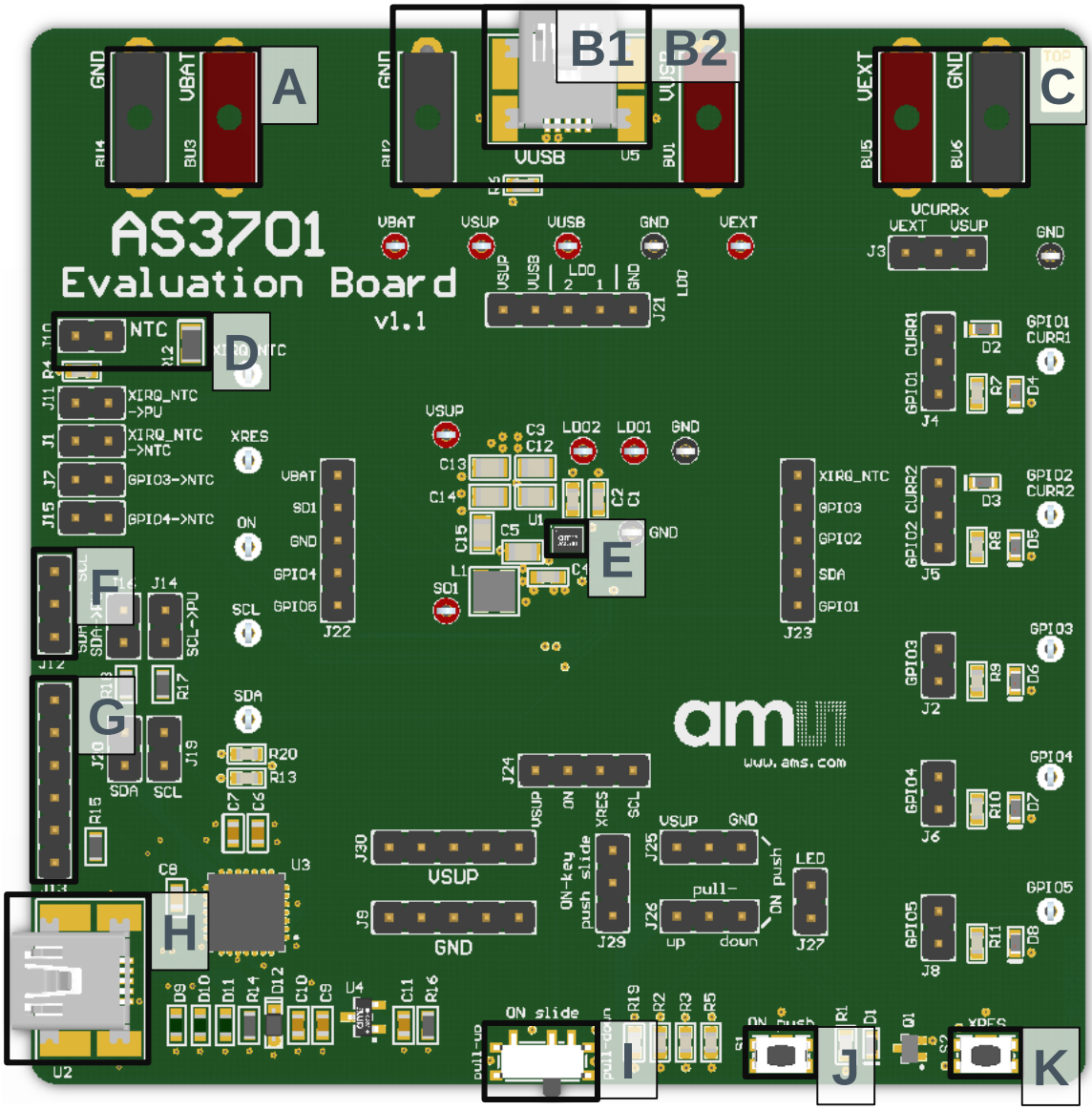
- Check all Jumpers for the default setting (factory-set) shown in **Figure 1: Kit Content**
- Install the GUI (GUI can be found on the included USB flash drive)
- Establish the connection between PC and Evaluation board via the enclosed USB cable (connector “U2”)
- Supply the Board via the charger input either through VUSB (USB Mini “U5”) or VUSB (“BU1”) and GND or through a Li-Ion battery connected to VBAT (“BU3”) and GND
- Start the GUI
- If prompted **perform a firmware upgrade** on the Evaluation board in order to ensure a proper communication to the GUI! The appropriate firmware file for the Evaluation board comes with the GUI software and can be found in the GUI installation directory
  Never disconnect the supply or interrupt the connection to the PC during the update!
- If the AS3701 Evaluation Board is supplied and connected properly to the PC and the appropriate firmware file is installed, both fields at the right bottom corner of the GUI turn green.

3 Hardware Description

The AS3701 Evaluation Board can be powered via battery, external power supply, or USB.

With the integrated linear charger Li-Ion batteries can be charged.

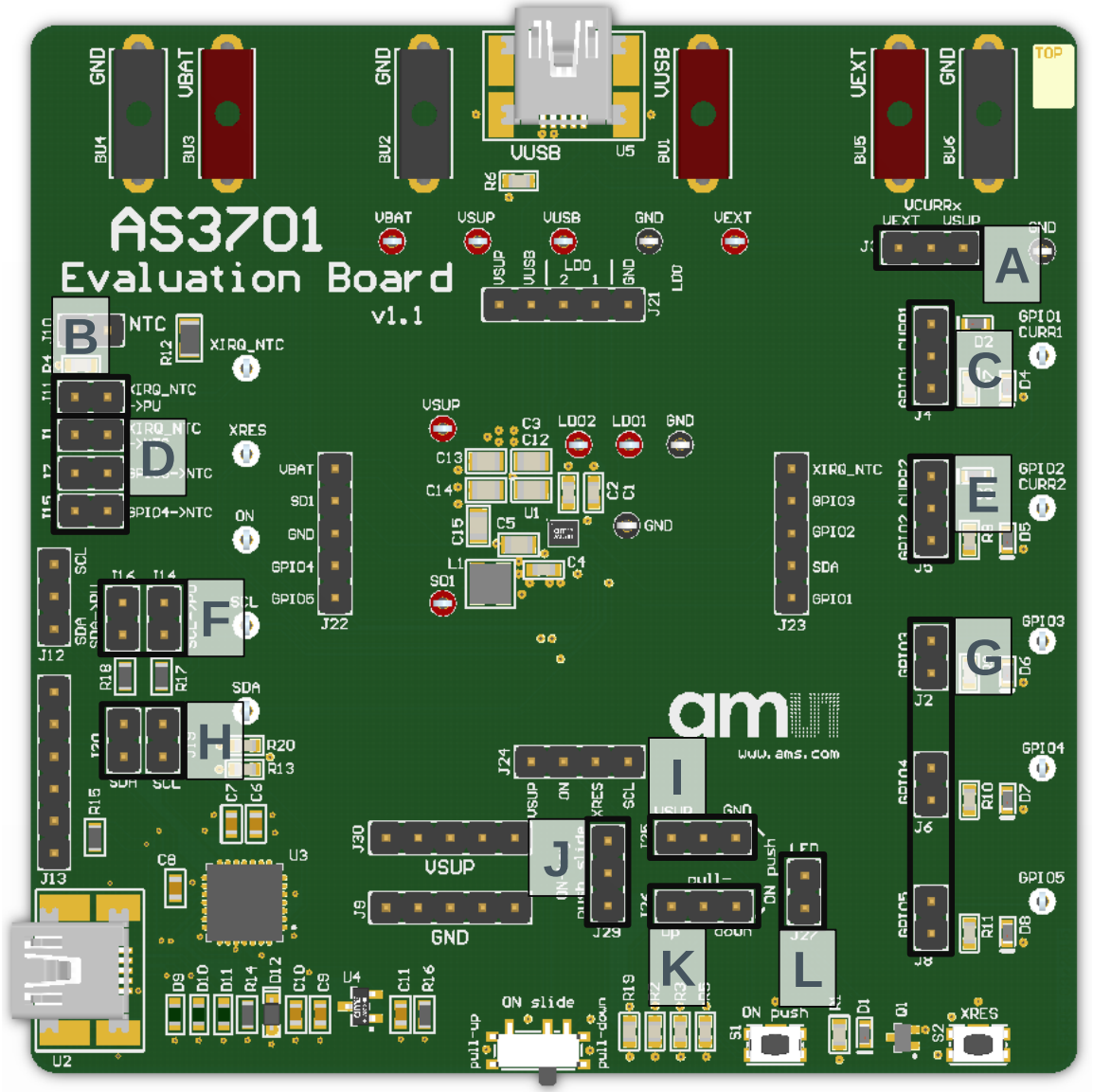
Figure 2: Evaluation Board Overview



Label	Name	Designator	Description	Info
A	VBAT,GND	BU3, BU4	VBAT	Li-Ion battery connector
B1	VUSB	U5	USB Mini	Charger adapter input
B2	VUSB, GND	BU1, BU2	VUSB	Charger adapter input
C	VEXT, GND	BU5, BU6	VEXT	External supply for current sinks

Label	Name	Designator	Description	Info
D	NTC	J10, R12	NTC resistor	Connector for external NTC resistor “J12” + parallel restistor “R12”
E	AS3701	U1	PMIC	AS3701B Micro-PMIC (20-ball WL-CSP)
F	J12	J12	I2C connector	-
G	J13	J13	Programming interface	-
H	U2	U2	USB Mini	Interface between board and PC
I	ON slide	S3	ON slide	ON-key switch
J	ON push	S1	ON push	ON-key push button
K	XRES	S2	XRES	Reset button

Figure 3: Jumper locations



Label	Name	Designator	Description	Info
A	VCURRx	J3	Supply for sinks	Selection of current sinks supply (via ext. supply or via VSUP)
B	XIRQ_NTC→PU	J11	XIRQ pull-up	Place jumper to connect pullup R4 to XIRQ_NTC pin
C	GPIO1 CURR1	J4	GPIO1 CURR1	Place jumper to connect GPIO1 to an indication LED CURR1: GPIO1 connected to D2 (current sink mode) GPIO1: GPIO1 connected to D4 via R7 (GPIO mode)

Label	Name	Designator	Description	Info
D	XIRQ_NTC→NTC, GPIO3→NTC, GPIO4→NTC,	J1, J7, J15	Input pin for NTC resistor	Place jumper to connect NTC resistor (J10, R12) to – XIRQ_NTC (J1) J11 must be removed! – GPIO3 (J7) – GPIO4 (J15)
E	GPIO2 CURR2	J5	GPIO2 CURR2	Place jumper to connect GPIO2 to an indication LED  CURR2: GPIO2 connected to D3 (current sink mode)  GPIO2: GPIO2 connected to D5 via R8 (GPIO mode)
F	SCL→PU SDA→PU	J14, J16	I2C Pull-up resistors to VSUP	Place Jumpers to connect I2C Pull-up resistors to VSUP SCL→PU (J14) SDA→PU (J16)
G	GPIO3, GPIO4, GPIO5	J2, J6, J8	GPIO3, GPIO4, GPIO5	Place jumper to connect GPIOx to LED for indication
H	SCL, SDA	J19, J20	I2C connection between µC and AS3701	Place Jumper to connect I2C Interface of onboard uC to AS3701
I	J25	J25	ON push to VSUP/GND	Place jumper to connect S1 either to VSUP or to GND – non-inverted: ON push→VSUP – inverted: ON push→GND
J	J29	J29	ON-key push/slide	Configure ON-key as push button or as switch (slider)  slider  push button
K	J26	J26	ON push to pull- up/down	Place jumper to connect ON pin either to pull-up (R19) or to pulldown (R2) – non-inverted: ON push→pull-down – inverted: ON push→pull-up
L	LED	J27	Status LED	Place jumper to enable the status LED

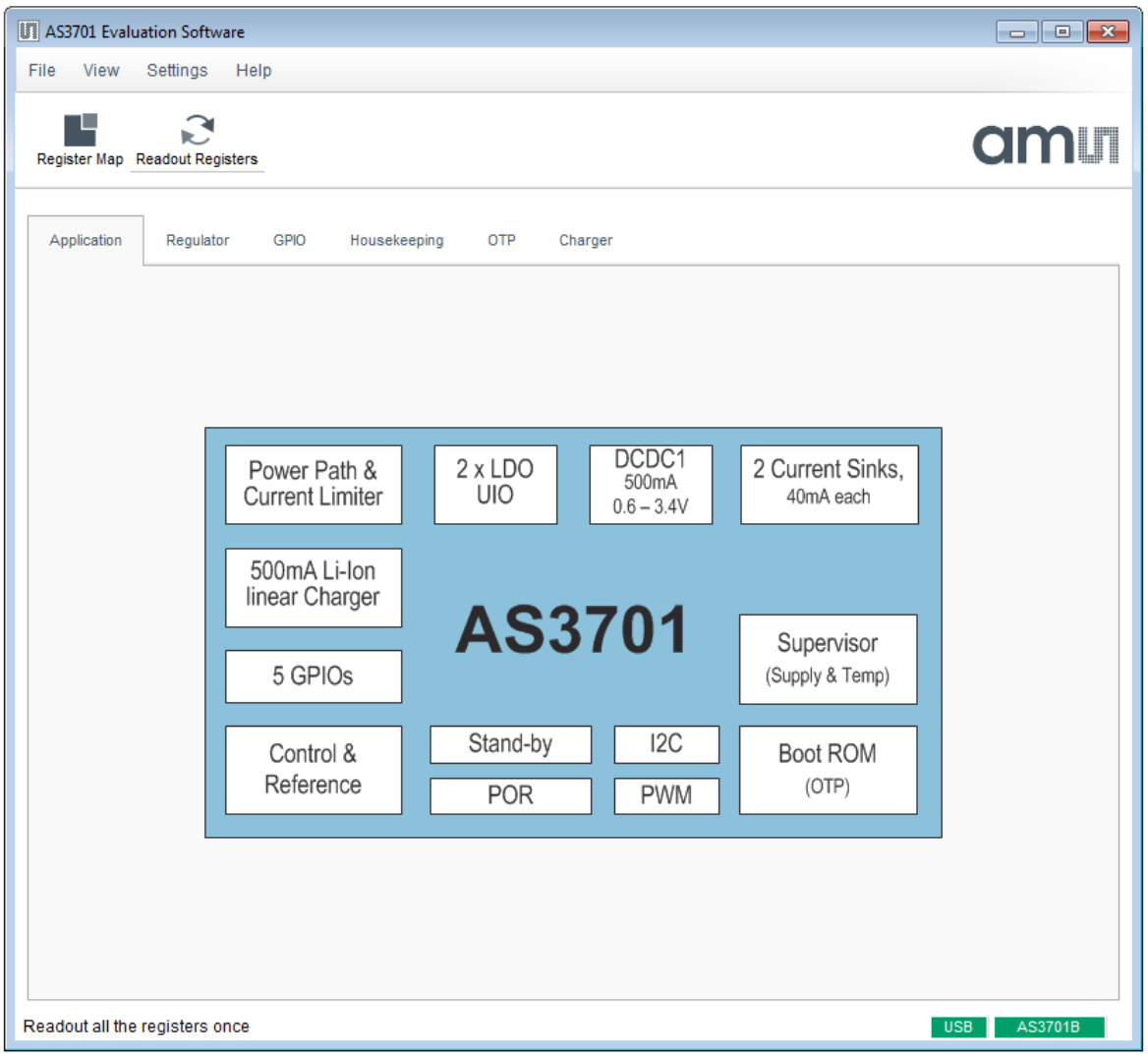
4 Software Description

The graphical user interface (GUI) is used to control the AS3701 Evaluation board.

Start the GUI and make sure that the Hardware settings are according to chapter 2, **Getting Started**.

Check if hardware is recognized and indicators in the bottom right corner of the GUI are green colored.

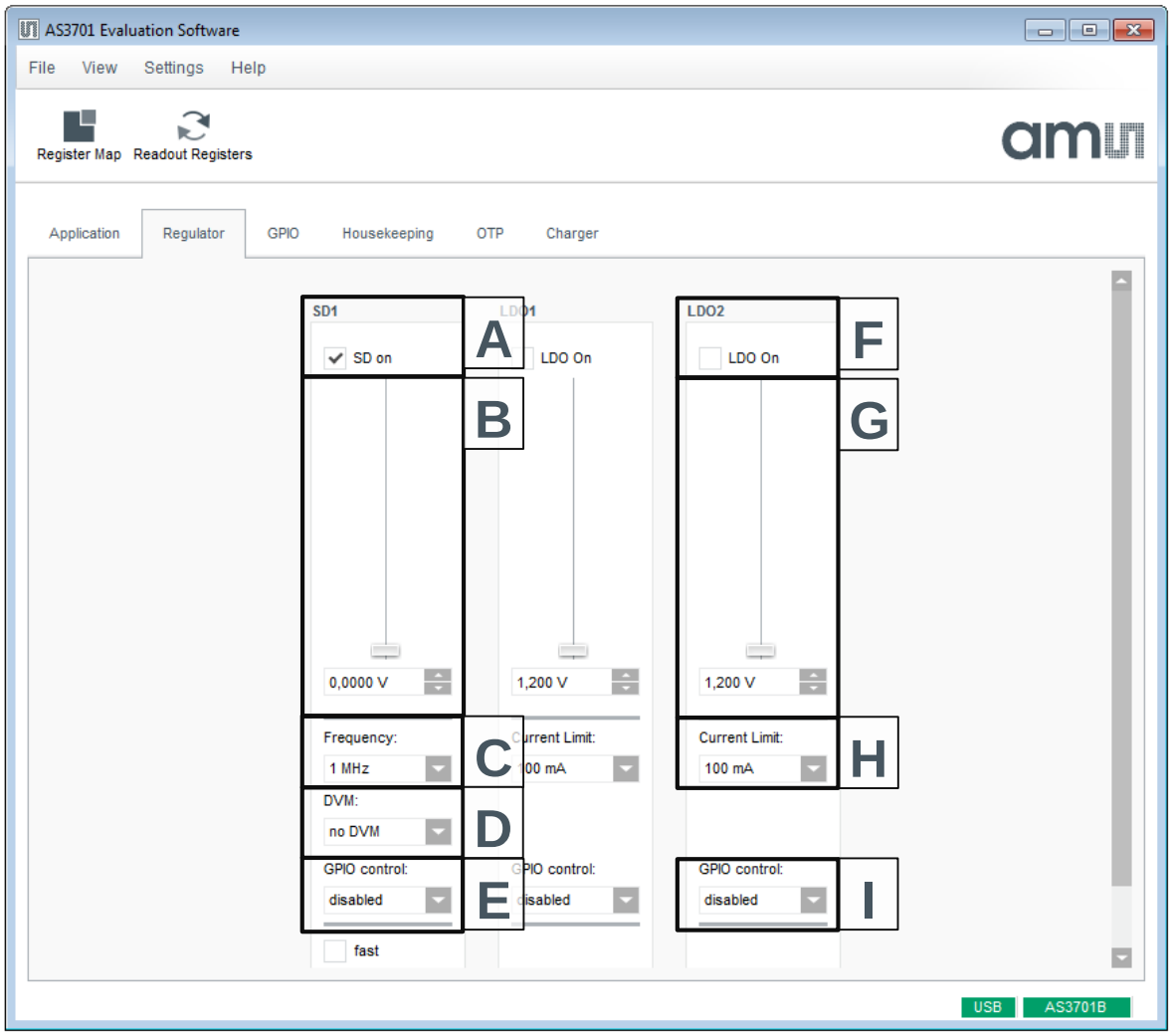
Figure 4: AS3701 Evaluation Software



4.1 LDO, DCDC

The AS3701 features 2 LDO's and 1 DCDC Step-down converter

Figure 5: Regulator tab



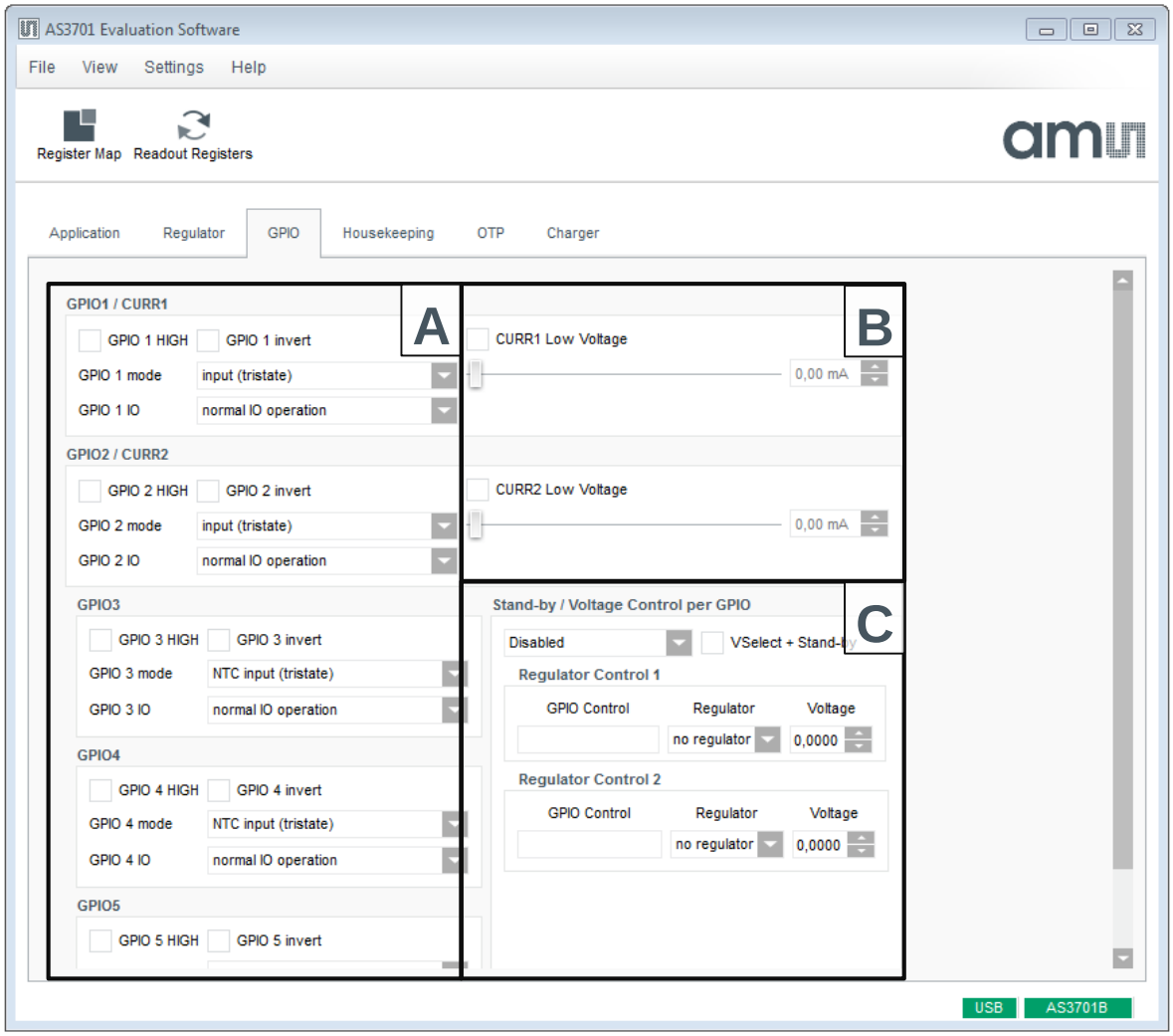
Label	Name	Comment
A	SD on	Enabling / Disabling of DCDC
B	Vout Regulator	Output voltage setting
C	Frequency/	Select switching frequency
D	DVM Control	With DVM the output voltage will ramp up/down with a selectable slope after the new value was written to the registers
E	GPIO Control	GPIO controlling of DCDC
F	LDO on	Enabling / Disabling of LDO
G	Vout Regulator	Output voltage setting
H	Current Limit	Current Limit setting

Label	Name	Comment
I	GPIO Control	GPIO controlling of LDO

4.2 GPIO

The AS3701A features 2 GPIOs and AS3701B features 5 GPIOs

Figure 6: GPIO tab



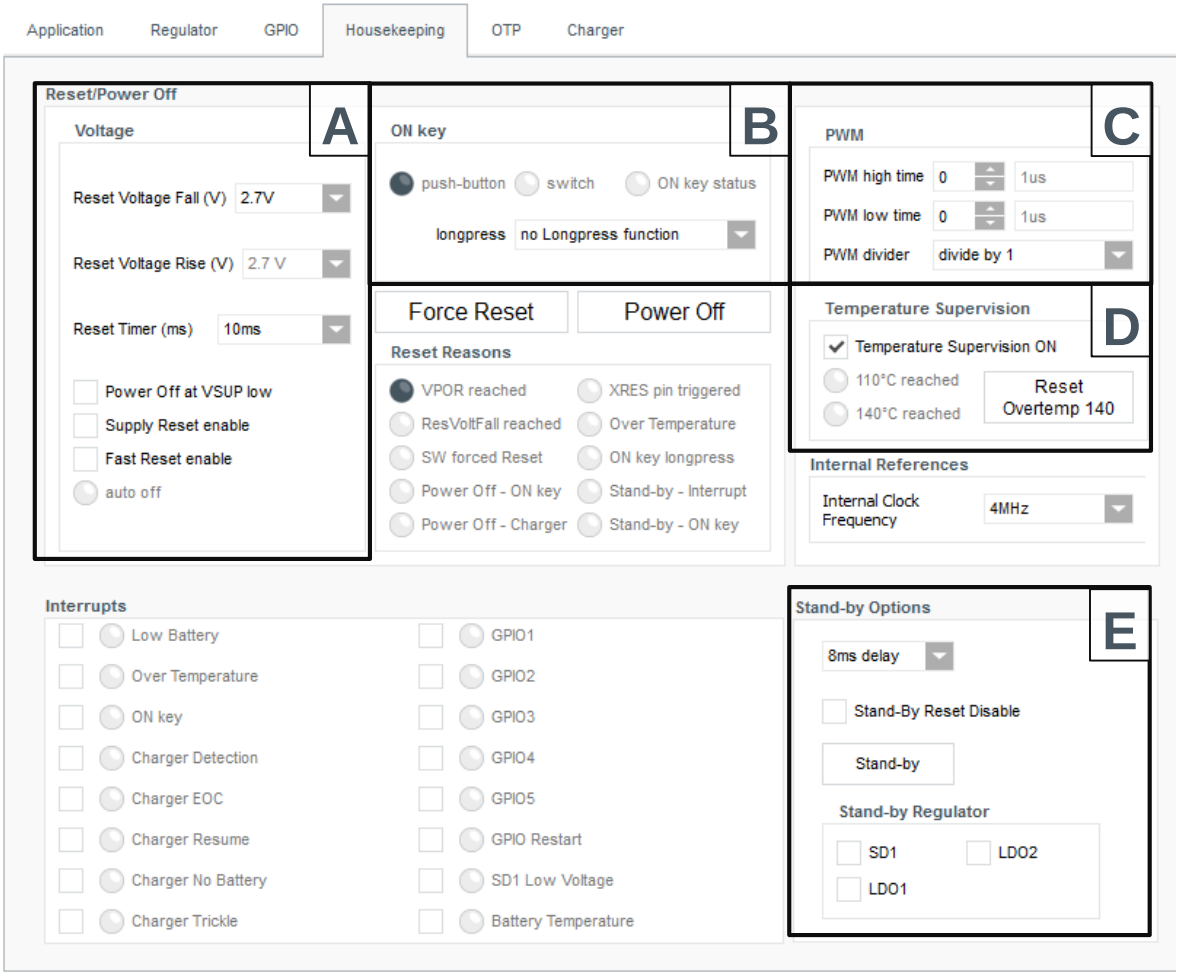
Label	Name	Comment
A	GPIO1,2,3,4,5	– "GPIO x HIGH": Determines the output signal on GPIOx pin when selected as output source – "GPIO x HIGH": Indicates the logic level on GPIOx pin when configured as digital input pin – "GPIO x invert": Setting of GPIOx to normal or inverted – "GPIO x mode": Selects the GPIOx mode – "GPIO x IO": Selects the GPIOx special function
B	CURR1,2 (GPIO1,2)	– "CURRx Low Voltage": Bit is set when voltage of current sink drops below low voltage threshold (1ms debounce time default) – CURRx slider: Defines the current into CURRx

Label	Name	Comment
C	Stand-by / Voltage Control per GPIO	– Assign any GPIOx for both “Regulator Control x” slots GPIO1 and GPIO2 may be used to control two regulator separately – “Vselect+Stand-by”: Additionally to the Vselect function the defined GPIOx (GPIO Control) can be used to enter Stand-by mode For further details please refer to the AS3701 datasheet

4.3 Housekeeping

In this section the Reset/Power Off behavior, ON-key configuration, PWM setting, Temperature Supervision, Stand-by options and Interrupts can be defined.

Figure 7: Housekeeping tab



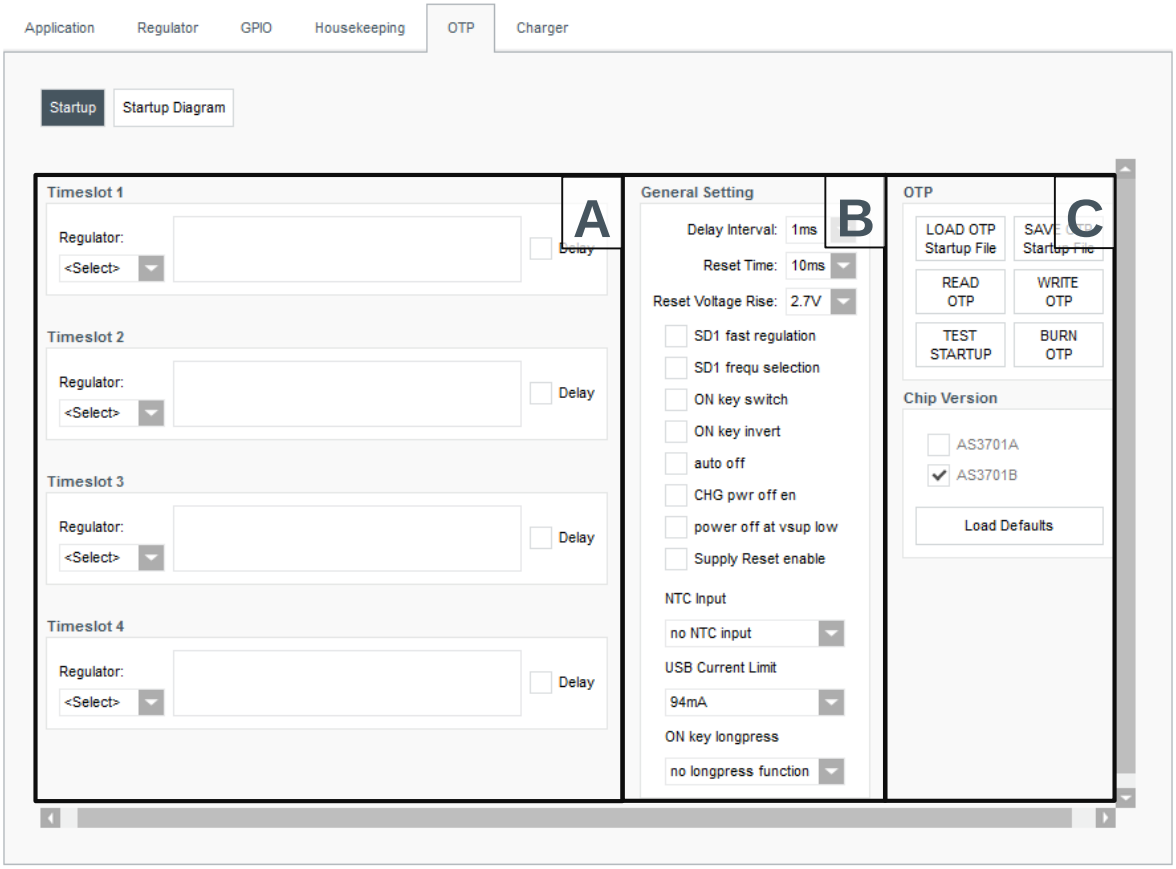
Label	Name	Comment
A	Reset / Power Off	– "Reset Voltage Fall": Selection of the reset level for falling VSUP – "Reset Timer": Set Reset Time, after the last regulator has started – "Power off at VSUP low": Enter power off mode if low VSUP is detected (Pin ON=low and bit auto_off=0) **0**: If low VSUP is detected, VSUP is continuously monitored and chip startup initiated if VSUP is above ResVoltRise **1**: If low VSUP is detected, enter power off mode *Note: low VSUP level depends on setting for "Supply Reset enable"* – "Supply Reset enable" **0**: A reset is generated if VSUP < 2.7V **1**: A reset is generated if VSUP < ResVoltFall

Label	Name	Comment
		– "Fast reset enable" **0**: Vresetfall debounce time = 3msec **1**: Vresetfall debounce time = 64usec – "auto off": Indicator for "auto off" bit (setting in OTP)
B	ON key	– Indicator for ON key mode, push-button or switch (setting in OTP) – Indicator of ON key status – "longpress" function Select the ON key longpress behavior (power off, reset) Select the ON key longpress delay time (4s, 8s)
C	PWM	– "PWM high time": Defines the high time of the PMW generator – "PWM low time": Defines the low time of the PMW generator – "PMW divider": Defines the divider ratio of the prescaler for the PWM generator *Note: For GPIO1 and GPIO2, the PWM output signal can be visualized via the Current sinks*
D	Temperature Supervision	– Switch ON/OFF temperature supervision (default ON) All other bits (in reg. 37h) are only valid if temperature supervision is 1! Leave at 1, do not disable – Indicator that 110°C threshold has been reached – Indicator that 140°C threshold has been reached By reaching 140°C a reset cycle is started - this flag is not reset by an over temperature caused reset and has to be reset by "Reset Overtemp 140" button (optionally reset by writing 1 and afterwards 0 to rst_ov_temp_140 in addr:37h)
E	Stand-by Options	– off-delay: Set Delay between I²C command, GPIO or Reset signal for power_off, standby mode or reset and execution of that command – "Stand-By Reset Disable" **0**: Normal mode, reset is active in standby mode **1**: No reset in standby mode and during exit of standby mode – "Stand-by" button: Enter Stand-by mode – "Stand-by Regulator": Define which regulators should be enabled during Stand-by mode

4.4 OTP

This section defines the startup sequence and enables programing of OTP.

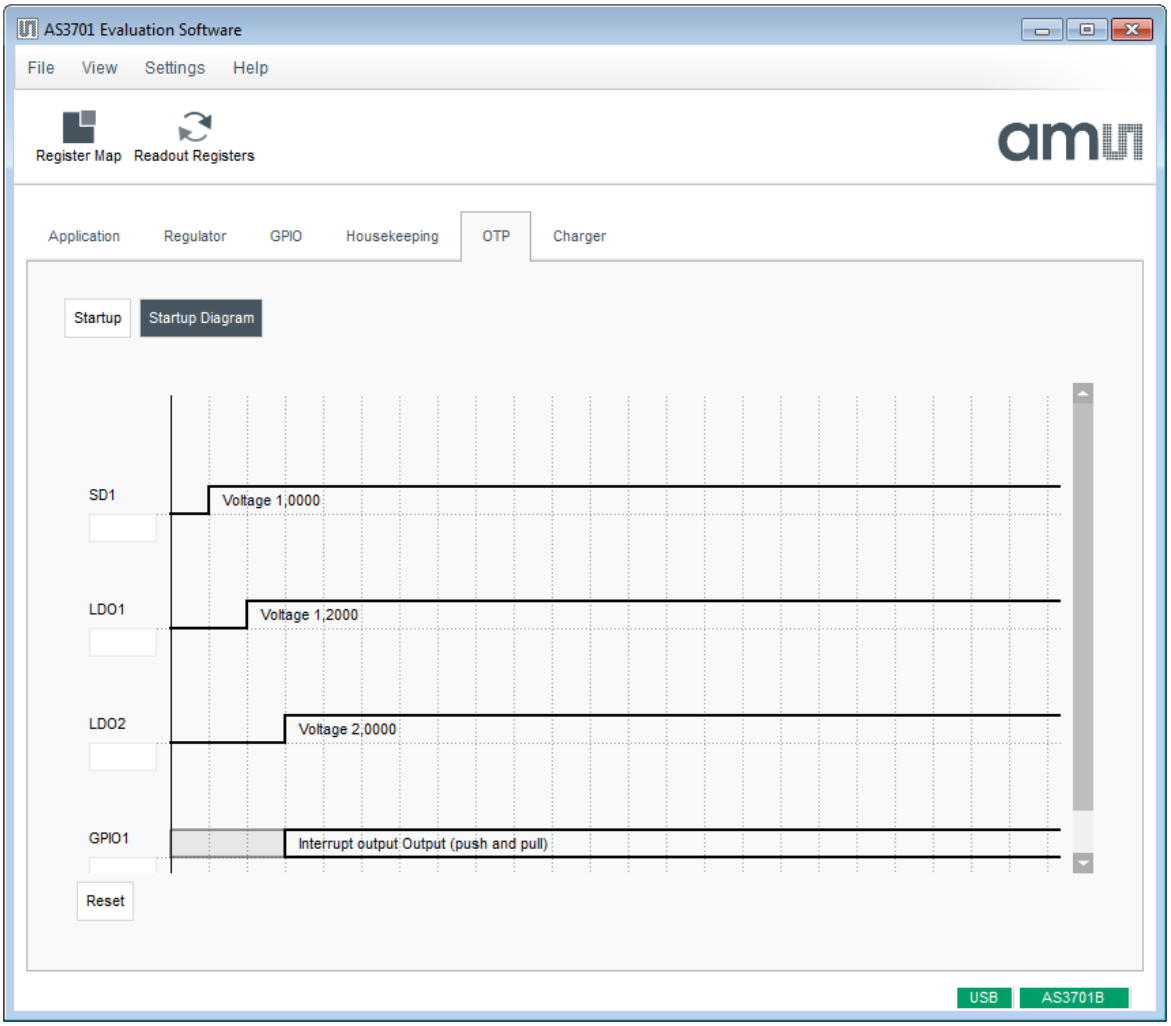
Figure 8: OTP tab - Startup



Label	Name	Comment
A	Timeslots	– 4 Timeslots (Startup sequentially beginning with Timeslot 1), to every single timeslot a delay can be added – For each timeslot one of the available regulators or available GPIOs can be defined – LDO settings: voltage and current limit – DCDC settings: voltage and frequency (“sd1_frequ”) Select between low (1/2 MHz) and high (3/4 MHz) frequency **0**: 1 MHz if sd1_fsel=0, 2MHz if sd1_fsel=1 **1**: 3 MHz if sd1_fsel=0, 4MHz if sd1_fsel=1 – GPIO settings: normal or inverted, GPIO mode and GPIO IO special function (GPIOx_iosf)
B	General Settings	– “Delay Interval”: Selection of 1ms or 4ms delay which can be enabled for each timeslot – “Reset Time”: Set Reset Time, after the last regulator has started

Label	Name	Comment
		– "Reset Voltage Rise": Selection of the reset level for rising VSUP It's recommended to set the ResVoltRise level 200mV above ResVoltFall level to have a hysteresis – "SD1 frequ selection": Select between low and high frequency range **0**: 1 MHz if sd1_frequ=0, 3MHz if sd1_frequ=1 **1**: 2 MHz if sd1_frequ=0, 4MHz if sd1_frequ=1 – "ON key switch": Selects the mode of ON input **0**: ON key works as push-button **1**: ON key works as switch (slider) The setting for ON key mode in the software must comply with the setting on the hardware! For the correct jumper setting of the ON key input please see section J in **Figure 3: Jumper locations** – "ON key invert": inverts the ON input **0**: ON input is active high (default) **1**: ON input is active low The setting for ON key invert in the software must comply with the setting on the hardware! For the correct jumper setting of the ON key input please see section I,K in **Figure 3: Jumper locations** In case ON key is configured as slider (hardware/software) no further settings are necessary – "auto off": Defines startup behavior at first battery insertion **0**: Startup of chip if VBAT>ResVoltRise **1**: Enter power OFF mode (Startup with ON key or charger insertion)
C	OTP	– Loading of existing OTP startup sequence – Saving OTP startup sequence as a .txt file – Reading the OTP registers of the chip – Writing into the OTP registers of the chip – Testing the startup from the OTP registers

Figure 9: OTP tab - Startup Diagram

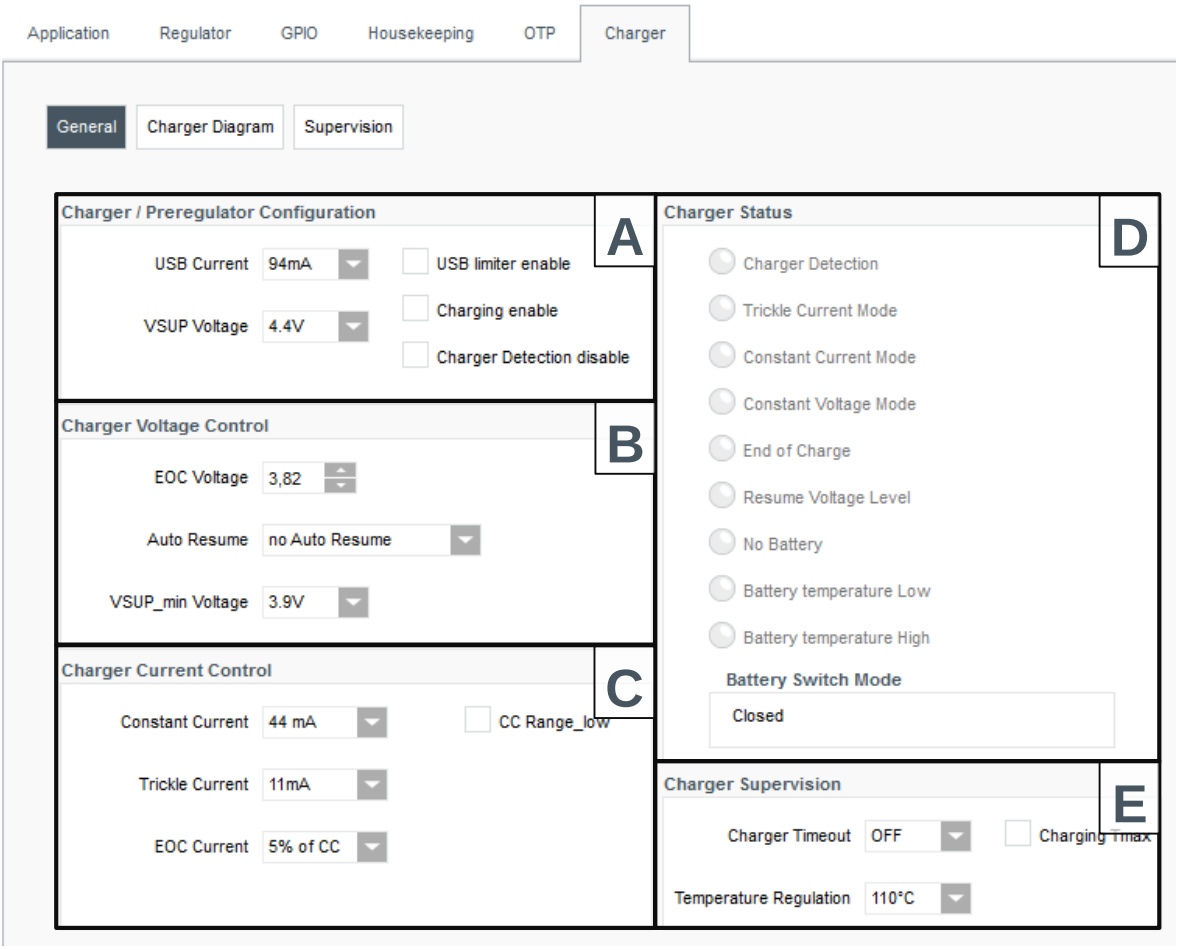


The OTP Startup Diagram shows the Startup Sequence defined in Timeslots 1 - 4, see section A in **Figure 8: OTP tab - Startup**

4.5 Charger

In this section the Charger settings can be defined.

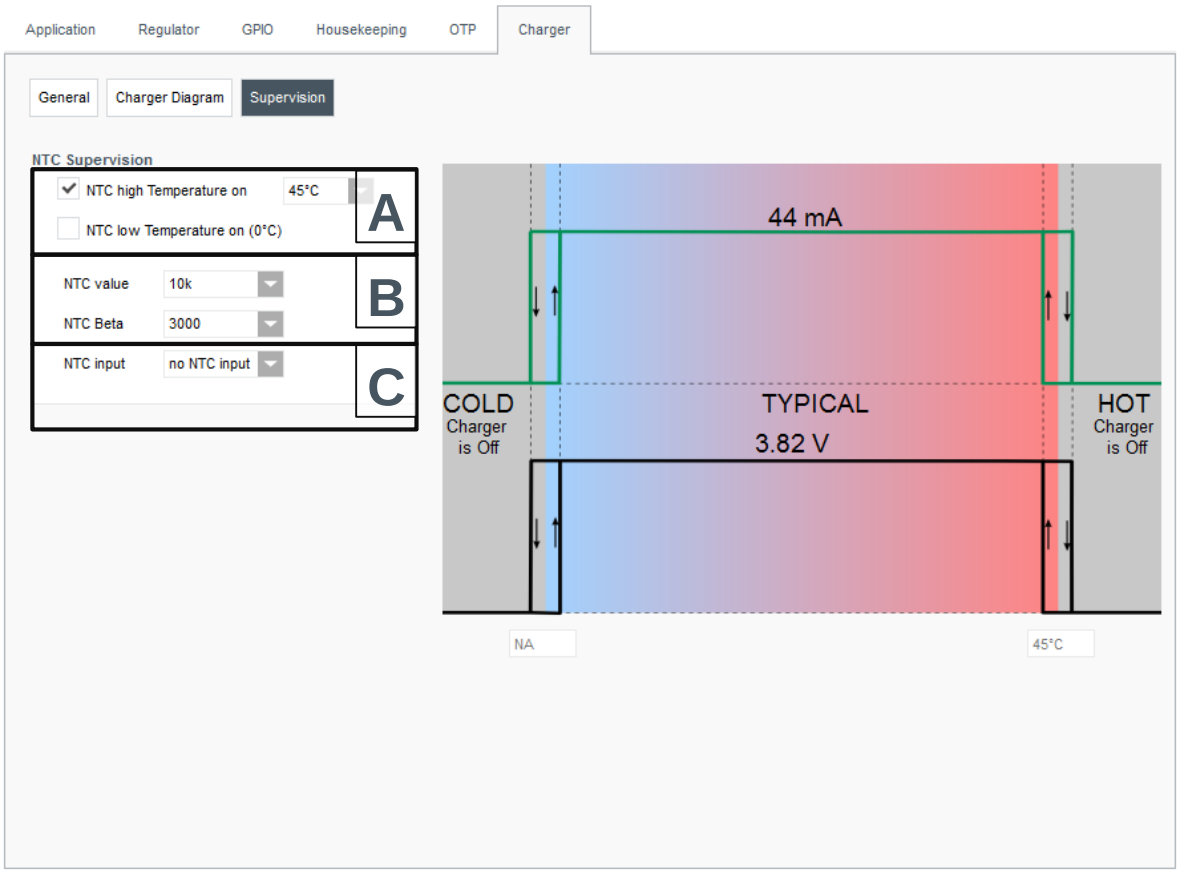
Figure 10: Charger tab - General



Label	Name	Comment
A	Charger / Preregulator Configuration	– "USB Current": USB input current limit – "VSUP Voltage": Voltage regulation of VSUP of the input current limiter – "USB limiter enable": ON/OFF control of USB charger input – "Charging enable": Enables charging, "USB limiter enable" must be set to ON – "Charger Detection disable": turn OFF charger detection circuit for power OFF state **0**: Charger detection is always enabled **1**: Charger detection is disabled in power-OFF state

Label	Name	Comment
B	Charger Voltage Control	– "EOC Voltage": End Of Charge voltage level By reaching EOC voltage, CVM (Constant Voltage Mode) will be initiated – "Auto Resume": Auto Resume level (3.33% or 5.56%) If battery voltage falls below the specified resume level the charging will start again – "VSUP_min Voltage": Regulates down the charging current on that level of VSUP, to prevent a drop on VSUP
C	Charger Current Control	– "Constant Current": charging current limit in constant current mode (44 – 493mA or trickle current range) – "Trickle Current": charging current limit in trickle current mode (11 – 130mA) – "EOC Current": Sets the EOC current (5 – 50% of Constant Current) – "CC Range_low": Defines the charging current range for constant current mode **0**: High current range **1**: Low current range (trickle current range)
D	Charger Status	– Charger Status bits
E	Charger Supervision	– "Charger Timeout": Charging timeout timer – "Temperature Regulation": Selects temperature regulation of charging current (die temp.) – "Charging Tmax": Write: reset charger timeout counter **0**: Read: no timeout reached **1**: Charging timeout reached and charging stopped

Figure 11: Charger tab - Supervision

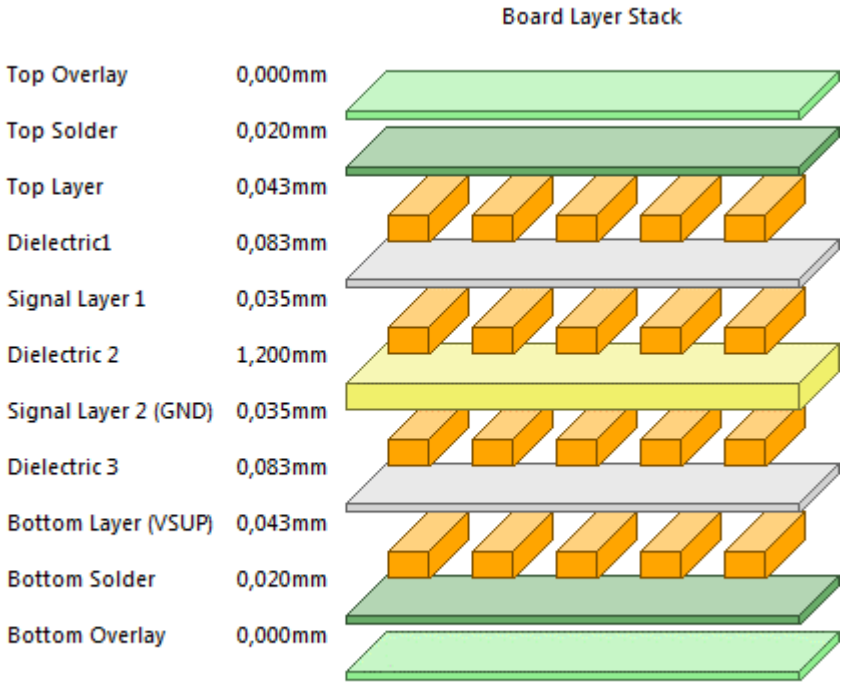


Label	Name	Comment
A	High/Low Temperature	– "NTC high Temperature on": Enable the checkbox to activate the high temperature supervision In case the temperature is higher than the set limit (45°C, 60°C) the charger will stop operation When the battery temperature falls below the high temperature threshold, the charger will start charging again – "NTC low Temperature on (0°C)": Enable the checkbox to activate the low temperature supervision In case the temperature is lower than 0°C the charger will stop operation When the battery temperature rises above the low temperature threshold, the charger will start charging again
B	NTC- Resistor and Beta value	– "NTC value": Set the NTC resistor value (10k, 100k) depending on the used NTC To keep the voltage drop over the whole temperature range inside of the comparator threshold voltage range, a 15k (150k) parallel resistor to the 10k (100k) NTC is needed For correct resistor connection, please see section D **in Figure 2: Evaluation Board Overview** – "NTC Beta": 4 different β-values depending on the used NTC can be set

Label	Name	Comment
C	NTC input	– Choose the input pin for the NTC resistor (XIRQ_NTC pin, GPIO3, GPIO4) The setting for NTC input in the software must comply with the setting on the hardware! For the correct jumper setting of the NTC input pin please see section D in **Figure 3: Jumper locations**

5 Schematics, Layers and BOM

The AS3701 Evaluation Board is a 4-layer FR4 board. The main components are the AS3701 together with some active components, passive components, several test points and connectors.



5.1 Schematics of AS3701 Evaluation Board

Figure 12: Schematic page 1

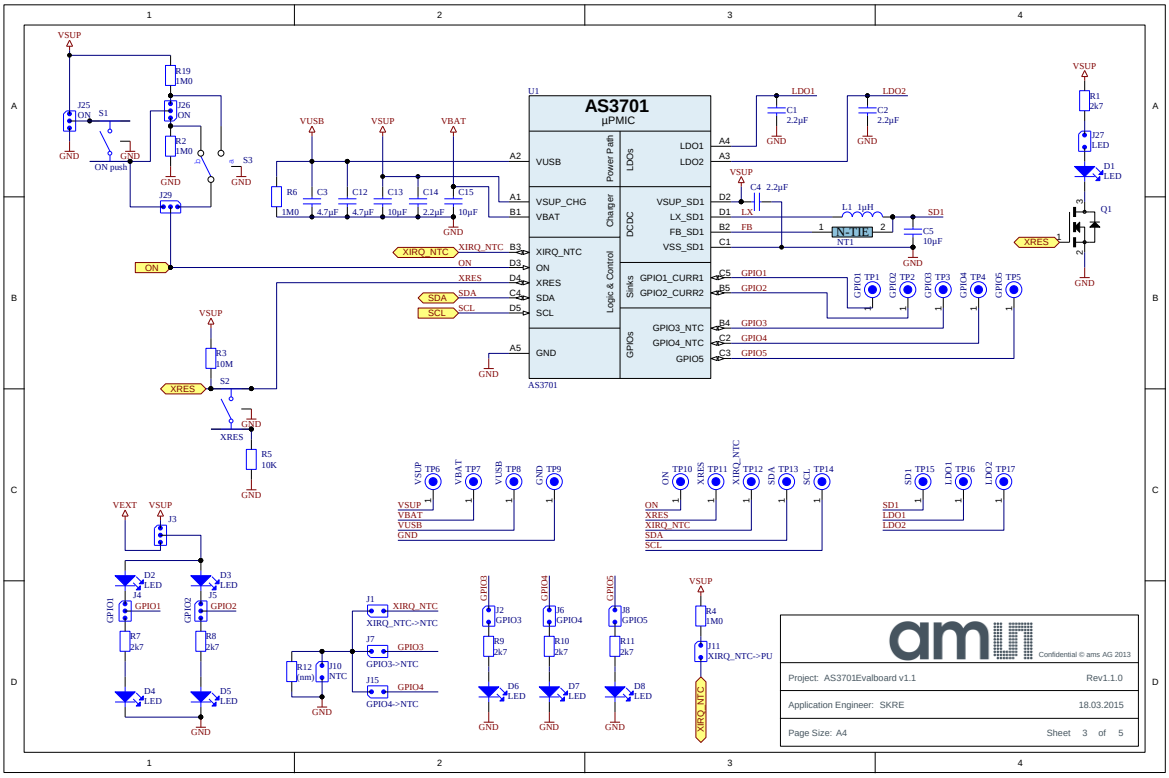


Figure 13: Schematic page 2

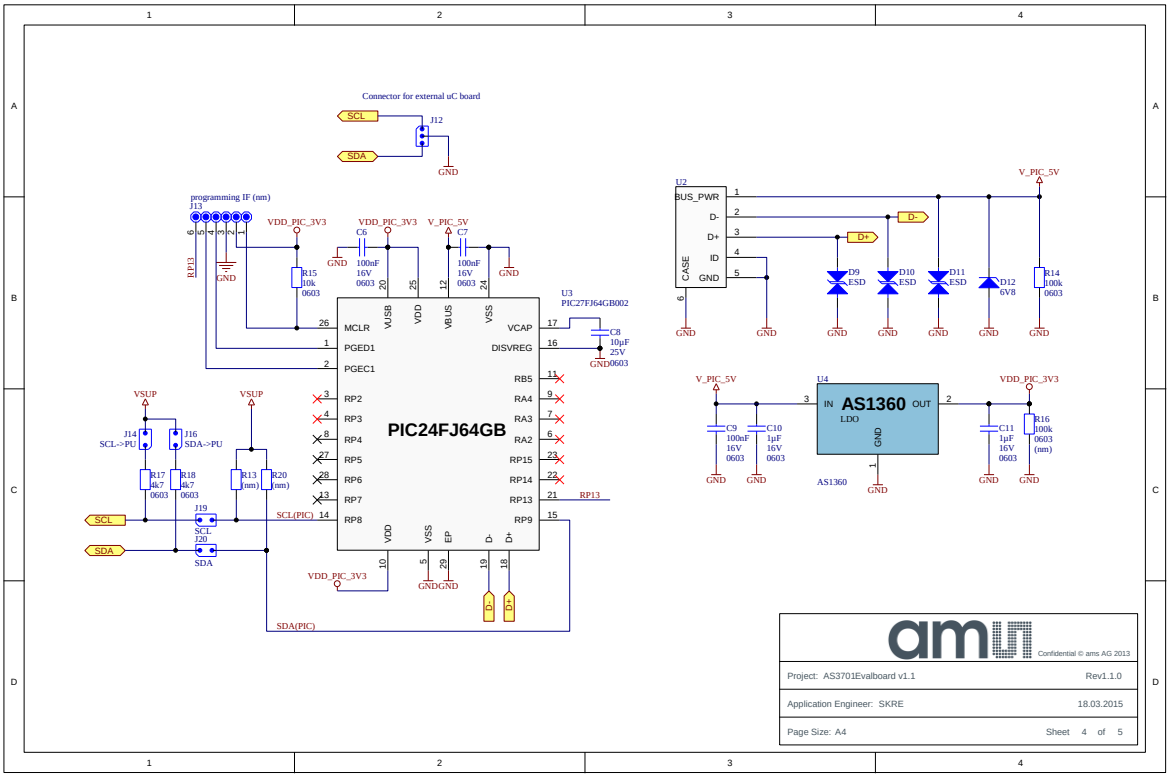
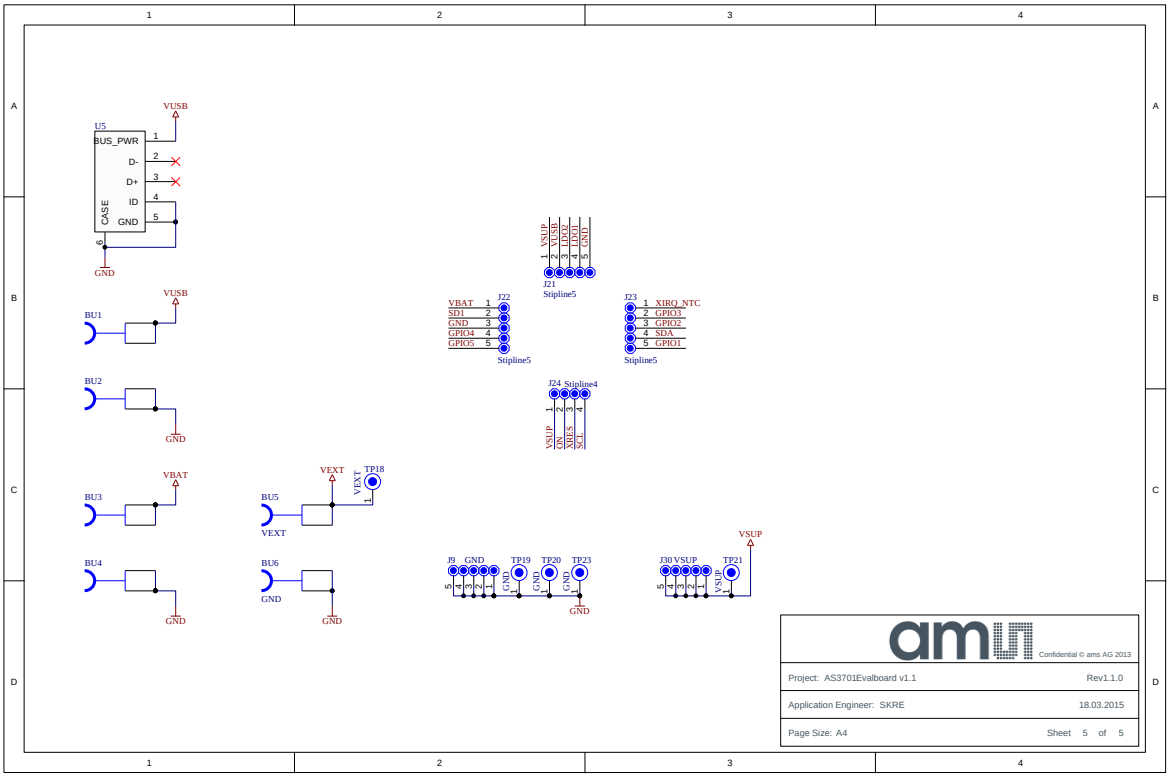


Figure 14: Schematic page 3



5.2 Board Layout of AS3701 Evaluation Board

Figure 15: Layer 1 (TOP)

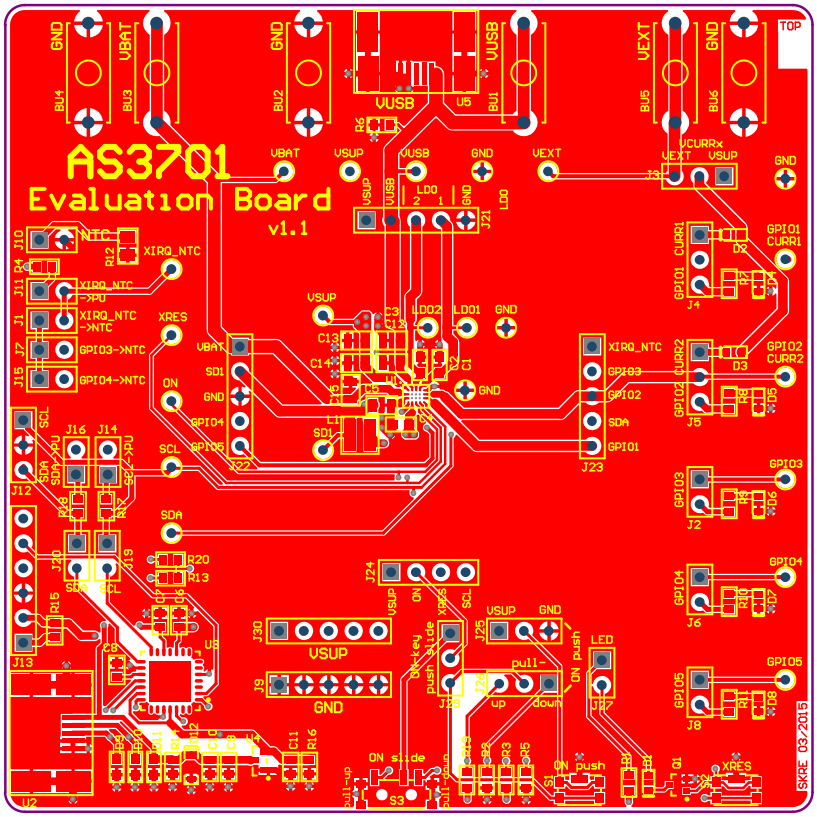


Figure 16: Layer 2 (Signal 1)

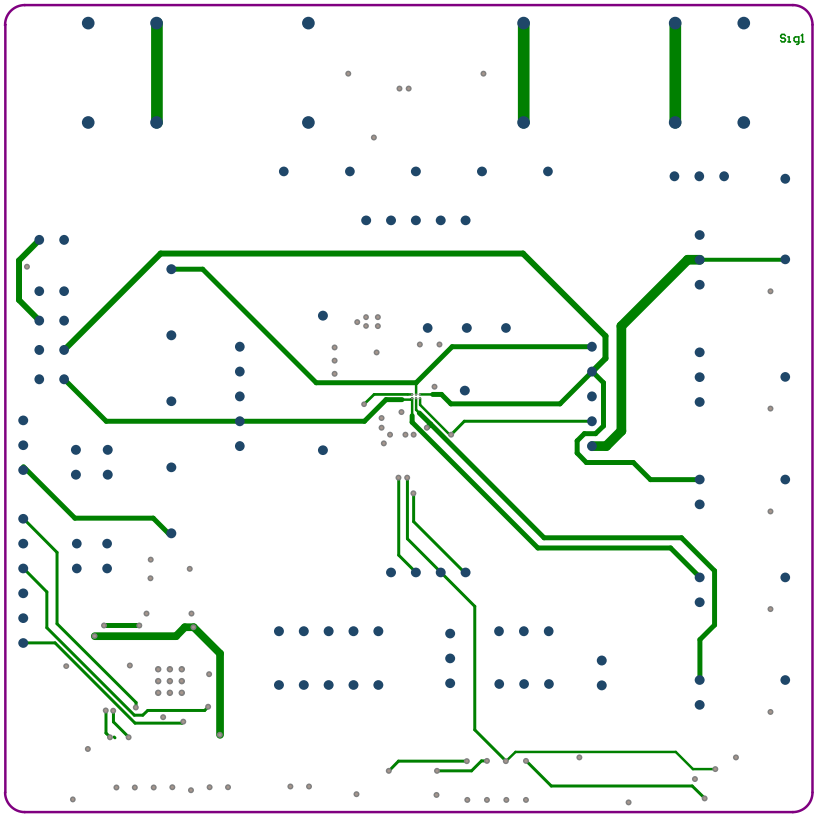


Figure 17: Layer 3 (Signal 2 - GND)

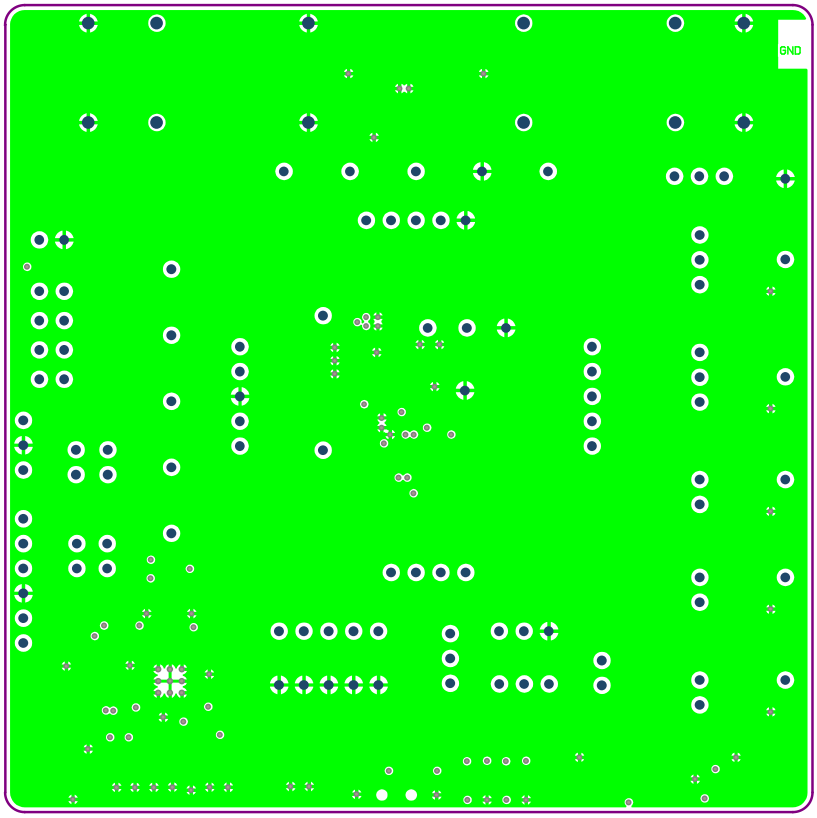
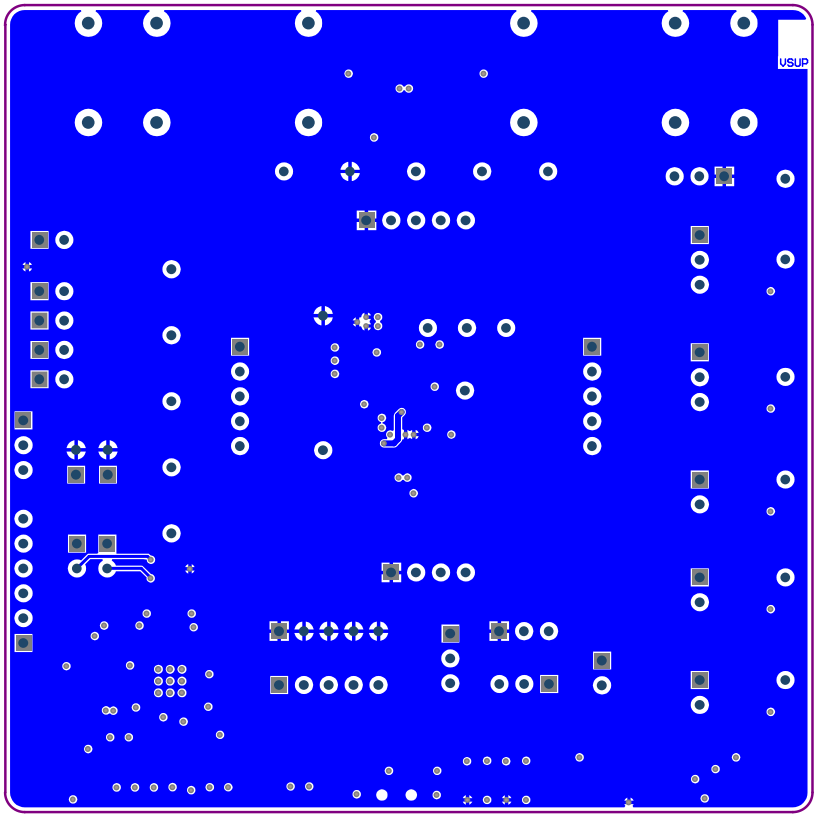


Figure 18: Layer 4 (BOT - VSUP)



5.3 BOM

Bill of Materials

Company:	ams AG
Application Engineer:	SKRE
Product Number:	AS3701
ARS Project Name:	-
Boardtype & Version:	Evalboard v1.1
Release Date:	18.03.2015
Revision:	Rev1.1.0

#	Designator	Comment	Component_Description	Manufacturer	Manufacturer Part Number	Quantity
	BU1, BU3, BU5	VUSB, VBAT, VEXT	HIRSCHMANN TEST AND MEASUREMENT - 930224101 - SOCKET, 2mm,red	HIRSCHMANN TEST AND MEASUREMENT	930224101	3
	BU2, BU4, BU6	GND	HIRSCHMANN TEST AND MEASUREMENT - 930224100 - SOCKET, 2mm,black	HIRSCHMANN TEST AND MEASUREMENT	930224100	3
	C1, C2, C4	2.2µF	CAP CER 2.2UF 16V 10% X5R 0603	Murata	GRM188R61C225KAADD	3
	C3, C12	4.7µF	CAP CER 4.7UF 25V 20% X5R 0805	Murata Electronics North America	GRM21BR61E475MA12L	2
	C5, C13, C15	10µF	Multilayer Ceramic Capacitors MLCC - SMD/SMT 0805 10uF 10volts X5R 20%	Murata Electronics	GRM219R61A106ME47D	3
	C6, C7, C9	100nF	CAP CER 100nF 16V 10% X7R 0603	Murata Electronics North America	GRM188R71C104KA01D	3
	C8	10µF	CAP CER 10UF 25V 20% X5R 0603	Murata Electronics North America	GRM188R61E106MA73D	1
	C10, C11	1µF	CAP CER 1UF 16V 20% X5R 0603	Murata Electronics North America	GRM188R61C105MA93D	2
	C14	2.2µF	CAP CER 2.2UF 25V 10% X5R 0805	Murata Electronics North America	GRM219R61E225KA12D	1
	D1, D4, D5, D6, D7, D8	LED	LED CHIPLED BLUE 470NM 0603 SMD	OSRAM Opto Semiconductors Inc	LB Q39G-L2N2-35-1	6
	D2, D3	LED	LED CHIPLED 633NM RED 0603 SMD	OSRAM Opto Semiconductors Inc	LS Q976-NR-1	2
	D9, D10, D11	ESD	SUPPRESSOR ESD 24VDC 0603 SMD	Cooper Bussmann	0603ESDA-TR1	3
	D12	6V8	DIODE ZENER 6.8V 200MW SOD-323	ON Semiconductor	MM3Z6V8T1G	1
	J1, J2, J6, J7, J8, J10, J11, J14, J15, J16, J19, J20, J27	XIRQ_NTC->NTC, GPIO3, GPIO4, GPIO3->NTC, GPIO5, NTC, XIRQ_NTC->PU, SCL->PU, GPIO4->NTC, SDA->PU, SCL, SDA, LED	TE CONNECTIVITY / AMP - 826629-2 - HEADER, 1ROW, 2POS	TE CONNECTIVITY / AMP	826629-2	13
	J3, J4, J5, J12, J25, J26, J29	VCURRx, GPIO1, GPIO2, I2C, ON, ON, ON-key	TE CONNECTIVITY / AMP - 826629-3 - HEADER, 1ROW, 3POS	TE CONNECTIVITY / AMP	826629-3	7
	J9, J21, J22, J23, J30	GND, Stipline5, Stipline5, Stipline5, VSUP	TE CONNECTIVITY / AMP - 826629-5 - CONNECTOR, HEADER, 5POS, 1ROW, 2.54MM	TE CONNECTIVITY / AMP	826629-5	5
	J24	Stipline4	TE CONNECTIVITY / AMP - 826629-4 - HEADER, 1ROW, 4POS	TE CONNECTIVITY / AMP	826629-4	1
	L1	1µH	FIXED IND 1UH 1.6A 55 MOHM SMD	Murata Electronics North America	LQM2HPN1R0MG0L	1
	Q1	Si1304, MOSFET,N KANAL, 30V	VISHAY SILICONIX - SI1304BDL-T1-E3 - MOSFET,N KANAL, 30V, 0.9A, SC-70	VISHAY SILICONIX	SI1304BDL-T1-E3	1
	R1, R7, R8, R9, R10, R11	2k7	RES 2.70K OHM 1/10W 1% 0603 SMD	Vishay Dale	CRCW06032K70FKEA	6
	R2, R4, R6, R19	1M0	RES 1.00M OHM 1/10W 1% 0603 SMD	Vishay Dale	CRCW06031M00FKEA	4
	R3	10M	RES SMD 10M OHM 1% 1/10W 0603	Vishay Dale	CRCW060310M0FKEA	1
	R5	10K	RES 10.0K OHM 1/10W 1% 0603 SMD	Vishay Dale	CRCW060310K0FKEA	1
	R14	100k	MULTICOMP - MC0063W06031100K - RES,0603,100K, 1%, REEL	MULTICOMP	MC0063W06031100K	1
	R15	10k	MULTICOMP - MC0063W0603110K - RES, 0603 10K	MULTICOMP	MC0063W0603110K	1
	R17, R18	4k7	MULTICOMP - MC0063W060314K7 - RES, 0603 4K7	MULTICOMP	MC0063W060314K7	2
	S1, S2	ON push, XRES	SWITCH TACTILE SPST-NO 0.05A 32V	C&K Components	KMR211GLFS	2
	S3	ON slide	SW SLIDE SP2T 6VDC 0.3A SMT	C&K Components	PCM12SMTR	1
	TP1, TP2, TP3, TP4, TP5, TP10, TP11, TP12, TP13, TP14	GPIO1, GPIO2, GPIO3, GPIO4, GPIO5, ON, XRES, XIRQ_NTC, SDA, SCL	VERO - 20-313139 - WHITE BEAD TERMINAL ASSY FOR 1.02mm hole	VERO	20-313139	10
	TP6, TP7, TP8, TP15, TP16, TP17, TP18, TP21	VSUP, VBAT, VUSB, SD1, LDO1, LDO2, VEXT, VSUP	VERO - 20-313137 - RED BEAD TERMINAL ASSY FOR 1.02mm hole	VERO	20-313137	8
	TP9, TP19, TP20, TP23	GND	VERO - 20-2137 - BLACK BEAD TERMINAL ASSY FOR 1.02mm hole	VERO	20-2137	4
	U1	AS3701	AS3701 µPMIC 20-balls WL-CSP with 0.4mm pitch	ams	AS3701	1
	U2, U5	USB_AB_MINI_SMD_MOLEX, VUSB	MOLEX - 56579-0576 - RECEPTACLE,USB,MINI-AB,SMT	MOLEX	56579-0576	2
	U3	PIC27FJ64GB002	IC MCU 16BIT 64KB FLASH 28QFN	Microchip Technology	PIC24FJ64GB002-I/ML	1
	U4	AS1360	LDO	ams	AS1360-33	1
Approved by			Notes			107

6 Ordering & Contact Information

Ordering Code	Description
AS3701B-WL-ES_EK_ST	AS3701B Eval Kit Standard Board

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8 Revision Information

Changes from 1-00 (2015-Feb-02) to current revision 1-01 (2015-May-21)	Page
minor changes	4,6,8,9,15, 16,17,18, 19,20
added Figure 11: Charger tab - Supervision	21,22
updated Schematics	24-26
updated Layers	27-30
updated BOM	31

Note: Page numbers for the previous version may differ from page numbers in the current revision.

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