ALAS3K-US

Hardware Interface Description

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1/ Introduction

This document[1] describes the hardware of the ALAS3K-US module. It helps you quickly retrieve interface specifications, electrical and mechanical details and information on the requirements to be considered for integrating further components.

1.1. Key Features at a Glance

Feature	Implementation
General	
Frequency bands	GSM/GPRS/EDGE: Quad band, 850/900/1800/1900MHz UMTS/HSPA+: Triple band, 850 (BdV), 1700 (BdIV), 1900 (BdII) LTE (FDD): Five band, 700 (Bd12 <MFBI Bd17>, Bd29 <supplementary downlink>), 850 (Bd5), 1700 (Bd4), 1900 (Bd2)
GSM class	Small MS
Output power (according to Release 99)	Class 4 (+33dBm ±2dB) for EGSM850 Class 4 (+33dBm ±2dB) for EGSM900 Class 1 (+30dBm ±2dB) for GSM1800 Class 1 (+30dBm ±2dB) for GSM1900 Class E2 (+27dBm ± 3dB) for GSM 850 8-PSK Class E2 (+27dBm ± 3dB) for GSM 900 8-PSK Class E2 (+26dBm +3 /-4dB) for GSM 1800 8-PSK Class E2 (+26dBm +3 /-4dB) for GSM 1900 8-PSK Class 3 (+24dBm +1/-3dB) for UMTS 1900,WCDMA FDD BdII Class 3 (+24dBm +1/-3dB) for UMTS 1700, WCDMA FDD BdIV Class 3 (+24dBm +1/-3dB) for UMTS 850, WCDMA FDD BdV
Output power (according to Release 8)	LTE (FDD): Class 3 (+23dBm +-2dB) for LTE 700, LTE FDD Bd12 <MFBI Bd17> Class 3 (+23dBm +-2dB) for LTE 850, LTE FDD Bd5 Class 3 (+23dBm +-2dB) for LTE 1700, LTE FDD Bd4 Class 3 (+23dBm +-2dB) for LTE1900, LTE FDD Bd2
Power supply	$3.3V \leq V_{BATT+} \leq 4.2V$
Operating temperature (board temperature)	Normal operation: -30°C to +85°C Restricted operation: -40°C to +95°C
Physical	Dimensions: 40mm x 32mm x 2.8mm Weight: approx. 6.5g
RoHS	All hardware components fully compliant with EU RoHS Directive

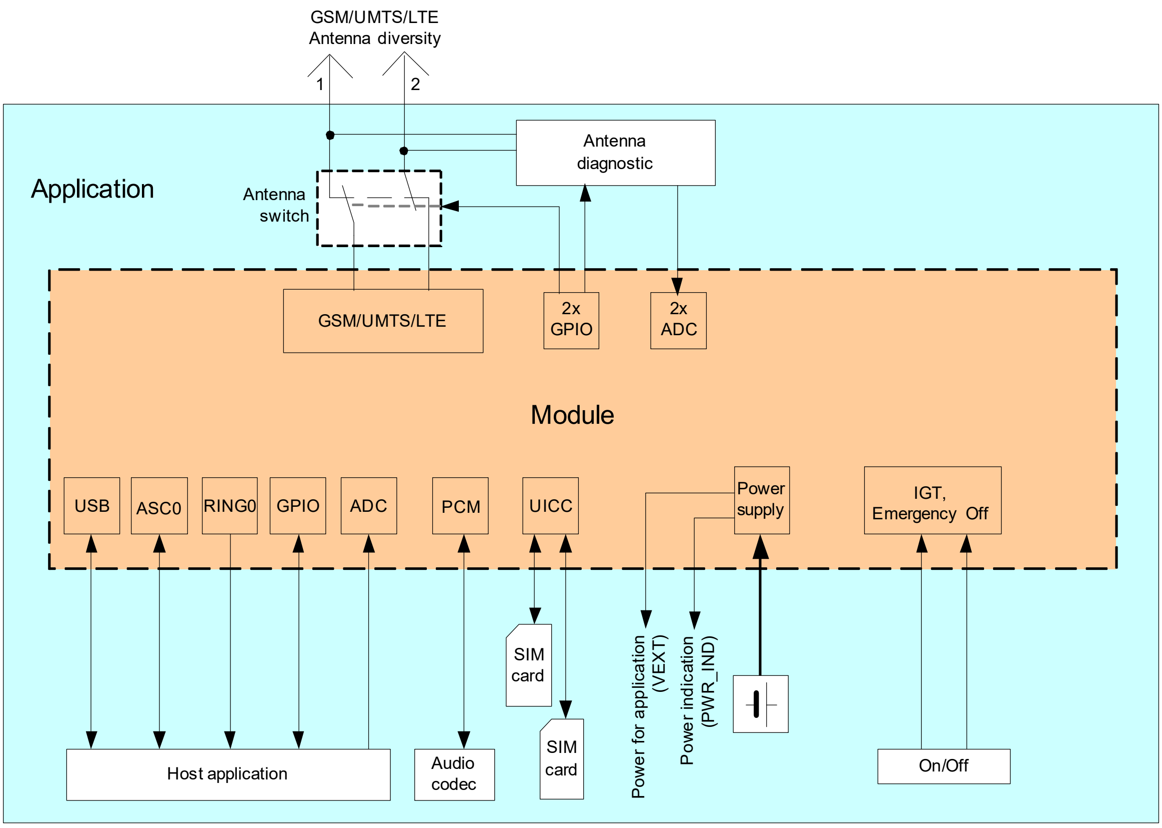
1. The document is effective only if listed in the appropriate Release Notes as part of the technical documentation delivered with your Kontron product.

Feature	Implementation
LTE features	
3GPP Release 10	Downlink carrier aggregation (CA) to increase bandwidth, and thereby increase bitrate: › Maximum aggregated bandwidth: 40MHz › Maximum number of component carriers: 2 › Inter-band FDD, non-contiguous › Intra-band FDD, non-contiguous › Supported inter-band CA configurations: CA_2A-5A (with bandwidth combination set 0), CA_2A-12A (with bandwidth combination sets 0 and 1), CA_2A-29A (with bandwidth combination sets 0, 1 and 2), CA_4A-5A (with bandwidth combination sets 0 and 1), CA_4A-12A (with bandwidth combination sets 0, 1, 2, 3 and 4), CA_4A-29A (with bandwidth combination sets 0, 1 and 2) › Supported intra-band CA configurations: CA_4A-4A (with bandwidth combination set 0) CAT 6 supported DL 300Mbps, UL 50Mbps 2x2 MIMO in DL direction
HSPA features	
3GPP Release 8	UE CAT. 14, 24 DC-HSPA+ – DL 42Mbps HSUPA – UL 5.76Mbps Compressed mode (CM) supported according to 3GPP TS25.212
UMTS features	
3GPP Release 8	PS data rate – 384 kbps DL / 384 kbps UL
GSM / GPRS / EGPRS features	
Data transfer	GPRS: › Multislot Class 12 › Mobile Station Class B › Coding Scheme 1 – 4 EGPRS: › Multislot Class 12 › EDGE E2 power class for 8 PSK › Downlink coding schemes – CS 1-4, MCS 1-9 › Uplink coding schemes – CS 1-4, MCS 1-9 › SRB loopback and test mode B › 8-bit, 11-bit RACH › 1 phase/2 phase access procedures › Link adaptation and IR › NACC, extended UL TBF › Mobile Station Class B
SMS	Point-to-point MT and MO, Cell broadcast, Text and PDU mode
Software	
AT commands	Hayes, 3GPP TS 27.007 and 27.005, and proprietary Kontron commands
Firmware update	Generic update from host application over USB 2.0 High Speed device interface
Interfaces	
Module interface	Surface mount device with solderable connection pads (SMT application interface). Land grid array (LGA) technology ensures high solder joint reliability and provides the possibility to use an optional module mounting socket. For more information on how to integrate SMT modules see also [3]. This application note comprises chapters on module mounting and application layout issues as well as on additional SMT application development equipment.

Feature	Implementation
Antenna	50Ω. GSM/UMTS/LTE main antenna, UMTS/LTE Diversity/MIMO antenna
USB	USB 2.0 High Speed (480Mbit/s) device interface or USB 3.0 Super Speed (5Gbit/s) device interface
Serial interface	ASC0: › 8-wire (plus GND line) modem interface with status and control lines, unbalanced, asynchronous › Fixed baud rates from 4,800 to 921,600bps › Supports RTS0/CTS0 hardware flow control
UICC interface	2 UICC interfaces (switchable) Supported chip cards: UICC/SIM/USIM 3V, 1.8V
RING0	Signal line to indicate URCs.
Power on/off, Reset	
Power on/off	Switch-on by hardware signal IGT Switch-off by AT command (AT^SMSO) or IGT (option) Automatic switch-off in case of critical temperature or voltage conditions
Reset	Orderly shutdown and reset by AT command
Emergency-off	Emergency-off by hardware signal EMERG_OFF
Special Features	
Antenna	SAIC (Single Antenna Interference Cancellation) / DARP (Downlink Advanced Receiver Performance) Rx Diversity (receiver type 3i - 64-QAM) / MIMO
GPIO	10 I/O pins of the application interface programmable as GPIO. Programming is done via AT commands.
ADC inputs	Analog-to-Digital Converter with two unbalanced analog inputs for (external) antenna diagnosis
Evaluation kit	
Evaluation module	ALAS3K-US module soldered onto a dedicated PCB that can be connected to the ALAS6A-DSB75 adapter in order to be mounted onto the DSB75.
ALAS6A-DSB75 adapter	A special adapter required to connect the ALAS3K-US evaluation module to the DSB75.
DSB75	DSB75 Development Support Board designed to test and type approve Kontron modules and provide a sample configuration for application engineering.

1.2. ALAS3K-US System Overview

Figure 1: ALAS3K-US system overview



1.3. Circuit Concept

Figure 2 shows a block diagram of the ALAS3K-US module and illustrates the major functional components:

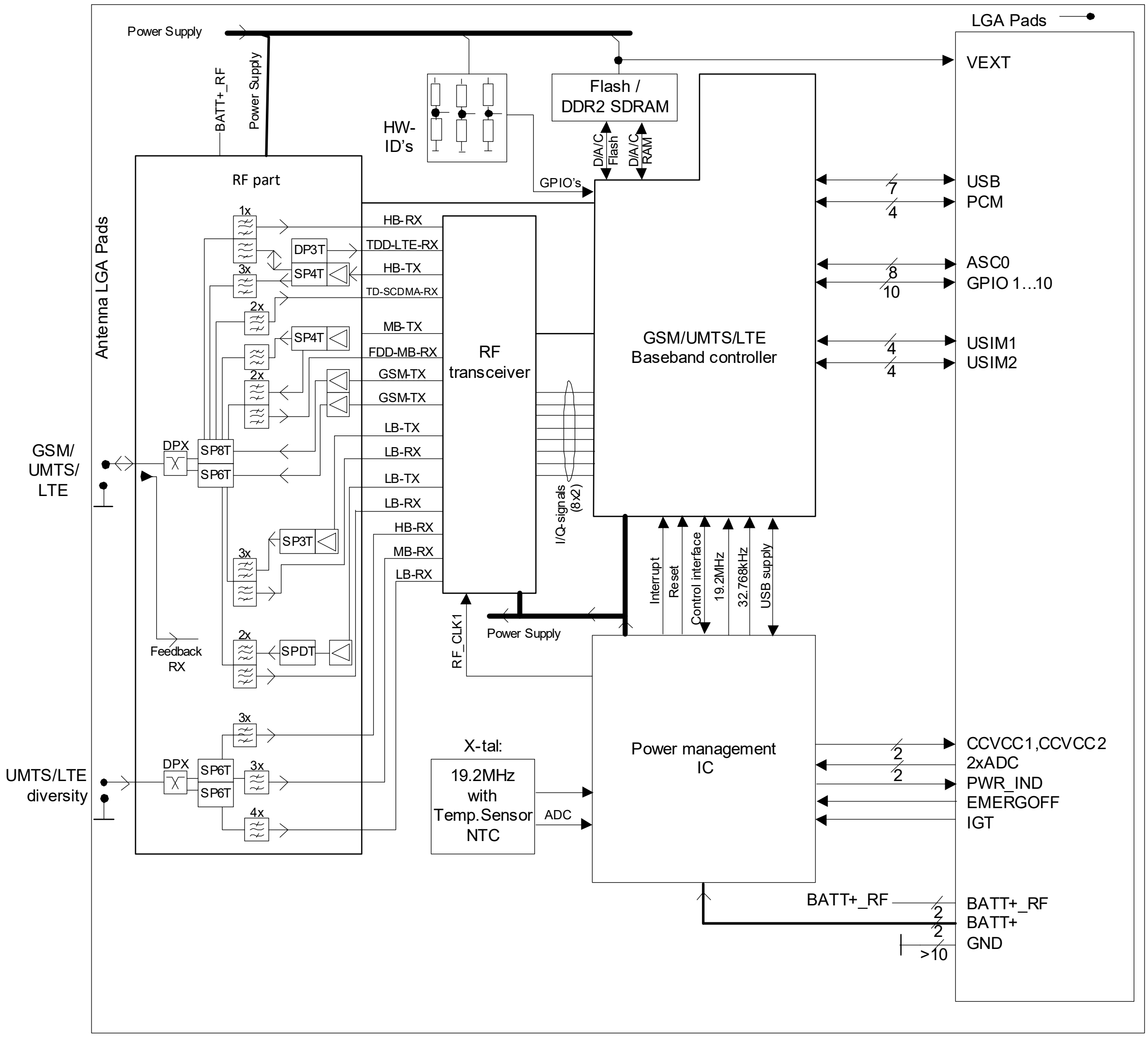
Baseband block:

- GSM/UMTS controller/transceiver/power supply
- Stacked Flash/RAM memory with multiplexed address data bus
- Application interface (SMT with connecting pads)

RF section:

- RF transceiver
- RF power amplifier/frontend
- RF filter
- Antenna pad

Figure 2: ALAS3K-US block diagram



LB – Low bands (699-960MHz); MB – Mid bands (1710-2025MHz); HB – High bands (2300-2690MHz)

2/ Interface Characteristics

ALAS3K-US is equipped with an SMT application interface that connects to the external application. The SMT application interface incorporates the various application interfaces as well as the RF antenna interface.

2.1. Application Interface

2.1.1. Pad Assignment

The SMT application interface on the ALAS3K-US provides connecting pads to integrate the module into external applications. Table 1 lists the pads' assignments. Figure 3 (bottom view) and Figure 4 (top view) show the connecting pads' numbering plan.

Please note that a number of connecting pads are marked as reserved for future use (rfu) and further qualified as either (<name>), (dnu), (GND) or (nc):

- Pads marked as "rfu" and qualified as "<name>" (signal name) may be soldered and could be connected to an external application compliant to the signals' electrical characteristics as described in Table 2.
- Pads marked "rfu" and qualified as "dnu" (do not use) may be soldered but should not be connected to an external application.
- Pads marked "rfu" and qualified as "GND" (ground) are assigned to ground with ALAS3K-US modules, but may have different assignments with future Kontron products using the same pad layout.
- Pads marked "rfu" and qualified as "nc" (not connected) are internally not connected with ALAS3K-US modules, but may be soldered and arbitrarily be connected to external ground.

Kontron strongly recommends to solder all connecting pads for mechanical stability and heat dissipation.

Also, Kontron strongly recommends to provide test points for certain signal lines to and from the module while developing SMT applications – for debug and/or test purposes during the manufacturing process. In this way it is possible to detect soldering problems. Please refer to [3] for more information on test points and how to implement them. The signal lines for which test points should be provided for are marked as "Test point recommended" in Section 2.1.2.: Table 2 describing signal characteristics.

Table 1: Overview: Pad assignments

Pad No.	Signal Name	Pad No.	Signal Name	Pad No.	Signal Name
A1	GND	E17	rfu (nc)	M7	CCVCC2
A5	rfu (dnu)	E18	rfu (dnu)	M8	rfu (dnu)
A6	GND	F2	rfu (dnu)	M9	rfu (dnu)
A7	GND	F3	GND	M10	rfu (dnu)
A9	GND	F4	GND	M11	rfu (dnu)
A10	GND	F5	GND	M12	rfu (dnu)
A11	GND	F6	GND	M13	rfu (dnu)
A12	GND	F13	CCIO2	M14	rfu (dnu)
A14	GND	F14	CCRST2	M15	CCRST1
A18	GND	F15	rfu (dnu)	M16	CCCLK1
B1	GND	F16	rfu (nc)	M17	IGT
B4	rfu (dnu)	F17	rfu (nc)	M18	rfu (dnu)
B5	rfu (nc)	F18	rfu (dnu)	N2	GND
B6	GND	G1	GND	N3	GND
B7	GND	G2	GND	N4	GND
B8	rfu (dnu)	G3	GND	N5	PWR_IND
B9	GND	G4	GND	N6	VEXT
B10	GND	G5	GND	N7	GND
B11	GND	G14	rfu (dnu)	N8	PCM_IN
B12	GND	G15	rfu (dnu)	N9	PCM_CLK
B13	ANT_DRX_MIMO	G16	rfu (dnu)	N10	PCM_FSC
B14	GND	G17	GPIO10	N11	PCM_OUT
B15	GND	G18	rfu (dnu)	N12	rfu (dnu)
B18	GND	H1	GND	N13	ADC2_IN
C3	rfu (dnu)	H2	GND	N14	ADC1_IN
C4	rfu (nc)	H3	GND	N15	CCIN1
C5	GND	H4	GND	N16	rfu (nc)
C6	GND	H5	rfu (nc)	N17	rfu (dnu)
C7	GND	H14	rfu (dnu)	P3	rfu (dnu)
C8	GND	H15	GPIO7	P4	BATT+_RF
C9	GND	H16	GPIO8	P5	BATT+_RF
C10	GND	H17	GPIO9	P6	VUSB_IN
C11	GND	H18	rfu (dnu)	P7	rfu (dnu)
C12	GND	J1	GND	P8	rfu (dnu)
C13	GND	J2	GND	P9	CTS0
C14	GND	J3	GND	P10	DCD0
C15	rfu (STATUS)	J4	GND	P11	RTS0
C16	rfu (dnu)	J5	GND	P12	GND
D2	GND	J14	rfu (dnu)	P13	rfu (dnu)
D3	GND	J15	GPIO4	P14	BATT+
D4	GND	J16	GPIO5	P15	EMERG_OFF
D5	GND	J17	GPIO6	P16	rfu (dnu)
D6	GND	J18	rfu (dnu)	R1	GND
D7	GND	K1	GND	R4	rfu (dnu)
D8	GND	K2	GND	R5	USB_DP
D9	GND	K3	GND	R6	USB_DN
D10	GND	K4	GND	R7	rfu (dnu)
D11	GND	K5	GND	R8	rfu (dnu)
D12	GND	K14	GND	R9	DTR0
D13	rfu (GND)	K15	GPIO1	R10	DSR0
D14	rfu (dnu)	K16	GPIO2	R11	RING0
D15	rfu (nc)	K17	GPIO3	R12	RXD0
D16	rfu (dnu)	K18	GND	R13	TXD0
D17	rfu (dnu)	L2	ANT_MAIN	R14	BATT+
E1	GND	L3	GND	R15	rfu (dnu)
E2	GND	L4	GND	R18	GND
E3	GND	L5	GND	T1	GND
E4	GND	L6	GND	T5	GND
E5	GND	L13	rfu (dnu)	T6	USB_SSTX_P
E6	rfu (dnu)	L14	rfu (dnu)	T7	USB_SSTX_N
E7	GND	L15	CCIO1	T8	GND
E8	GND	L16	CCVCC1	T9	USB_SSRX_P
E9	GND	L17	rfu (dnu)	T10	USB_SSRX_N
E10	GND	L18	rfu (dnu)	T11	GND
E11	GND	M1	GND	T12	rfu (dnu)
E12	GND	M2	GND	T13	rfu (dnu)
E13	CCIN2	M3	GND	T14	GND
E14	rfu (dnu)	M4	GND	T18	GND
E15	CCCLK2	M5	GND		
E16	rfu (nc)	M6	rfu (BATT_ID)		

Figure 3: ALAS3K-US bottom view: Pad assignments

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
T	GND				GND	USB_SSTX_P	USB_SSTX_N	GND	USB_SSRX_P	USB_SSRX_N	GND	rfu (dnu)	rfu (dnu)	GND				GND
R	GND			rfu (dnu)	USB_DP	USB_DN	rfu (dnu)	rfu (dnu)	DTR0	DSR0	RING0	RXD0	TXD0	BATT+	rfu (dnu)			GND
P			rfu (dnu)	BATT+_RF	BATT+_RF	VUSB_IN	rfu (dnu)	rfu (dnu)	CTS0	DCD0	RTS0	GND	rfu (dnu)	BATT+	EMERG_OFF	rfu (dnu)		
N		GND	GND	GND	PWR_IND	VEXT	GND	PCM_IN	PCM_CLK	PCM_FSC	PCM_OUT	rfu (dnu)	ADC2_IN	ADC1_IN	CCIN1	rfu (nc)	rfu (dnu)	
M	GND	GND	GND	GND	GND	rfu (BATT_ID)	CCVCC2	rfu (dnu)	rfu (dnu)	rfu (dnu)	rfu (dnu)	rfu (dnu)	rfu (dnu)	rfu (dnu)	CCRST1	CCCLK1	IGT	rfu (dnu)
L		ANT_MAIN	GND	GND	GND	GND							rfu (dnu)	rfu (dnu)	CCIO1	CCVCC1	rfu (dnu)	rfu (dnu)
K	GND	GND	GND	GND	GND									GND	GPIO1	GPIO2	GPIO3	GND
J	GND	GND	GND	GND	GND									rfu (dnu)	GPIO4	GPIO5	GPIO6	rfu (dnu)
H	GND	GND	GND	GND	rfu (nc)									rfu (dnu)	GPIO7	GPIO8	GPIO9	rfu (dnu)
G	GND	GND	GND	GND	GND									rfu (dnu)	rfu (dnu)	rfu (dnu)	GPIO10	rfu (dnu)
F		rfu (dnu)	GND	GND	GND	GND							CCIO2	CCRST2	rfu (dnu)	rfu (nc)	rfu (nc)	rfu (dnu)
E	GND	GND	GND	GND	GND	rfu (dnu)	GND	GND	GND	GND	GND	GND	CCIN2	rfu (dnu)	CCCLK2	rfu (nc)	rfu (nc)	rfu (dnu)
D		GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	rfu (GND)	rfu (dnu)	rfu (nc)	rfu (dnu)	rfu (dnu)	
C			rfu (dnu)	rfu (nc)	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	rfu (STATUS)	rfu (dnu)		
B	GND			rfu (dnu)	rfu (nc)	GND	GND	rfu (dnu)	GND	GND	GND	GND	ANT_DRX_MIMO	GND	GND			GND
A	GND				rfu (dnu)	GND	GND		GND	GND	GND	GND		GND				GND

rfu: Reserved for future use (may be connected to external application

(nc): Internally not connected (may be arbitrarily connected to external GND)

(dnu): Do not use (should not be connected to external application)

Figure 4: ALAS3K-US top view: Pad assignments

	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
T	GND				GND	rfu (dnu)	rfu (dnu)	GND	USB_ SSRX_N	USB_ SSRX_P	GND	USB_ SSTX_N	USB_ SSTX_P	GND				GND
R	GND			rfu (dnu)	BATT+	TXD0	RXD0	RING0	DSR0	DTR0	rfu (dnu)	rfu (dnu)	USB_DN	USB_DP	rfu (dnu)			GND
P			rfu (dnu)	EMERG_ OFF	BATT+	rfu (dnu)	GND	RTS0	DCD0	CTS0	rfu (dnu)	rfu (dnu)	VUSB_IN	BATT+_ RF	BATT+_ RF	rfu (dnu)		
N		rfu (dnu)	rfu (nc)	CCIN1	ADC1_ IN	ADC2_ IN	rfu (dnu)	PCM_ OUT	PCM_ FSC	PCM_ CLK	PCM_ IN	GND	VEXT	PWR_ IND	GND	GND	GND	
M	rfu (dnu)	IGT	CCCLK1	CCRST1	rfu (dnu)	rfu (dnu)	rfu (dnu)	rfu (dnu)	rfu (dnu)	rfu (dnu)	rfu (dnu)	CCVCC2	rfu (BATT _ID)	GND	GND	GND	GND	GND
L	rfu (dnu)	rfu (dnu)	CCVCC1	CCIO1	rfu (dnu)	rfu (dnu)							GND	GND	GND	GND	ANT_ MAIN	
K	GND	GPIO3	GPIO2	GPIO1	GND									GND	GND	GND	GND	GND
J	rfu (dnu)	GPIO6	GPIO5	GPIO4	rfu (dnu)									GND	GND	GND	GND	GND
H	rfu (dnu)	GPIO9	GPIO8	GPIO7	rfu (dnu)									rfu (nc)	GND	GND	GND	GND
G	rfu (dnu)	GPIO10	rfu (dnu)	rfu (dnu)	rfu (dnu)									GND	GND	GND	GND	GND
F	rfu (dnu)	rfu (nc	rfu (nc)	rfu (dnu)	CCRST2	CCIO2							GND	GND	GND	GND	rfu (dnu)	
E	rfu (dnu)	rfu (nc	rfu (nc)	CCCLK2	rfu (dnu)	CCIN2	GND	GND	GND	GND	GND	GND	rfu (dnu)	GND	GND	GND	GND	GND
D		rfu (dnu)	rfu (dnu)	rfu (nc)	rfu (dnu)	rfu (GND)	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	
C			rfu (dnu)	rfu (STA- TUS)	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	rfu (nc)	rfu (dnu)		
B	GND			GND	GND	ANT_ DRX_ MIMO	GND	GND	GND	GND	rfu (dnu)	GND	GND	rfu (nc)	rfu (dnu)			GND
A	GND				GND		GND	GND	GND	GND		GND	GND	rfu (dnu)				GND

rfu: Reserved for future use (may be connected to external application
(nc): Internally not connected (may be arbitrarily connected to external GND)
(dnu): Do not use (should not be connected to external application)

2.1.2. Signal Properties

Please note that the reference voltages listed in Table 2 are the values measured directly on the ALAS3K-US module. They do not apply to the accessories connected.

Table 2: Signal description

Function	Signal name	IO	Signal form and level	Comment
Power supply	BATT+_RF	I	$V_I$max = 4.2V $V_I$norm = 3.8V $V_I$min = 3.3V during Tx burst on board Imax ≈ 2A, during Tx burst (GSM) n Tx = n x 577µs peak current every 4.615ms Imax = 800mA (continuous) during WCDMA TX Imax = 800mA (continuous) during LTE TX	Lines of BATT+ and GND must be connected in parallel for supply purposes because higher peak currents may occur. Minimum voltage must not fall below 3.3V including drop, ripple, spikes.
	BATT+	I	$V_I$max = 4.2V $V_I$norm = 3.8V $V_I$min = 3.3V during Tx burst on board Imax = 500mA	
	GND		Ground	Application Ground
External supply voltage	VEXT	O	$C_L$max = 1µF V_O = 1.80V +3% -5% $I_O$max = -50mA	VEXT may be used for application circuits. If unused keep line open. Test point recommended. The external digital logic must not cause any spikes or glitches on voltage VEXT. Do not exceed $I_O$max
Ignition	IGT	I	Open circuit voltage: V_{OHtyp}=0.8V External driver: R_{off} > 5 MOhm Switch-On-Condition: V_{IL}max = 0.3V @ I < 25µA (IGT to GND) ~~|___|~~ Recommended low impulse width > 100ms	This signal switches the module ON. It is required to drive this line low by an open drain or open collector driver connected to GND. Test point recommended.
Emergency off	EMERG_OFF	I	R_{PU} ≈ 40kΩ V_{OH}max = *1.8V* V_{IH}max = *2.1V* V_{IH}min = *1.17V* V_{IL}max = *630mV* ~~|___|~~ low impulse width up to 2200ms (as long as PWR_IND stays low typ. 346ms if firmware running properly)	This line must be driven low by an open drain or open collector driver connected to GND as long as the module turns off. If unused keep line open. Test point recommended.
FW Download Mode	DCD0	I/O	V_{IL}max = 0.63V V_{IH}min = 1.20V V_{IH}max = 2.1V I_{IHPD} = 27.5µA...97.5µA I_{ILPU} = -27.5µA...-97.5µA IHigh-z = max +- 1µA	If DCD0 is driven low during startup-phase, module enters Download Mode (see Section 3.2.2.) DCD0 should be connected with a 1kOhm resistor to ground to prevent possible back powering.

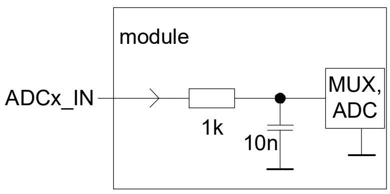
Table 2: Signal description

Function	Signal name	IO	Signal form and level	Comment
SIM card detection (2x)	CCIN1	I	$R_{PU} \approx 24.2k\Omega$ $V_{OH}max=1.9V$ $V_{IH}min = 1.15V$ $V_{IH}max= 2.1V$ $V_{IL}max = 0.4V$	CCINx = Low, SIM card inserted. If SIM card holder does not support CCINx, connect to GND. CCIN2: External pull-up required - for details please refer to Section 2.1.5.. If 2nd SIM interface not used, keep line open.
	CCIN2	I	$V_{IH}min = 1.20V$ $V_{IH}max= 2.1V$ $V_{IL}max = 0.63V$ $I_{IHPD} = 27.5µA...97.5µA$ External pull-up to VEXT required: $R_{PU} \approx 24k\Omega$	
3V SIM card interfaces (2x)	CCRST1 CCRST2	O	$V_{OL}max = 0.4V$ at I = 2mA $V_{OH}min = 2.36V$ at I = -2mA $V_{OH}max = 3.01V$	Maximum cable length or copper track should be not longer than 100mm to SIM card holder. CCIO2: External 10kΩ pull-up required - for details please refer to Section 2.1.5.. If 2nd SIM interface not used, keep line open.
	CCIO1 CCIO2	I/O	CCIO1: $R_{PU} = 8.7..9.5k\Omega$ to CCVCC1 CCIO2: $R_{PU} = 65..200k\Omega$ to CCVCC2 Additional external pull up 10k to CCVCC2 required $V_{IL}max = 0.59V$ $V_{IL}min = -0.3V$ $V_{IH}min = 2.07V$ $V_{IH}max = 3.25V$ $V_{OL}max = 0.4V$ at I = 2mA $V_{OH}min = 2.36V$ at I = -0.05mA $V_{OH}max = 3.01V$	
	CCCLK1 CCCLK2	O	$V_{OL}max = 0.4V$ at I = 2mA $V_{OH}min = 2.36V$ at I = -2mA $V_{OH}max = 3.01V$	
	CCVCC1 CCVCC2	O	$V_{O}min = 2.85V$ $V_{O}typ =2.95V$ $V_{O}max = 3.01V$ $I_{O}max = -50mA$	
1.8V SIM card inter-face (2x)	CCRST1 CCRST2	O	$V_{OL}max = 0.4V$ at I = 2mA $V_{OH}min = 1.45V$ at I = -2mA $V_{OH}max = 1.84V$	Maximum cable length or copper track should be not longer than 100mm to SIM card holder. CCIO2: External 10kΩ pull-up required - for details please refer to Section 2.1.5.. If 2nd SIM interface not used, keep line open.
	CCIO1 CCIO2	I/O	CCIO1: $R_{PU} = 8.7..9.5k\Omega$ to CCVCC1 CCIO2: $R_{PU} = 65..200k\Omega$ to CCVCC2 Additional external pull up 10k to CCVCC2 required $V_{IL}max = 0.36V$ $V_{IL}min = -0.3V$ $V_{IH}min = 1.30V$ $V_{IH}max = 2.1V$ $V_{OL}max = 0.4V$ at I = 2mA $V_{OH}min = 1.45V$ at I = -0.05mA $V_{OH}max = 1.84V$	
	CCCLK1 CCCLK2	O	$V_{OL}max = 0.4V$ at I = 2mA $V_{OH}min = 1.45V$ at I = -2mA $V_{OH}max = 1.84V$	
	CCVCC1 CCVCC2	O	$V_{O}min = 1.75V$ $V_{O}typ = 1.80V$ $V_{O}max = 1.84V$ $I_{O}max = -50mA$	

Table 2: Signal description

Function	Signal name	IO	Signal form and level	Comment
SIM interface shutdown	BATT_ID	I	Internal pull up 100k to 1.8V	Reserved for future use. Connect line to GND.
Serial Modem Interface ASC0	RXD0	O	V_{OL}max = 0.45V at I = 2mA V_{OH}min = 1.35V at I = -2mA V_{OH}max = 1.84V	Test points recommended for RXD0, TXD0, DCD0 and RING0. If DCD0 is driven low during startup-phase, module enters Download Mode (see Section 3.2.2.) If unused keep line open.
	CTS0	O		
	DSR0	O		
	RING0	O		
	DCD0	I/O		
	TXD0	I	V_{IL}max = 0.63V V_{IH}min = 1.20V V_{IH}max = 2.1V I_{IHPD} = 27.5µA...97.5µA I_{ILPU} = -27.5µA...-97.5µA I_{High-Z} = max +-1µA	
	RTS0	I		
	DTR0	I		
Host wakeup	RING0	O	V_{OL}max = 0.45V at I = 2mA V_{OH}min = 1.35V at I = -2mA V_{OH}max = 1.84V	If unused keep line open. Test point recommended.
Power indicator	PWR_IND	O	V_{IH}max = 5.5V V_{OL}max = 0.4V at Imax = 1mA	PWR_IND (Power Indicator) notifies the module's on/off state. PWR_IND is an open collector that needs to be connected to an external pull-up resistor. Low state of the open collector indicates that the module is on. Vice versa, high level notifies the Power Down mode. Therefore, signal may be used to enable external vol-tage regulators that supply an external logic for communication with the module, e.g. level converters. Test point recommended.
USB	VUSB_IN	I	V_{IN}min = 3.0V V_{IN}max = 5.75V $I_I$typ = 150µA $I_I$max = 200µA Cin=1µF	All electrical characteristics according to USB Implementers' Forum, USB 2.0 High Speed Specification. Test point recommended.
	USB_DN	I/O	Full and High speed signal (differential) characteristics according USB 2.0 specification.	If unused keep lines open. Test point recommended. USB High Speed mode operation requires a differential impedance of 90Ω.
	USB_DP	I/O		
	USB_SSRX_N	I	Super Speed signal (differential) Rx characteristics according USB 3.0 specification.	If unused keep lines open. USB Super Speed mode operation requires a differential impedance of 90Ω.
	USB_SSRX_P	I		
	USB_SSTX_N	O	Super Speed signal (differential) Tx characteristics according USB 3.0 specification.	
	USB_SSTX_P	O		

Table 2: Signal description

Function	Signal name	IO	Signal form and level	Comment
(PCM)	PCM_IN	I	$V_{IL}max = 0.63V$ $V_{IH}min = 1.20V$ $V_{IH}max = 2.1V$ I_{IHPD} = 27.5µA...97.5µA I_{ILPU} = -27.5µA...-97.5µA I_{High-Z} = max +-1µA $V_{OL}max$ = 0.45V at I = 2mA $V_{OH}min$ = 1.35V at I = -2mA $V_{OH}max$ = 1.85V	PCM Master mode. If unused keep lines open.
	PCM_CLK	O		
	PCM_FSC	O		
	PCM_OUT	O		
GPIO interface	GPIO1 GPIO2 GPIO3 GPIO4 GPIO5 GPIO6 GPIO7 GPIO8 GPIO9 GPIO10	I/O	$V_{IL}max = 0.63V$ $V_{IH}min = 1.20V$ $V_{IH}max = 2.1V$ I_{IHPD} = 27.5µA...97.5µA I_{ILPU} = -27.5µA...-97.5µA I_{High-Z} = max +-1µA $V_{OL}max$ = 0.45V at I = 2mA $V_{OH}min$ = 1.35V at I = -2mA $V_{OH}max$ = 1.84V	If unused keep lines open. Test point recommended for GPIO9 and GPIO10. Following functions can be configured for GPIOs using AT commands: Any GPIO --> Low current indication. By default GPIO6 is configured as LCI line. Any GPIO --> Remote host wakeup line
Low Current Indi-cation	GPIOx (LCI_IND)	O	$V_{OL}max$ = 0.45V at I = 2mA $V_{OH}min$ = 1.35V at I = -2mA $V_{OH}max$ = 1.85V	If the feature is enabled (see Section 2.1.11.4.).
		I	$V_{IH}max = 2V$ R_{PD}= appr. 100kΩ	If the feature is disabled (see Section 2.1.11.4.).
Remote host wakeup	GPIOx	O	$V_{OL}max$ = 0.45V at I = 2mA $V_{OH}min$ = 1.35V at I = -2mA $V_{OH}max$ = 1.85V	If the feature is enabled (see Section 2.1.11.3.).
ADC interface	ADC1_IN, ADC2_IN	I	Full specification compliance range V_{Imin}>=0.05V V_{Imax}<=V_{BATT+} Degraded accuracy range V_{Imin} 0V ... 0.05V Ridc>1MΩ Resolution: 16 Bit (sign+15Bit) Offset error: <+-10mV Gain error: <±1% Conversation time: approx. 1.722ms 	If unused keep line open. Prepared for general purpose and antenna diagnostic use.

2.1.2.1. Absolute Maximum Ratings

The absolute maximum ratings stated in Table 3 are stress ratings under any conditions. Stresses beyond any of these limits will cause permanent damage to ALAS3K-US.

Table 3: Absolute maximum ratings

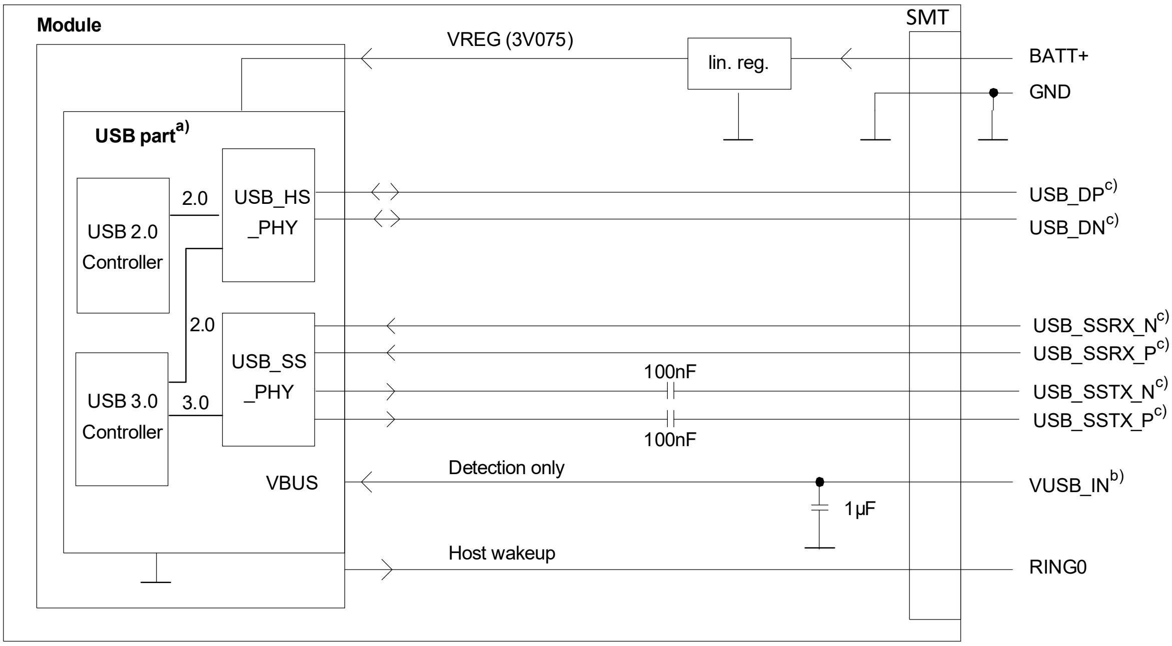
Parameter	Min	Max	Unit
Supply voltage BATT+	-0.5	+6.0	V
Voltage at all digital lines in Power Down mode (except VEXT)	-0.5	+0.5	V
Voltage at VEXT in Power Down mode	-0.3	+0.3	V
Voltage at digital lines in normal operation	-0.5	+2.3	V
Voltage at SIM/USIM interface, CCVCC 1.8V in normal operation	-0.5	+2.3	V
Voltage at SIM/USIM interface, CCVCC 3.0V in normal operation	-0.5	+3.4	V
Voltage at ADC lines if the module is powered by BATT+	-0.5	V_{BATT+}+0.5V	V
Voltage at ADC lines if the module is not powered	-0.5	+0.5	V
VEXT maximum current shorted to GND		-300	mA
VUSB_IN	-0.5	5.75	V
USB_DN, USB_DP	-0.5	3.6	V
USB_SSTX_N, USB_SSTX_P, USB_SSRX_N, USB_SSRX_P	-0.5	1.4	V
Voltage at PWR_IND line	-0.5	5.5	V
PWR_IND input current if PWR_IND= low		2	mA
Voltage at following signals: IGT, EMERG_OFF	-0.5	2.3	V

2.1.3. USB Interface

ALAS3K-US supports a USB 3.0 Super Speed (5Gbps) device interface, and alternatively a USB 2.0 device interface that is High Speed and Full Speed compatible. The USB interface is primarily intended for use as command and data interface, and for downloading firmware[1].

The USB host is responsible for supplying the VUSB_IN line. This line is for voltage detection only. The USB part (driver and transceiver) is supplied by means of BATT+. This is because ALAS3K-US is designed as a self-powered device compliant with the “Universal Serial Bus Specification Revision 3.0”[2].

Figure 5: USB circuit



a) All serial (including R_S) and pull-up resistors for data lines are implemented.

b) Since VUSB_IN is used for detection only it is recommended not to add any further blocking capacitors on the VUSB_IN line.

c) If the USB interface is operated with super or high speeds, it is recommended to take special care routing the data lines. Application layout should implement a differential impedance of 90 ohms for proper signal integrity.

To properly connect the module's USB interface to the external application, a USB 3.0 or 2.0 compatible connector and cable or hardware design is required. For further guidelines on implementing the external application’s USB 3.0 or 2.0 interface see [4] and [5]. For more information on the USB related signals see Table 2. Furthermore, the USB modem driver distributed with ALAS3K-US needs to be installed.

When using the USB interface in a USB 2.0 only electrical environment, it is strongly recommended to connect to a USB High Speed host.

1. **Note:** For firmware download, the module enumerates new as a USB 2.0 device. Also note that it is not possible to use the USB 2.0 High Speed device mode and the USB 3.0 Super speed device mode simultaneously.
2. The specification is ready for download on http://www.usb.org/developers/docs/

2.1.3.1. Reducing Power Consumption

While a USB connection is active, the module will never switch into SLEEP mode. Only if the USB interface is in Suspended state or Detached (i.e., VUSB_IN = 0) is the module able to switch into SLEEP mode thereby saving power[1]. There are two possibilities to enable power reduction mechanisms:

- **Recommended implementation of USB Suspend/Resume/Remote Wakeup:**
  The USB host should be able to bring its USB interface into the Suspended state as described in the “Universal Serial Bus Specification Revision 3.0“[2]. For this functionality to work, the VUSB_IN line should always be kept enabled. On incoming calls and other events ALAS3K-US will then generate a Remote Wakeup request to resume the USB host controller.

  See also [5] (USB Specification Revision 2.0, Section 10.2.7, p.282):
  "If USB System wishes to place the bus in the Suspended state, it commands the Host Controller to stop all bus traffic, including SOFs. This causes all USB devices to enter the Suspended state. In this state, the USB System may enable the Host Controller to respond to bus wakeup events. This allows the Host Controller to respond to bus wakeup signaling to restart the host system."
- **Implementation for legacy USB applications not supporting USB Suspend/Resume:**
  As an alternative to the regular USB suspend and resume mechanism it is possible to employ a remote wakeup line (e.g., the RING0 line) to wake up the host application in case of incoming calls or events signalized by URCs while the USB interface is in Detached state (i.e., VUSB_IN = 0). Every wakeup event will force a new USB enumeration. Therefore, the external application has to carefully consider the enumeration timings to avoid loosing any signaled events. For details on this remote wakeup functionality see Section 2.1.11.3..

  It is possible to prevent existing data connections from being disconnected while the USB interface is in detached state (i.e., VUSB_IN=0) by configuring at least one of the module’s USB ports to contribute to a host wakeup, i.e., configuring the port to try to wake up a connected host in case an appropriate event occurs (see [1]: AT^SCFG=”RemoteWakeUp/Ports"), and by configuring a GPIO as USB wakeup GPIO (see [1]: AT^SCFG=”RemoteWakeUp/Event/USB").

1. Please note that if the USB interface is employed, and a USB cable is connected, there should also be a terminal program linked to the USB port in order to receive and process the initial SYSSTART URC after module startup. Otherwise, the SYSSTART URC remains pending in the USB driver's output buffer and this unprocessed data prevents the module from power saving.
2. The specification is ready for download on http://www.usb.org/developers/docs/

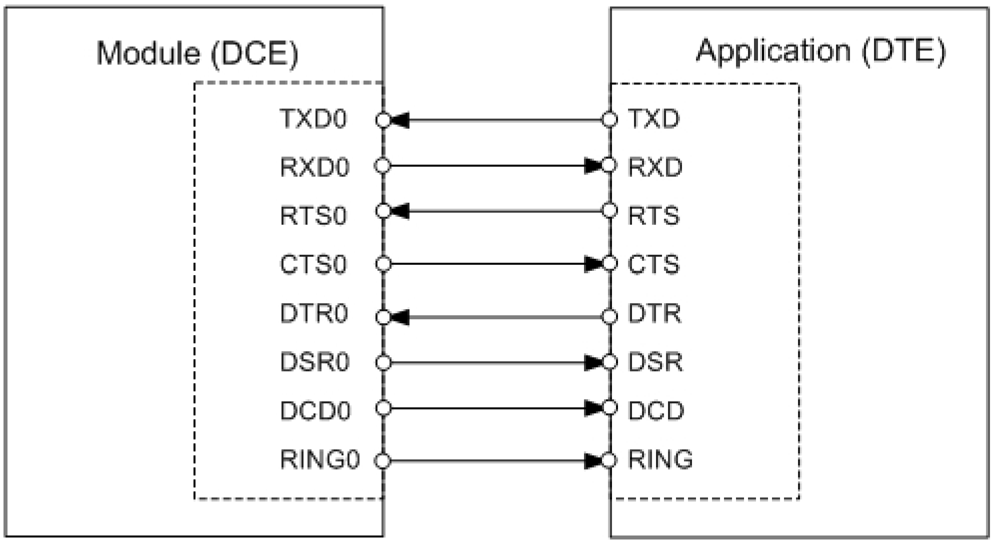
2.1.4. Serial Interface ASC0

ALAS3K-US offers an 8-wire (plus GND) unbalanced, asynchronous modem interface ASC0 conforming to ITU-T V.24 protocol DCE signaling. The electrical characteristics do not comply with ITU-T V.28. The significant levels are 0V (for low data bit or active state) and 1.8V (for high data bit or inactive state). For electrical characteristics please refer to Table 2.

ALAS3K-US is designed for use as a DCE. Based on the conventions for DCE-DTE connections it communicates with the customer application (DTE) using the following signals:

- Port TXD @ application sends data to the module's TXD0 signal line
- Port RXD @ application receives data from the module's RXD0 signal line

Figure 6: Serial interface ASC0



Features:

- Includes the data lines TXD0 and RXD0, the status lines RTS0 and CTS0 and, in addition, the modem control lines DTR0, DSR0, DCD0 and RING0.
- The RING0 signal serves to indicate URCs (Unsolicited Result Code). It can also be used to send pulses to the host application, for example to wake up the application from power saving state. See [1] for details on how to configure the RING0 line by AT^SCFG.
- Configured for 8 data bits, no parity and 1 stop bit.
- ASC0 can be operated at fixed bit rates from 4,800 to 921,600bps.
- Supports RTS0/CTS0 hardware flow control.

Note: If the ASC0 serial interface is the application's only interface, it is suggested to connect test points on the USB signal lines as a potential tracing possibility.

Table 4: DCE-DTE wiring of ASC0

V.24 circuit	DCE		DTE	
	Line function	Signal direction	Line function	Signal direction
103	TXD0	Input	TXD	Output
104	RXD0	Output	RXD	Input
105	RTS0	Input	RTS	Output
106	CTS0	Output	CTS	Input
108/2	DTR0	Input	DTR	Output
107	DSR0	Output	DSR	Input
109	DCD0	Output	DCD	Input
125	RING0	Output	RING	Input

2.1.5. UICC/SIM/USIM Interface

ALAS3K-US has two UICC/SIM/USIM interfaces compatible with the 3GPP 31.102 and ETSI 102 221. These are wired to the host interface in order to be connected to an external SIM card holder. Five pads on the SMT application interface are reserved for each of the two SIM interfaces.

The UICC/SIM/USIM interface supports 3V and 1.8V SIM cards. Please refer to Table 2 for electrical specifications of the UICC/SIM/USIM interface lines depending on whether a 3V or 1.8V SIM card is used.

The CCINx signal serves to detect whether a tray (with SIM card) is present in the card holder. Using the CCINx signal is mandatory for compliance with the GSM 11.11 recommendation if the mechanical design of the host application allows the user to remove the SIM card during operation. To take advantage of this feature, an appropriate SIM card detect switch is required on the card holder. For example, this is true for the model supplied by Molex, which has been tested to operate with ALAS3K-US and is part of the Kontron reference equipment submitted for type approval. See Chapter 7/ for Molex ordering numbers.

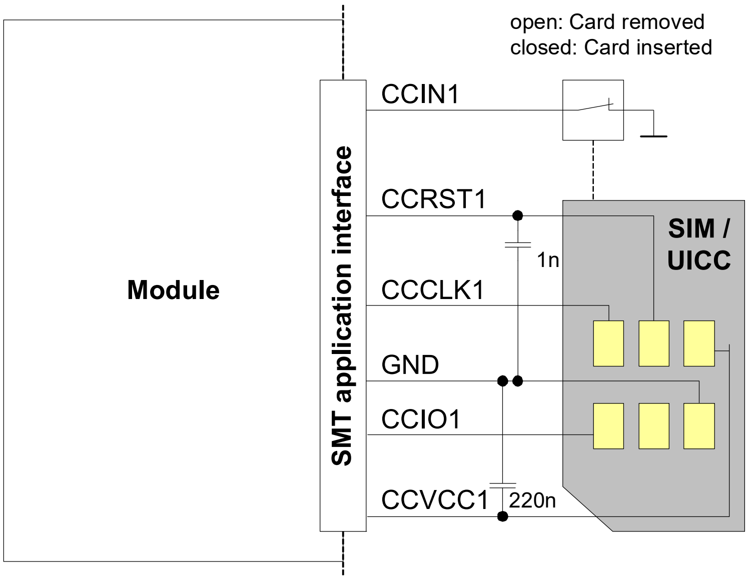
Table 5: Signals of the SIM interface (SMT application interface)

Signal	Description
GND	Ground connection for SIM interfaces. Optionally a separate SIM ground line using e.g., pad P12, may be used to improve EMC.
CCCLK1 CCCLK2	Chipcard clock lines for 1st and 2nd SIM interface.
CCVCC1 CCVCC2	SIM supply voltage lines for 1st and 2nd SIM interface.
CCIO1 CCIO2	Serial data lines for 1st and 2nd SIM interface, input and output.
CCRST1 CCRST2	Chipcard reset lines for 1st and 2nd SIM interface.
CCIN1 CCIN2	Input on the baseband processor for detecting a SIM card tray in the holder. If the SIM is removed during operation the SIM interface is shut down immediately to prevent destruction of the SIM. The CCINx signal is active low. The CCINx signal is mandatory for applications that allow the user to remove the SIM card during operation. The CCINx signal is solely intended for use with a SIM card. It must not be used for any other purposes. Failure to comply with this requirement may invalidate the type approval of ALAS3K-US.

Note: No guarantee can be given, nor any liability accepted, if loss of data is encountered after removing the SIM card during operation. Also, no guarantee can be given for properly initializing any SIM card that the user inserts after having removed the SIM card during operation. In this case, the application must restart ALAS3K-US.

By default, only the 1st SIM interface is available and can be used. Using the AT command AT^SCFG=”SIM/CS” it is possible to switch between the two SIM interfaces. Command settings are non-volatile - for details see [1].

Figure 7: First UICC/SIM/USIM interface



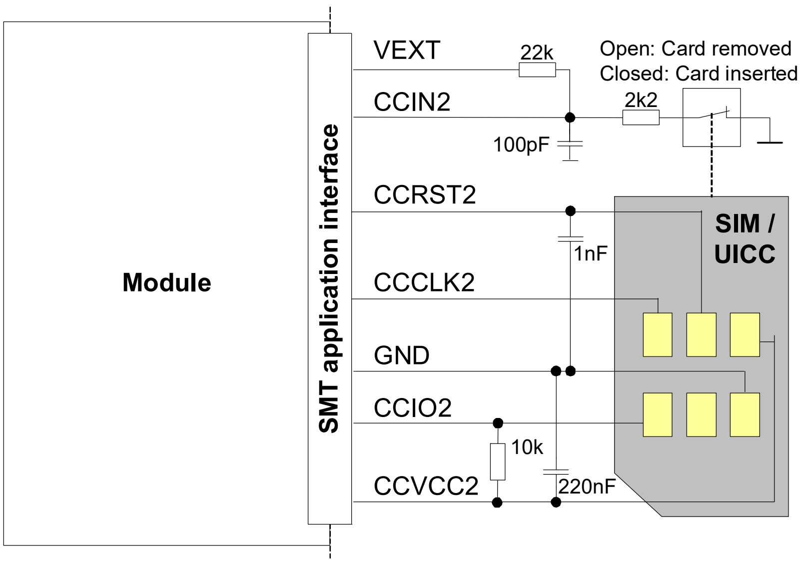
The total cable length between the SMT application interface pads on ALAS3K-US and the pads of the external SIM card holder must not exceed 100mm in order to meet the specifications of 3GPP TS 51.010-1 and to satisfy the requirements of EMC compliance.

To avoid possible cross-talk from the CCCLKx signal to the CCIOx signal be careful that both lines are not placed closely next to each other. A useful approach is using the GND line to shield the CCIOx line from the CCCLKx line.

An example for an optimized ESD protection for the SIM interface is shown in Section 2.1.6..

Note: Figure 7 shows how to connect a SIM card holder to the first SIM interface. With the second SIM interface some internally integrated components on the SIM circuit will have to be externally integrated as shown for the second SIM interface in Figure 8. The external components at CCIN2 should be populated as close as possible to the signal's SMT pad.

Figure 8: Second UICC/SIM/USIM interface

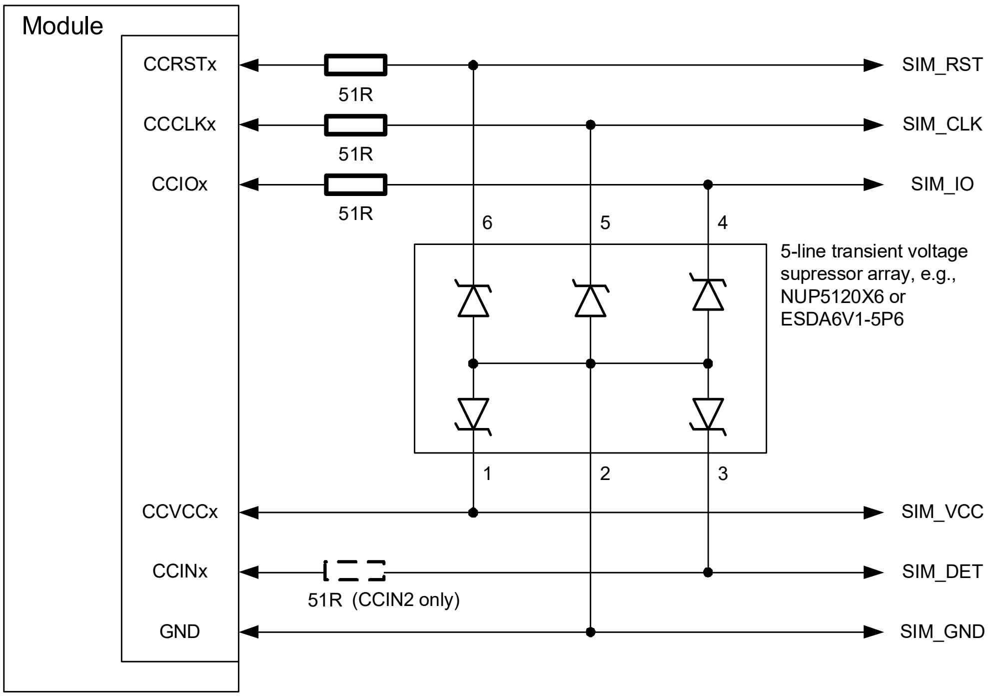


2.1.6. Enhanced ESD Protection for SIM Interfaces

To optimize ESD protection for the SIM interfaces it is possible to add ESD diodes to the interface lines of the first and second SIM interface as shown in the example given in Figure 9.

The example was designed to meet ESD protection according ETSI EN 301 489-1/7: Contact discharge: ± 4kV, air discharge: ± 8kV.

Figure 9: SIM interfaces - enhanced ESD protection



2.1.7. Digital Audio Interface

ALAS3K-US supports a digital audio interface that can be employed as pulse code modulation interface (see Section 2.1.7.1.).

2.1.7.1. Pulse Code Modulation Interface (PCM)

ALAS3K-US's PCM interface can be used to connect audio devices capable of pulse code modulation. The PCM functionality is limited to the use of wideband codecs with 16kHz sample rate only. The PCM interface runs at 16 kHz sample rate (62.5µs frame length), while the signal processing maintains this rate in a wideband AMR call or samples automatically down to 8kHz in a narrowband call. Therefore, the PCM sample rate is independent of the audio bandwidth of the call.

The PCM interface has the following implementation:

› Master mode
› Short frame synchronization
› 4096kHz bit clock at 16kHz sample rate

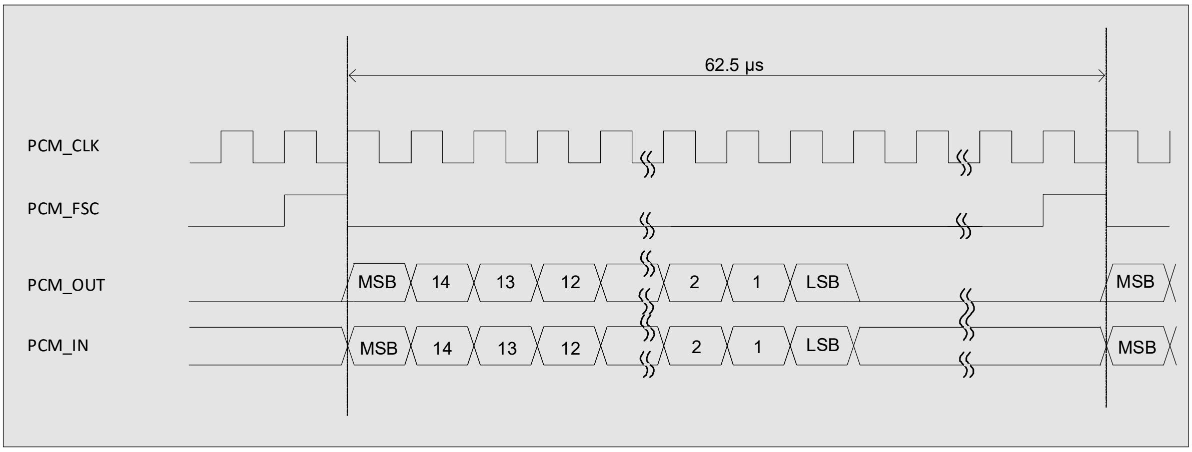
Table 6 lists the available PCM interface signals.

Table 6: Overview of PCM pin functions

Signal name on SMT application interface	Signal direction: Master	Description
PCM_OUT	O	PCM Data from ALAS3K-US to external codec
PCM_IN	I	PCM Data from external codec to ALAS3K-US
PCM_FSC	O	Frame synchronization signal to external codec
PCM_CLK	O	Bit clock to external codec

Note: PCM data is always formatted as 16-bit uncompressed two's complement. Also, all PCM data and frame synchronization signals are written to the PCM bus on the rising clock edge and read on the falling edge.
The timing of a PCM short frame is shown in Figure 10.

Figure 10: PCM timing short frame (master, 4096KHz)



Characteristics of Audio Modes

ALAS3K-US has various audio modes selectable with AT^SNFS (for details on AT^SNFS see [1]).

Audio mode 1 is only used for type approval with the Votronic handset via the DSB75 codec adapter. The handset is adjusted for the type 3.2 low-leakage ear simulator for narrowband and wideband calls. The characteristics of this mode cannot be changed.

Audio mode 6 is used for transparent access to the narrowband or wideband speech coders without any signal processing (except for sample rate converters in case of narrowband calls). The full scale level of the PCM interface is mapped to the full scale level of the speech codecs.

2.1.8. Analog-to-Digital Converter (ADC)

ALAS3K-US provides two unbalanced ADC input lines: ADC1_IN and ADC2_IN. They can be used to measure two independent, externally connected DC voltages in the range of 0.05V to V_{BATT+}. As described in Section 2.2.4. they can be used especially for antenna diagnosing.

The AT^SRADC command can be employed to select the ADC line, set the measurement mode and read out the measurement results.

2.1.9. RTC Backup

The internal Real Time Clock of ALAS3K-US is supplied from a separate voltage regulator in the power supply component which is also active when ALAS3K-US is in Power Down mode and BATT+ is available, and does not drop below approx. 1.4V.

2.1.10. GPIO Interface

ALAS3K-US has 10 GPIOs for external hardware devices. Each GPIO can be configured for use as input or output. All settings are AT command controlled.

The IO port driver has to be open before using and configuring GPIOs. Before changing the configuration of a GPIO pin (e.g. input to output) the pin has to be closed. If the GPIO pins are not configured or the pins/driver were closed, the GPIO pins are high-Z with pull down resistor. If a GPIO is configured to input, the pin has high-Z without pull resistor.

GPIO1...GPIO10 may be configured as low current indicator signal (see Section 2.1.11.4.), or may be set as remote host wakeup lines (see Section 2.1.11.3.).

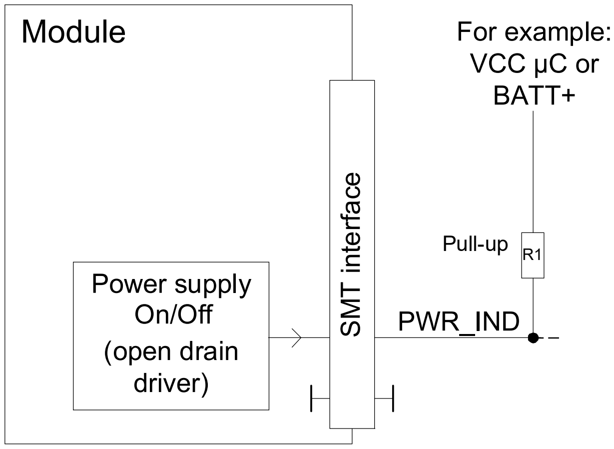
If ALAS3K-US is in power save (SLEEP) mode a level state transition at GPIO1, GPIO3, GPIO4, GPIO5 and GPIO9 will wake up the module, if such a GPIO was configured as input using AT^SCPIN. To query the level state the AT^SCPOL command may be used. For details on the mentioned AT commands please see [1].

2.1.11. Control Signals

2.1.11.1. PWR_IND Signal

PWR_IND notifies the on/off state of the module. High state of PWR_IND indicates that the module is switched off. The state of PWR_IND immediately changes to low when IGT is pulled low. For state detection an external pull-up resistor is required.

Figure 11: PWR_IND signal



2.1.11.2. Behavior of the RING0 Line

The RING0 line serves to indicate URCs (Unsolicited Result Code).

Although not mandatory for use in a host application, it is strongly suggested that you connect the RING0 line to an interrupt line of your application. In this case, the application can be designed to receive an interrupt when a falling edge on RING0 occurs. This solution is most effective, particularly, for waking up an application from power saving. Therefore, utilizing the RING0 line provides an option to significantly reduce the overall current consumption of your application.

The RING0 line behavior and usage can be configured by AT command. For details see [1]: AT^SCFG.

2.1.11.3. Remote Wakeup

If no call, data or message transfer is in progress, the external host application may shut down its own module interfaces or other components in order to save power. If a call, data, or other request (URC) arrives, the external application can be notified of this event and be woken up again by a state transition of a configurable remote wakeup line. Available as remote wakeup lines are all GPIO signals as well as the RING0 line. Please refer to [1]: AT^SCFG: "RemoteWakeUp/..." for details on how to configure these lines for defined wakeup events on specified device interfaces.Possible states are listed in Table 7.

If no line is specifically configured as remote wakeup signal, the remote USB suspend and resume mechanism as specified in the "Universal Serial Bus Specification Revision 2.0"1 applies for the USB interface (see Section 2.1.3.), or the RING0 line may be employed with USB applications not supporting this mechanism (see also Section 2.1.3.1.). This legacy behavior of the RING0 line as remote host wakeup line has to be enabled and configured by AT command (see [1]: AT^SCFG: "URC/Ringline"). Possible states are listed in Table 7.

Table 7: Remote wakeup lines

Signal	I/O/P	Description
RING0	O	Inactive to active low transition: 0 = The host shall wake up 1 = No wake up request
GPIOx	O	Inactive to active high transition: 0 = No wake up request 1 = The host shall wake up

2.1.11.4. Low Current Indicator

A low current indication is optionally available over a GPIO line. By default, low current indication is disabled and the GPIO pads can be configured and employed as usual.

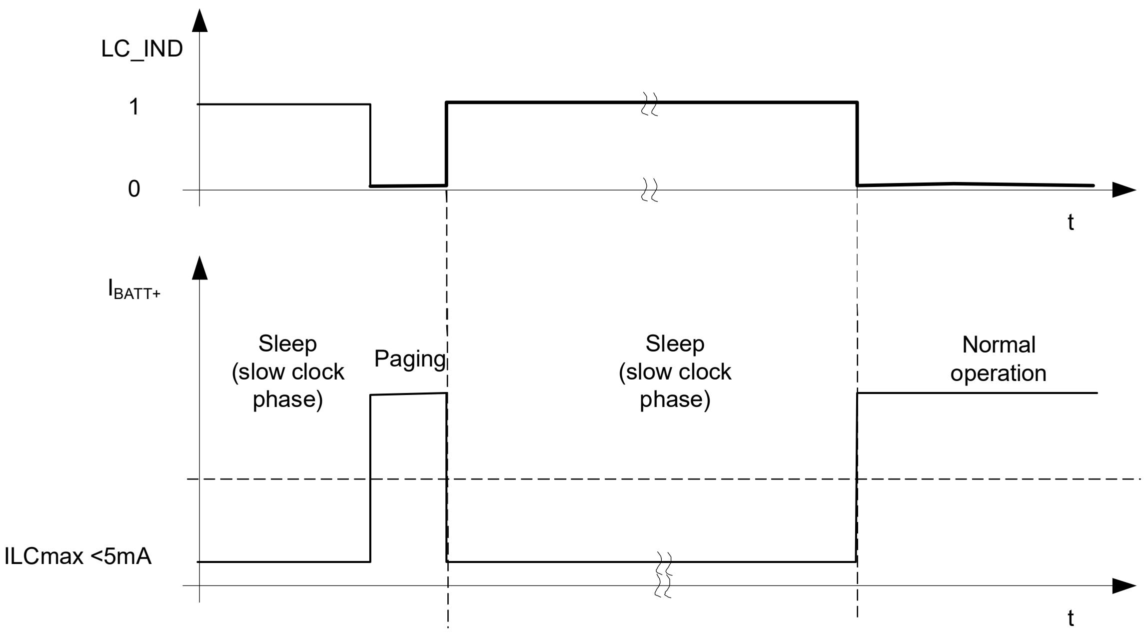
For a GPIO pad to work as a low current indicator the feature has to be enabled by AT command (see [1]: AT^SCFG: MEop-Mode/PowerMgmt/LCI). By default, the GPIO6 pad is configured as LCI_IND signal.

If enabled, the GPIOx/LCI_IND signal is high when the module is sleeping. During its sleep the module will for the most part be slow clocked with 32kHz RTC.

Table 8: Low current indicator line

Signal	I/O/P	Description
GPIOx/LCI_IND	O	Inactive to active high transition: 0 = High current consumption The module draws its power via BATT+ 1 = Low current consumption (only reached during SLEEP mode) The module draws only a low current via BATT+

Figure 12: Low current indication timing



ILCmax During the low current periods the current consumption does not exceed the ILCmax value.

2.2. GSM/UMTS/LTE Antenna Interface

The ALAS3K-US GSM/UMTS/LTE antenna interface comprises a GSM/UMTS/LTE main antenna as well as a UMTS/LTE Rx diversity/MIMO antenna to improve signal reliability and quality[1]. The interface has an impedance of 50Ω. ALAS3K-US is capable of sustaining a total mismatch at the antenna interface without any damage, even when transmitting at maximum RF power.

The external antennas must be matched properly to achieve best performance regarding radiated power, modulation accuracy and harmonic suppression. Matching networks are not included on the ALAS3K-US PCB and should be placed in the host application, if the antenna does not have an impedance of 50Ω.

Regarding the return loss ALAS3K-US provides the following values in the active band:

Table 9: Return loss in the active band

State of module	Return loss of module	Recommended return loss of application
Receive	≥ 8dB	≥ 12dB
Transmit	not applicable	≥ 12dB
Idle	≤ 5dB	not applicable

1. By delivery default the UMTS/LTE Rx diversity/MIMO antenna is configured as available for the module since its usage is mandatory for LTE. Please refer to [1] for details on how to configure antenna settings.

2.2.1. Antenna Interface Specifications

Table 10: RF Antenna interface GSM/UMTS/LTE (at operating temperature range[1])

Parameter	Conditions	Min.	Typical	Max.	Unit
LTE connectivity[2]	Band 2, 4, 5, 12, 29				
Receiver Input Sensitivity @ ARP (ch. bandwidth 5MHz)	LTE 1900 Band 2	-98	-102		dBm
	LTE 1700 Band 4	-100	-103		dBm
	LTE 850 Band 5	-98	-104		dBm
	LTE 700 Band 12	-97	-103		dBm
	LTE 700 Band 29	-97	-102		dBm
RF Power @ ARP with 50Ω Load	LTE 1900 Band 2	+21	+23	+25	dBm
	LTE 1700 Band 4	+21	+23	+25	dBm
	LTE 850 Band 5	+21	+23	+25	dBm
	LTE 700 Band 12	+21	+23	+25	dBm
UMTS/HSPA connectivity[2]	Band II, IV, V				
Receiver Input Sensitivity @ ARP	UMTS 1900 Band II	-104.7	-109		dBm
	UMTS 1700 Band IV	-106.7	-110		dBm
	UMTS 850 Band V	-104.7	-110		dBm
RF Power @ ARP with 50Ω Load	UMTS 1900 Band II	+21	+24	+25	dBm
	UMTS 1700 Band IV	+21	+24	+25	dBm
	UMTS 850 Band V	+21	+24	+25	dBm
GPRS coding schemes	Class 12, CS1 to CS4				
EGPRS	Class 12, MCS1 to MCS9				
GSM Class	Small MS				
Static Receiver input Sensitivity @ ARP	GSM 850 / E-GSM 900	-102	-110		dBm
	GSM 1800 / GSM 1900	-102	-109		dBm
RF Power @ ARP with 50Ω Load GSM	GSM 850 / E-GSM 900		33		dBm
	GSM 1800 / GSM 1900		30		dBm

Table 10: RF Antenna interface GSM/UMTS/LTE (at operating temperature range[1])

Parameter		Conditions	Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ω Load (**ROPR=4**, i.e., no reduction)	GPRS, 1 TX	GSM 850 / E-GSM 900		33		dBm
		GSM 1800 / GSM 1900		30		dBm
	EDGE, 1 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
	GPRS, 2 TX	GSM 850 / E-GSM 900		33		dBm
		GSM 1800 / GSM 1900		30		dBm
	EDGE, 2 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
	GPRS, 3 TX	GSM 850 / E-GSM 900		33		dBm
		GSM 1800 / GSM 1900		30		dBm
	EDGE, 3 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
	GPRS, 4 TX	GSM 850 / E-GSM 900		33		dBm
		GSM 1800 / GSM 1900		30		dBm
	EDGE, 4 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
RF Power @ ARP with 50Ω Load (**ROPR=5**)	GPRS, 1 TX	GSM 850 / E-GSM 900		33		dBm
		GSM 1800 / GSM 1900		30		dBm
	EDGE, 1 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
	GPRS, 2 TX	GSM 850 / E-GSM 900		33		dBm
		GSM 1800 / GSM 1900		30		dBm
	EDGE, 2 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
	GPRS, 3 TX	GSM 850 / E-GSM 900		32.2		dBm
		GSM 1800 / GSM 1900		29.2		dBm
	EDGE, 3 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
	GPRS, 4 TX	GSM 850 / E-GSM 900		31		dBm
		GSM 1800 / GSM 1900		28		dBm
	EDGE, 4 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm

Table 10: RF Antenna interface GSM/UMTS/LTE (at operating temperature range[1])

Parameter		Conditions	Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ω Load (**ROPR=6**)	GPRS, 1 TX	GSM 850 / E-GSM 900		33		dBm
		GSM 1800 / GSM 1900		30		dBm
	EDGE, 1 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
	GPRS, 2 TX	GSM 850 / E-GSM 900		31		dBm
		GSM 1800 / GSM 1900		28		dBm
	EDGE, 2 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
	GPRS, 3 TX	GSM 850 / E-GSM 900		30.2		dBm
		GSM 1800 / GSM 1900		27.2		dBm
	EDGE, 3 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
	GPRS, 4 TX	GSM 850 / E-GSM 900		29		dBm
		GSM 1800 / GSM 1900		26		dBm
	EDGE, 4 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
RF Power @ ARP with 50Ω Load (**ROPR=7**)	GPRS, 1 TX	GSM 850 / E-GSM 900		33		dBm
		GSM 1800 / GSM 1900		30		dBm
	EDGE, 1 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
	GPRS, 2 TX	GSM 850 / E-GSM 900		30		dBm
		GSM 1800 / GSM 1900		27		dBm
	EDGE, 2 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
	GPRS, 3 TX	GSM 850 / E-GSM 900		28.2		dBm
		GSM 1800 / GSM 1900		25.2		dBm
	EDGE, 3 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
	GPRS, 4 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		24		dBm
	EDGE, 4 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm

Table 10: RF Antenna interface GSM/UMTS/LTE (at operating temperature range[1])

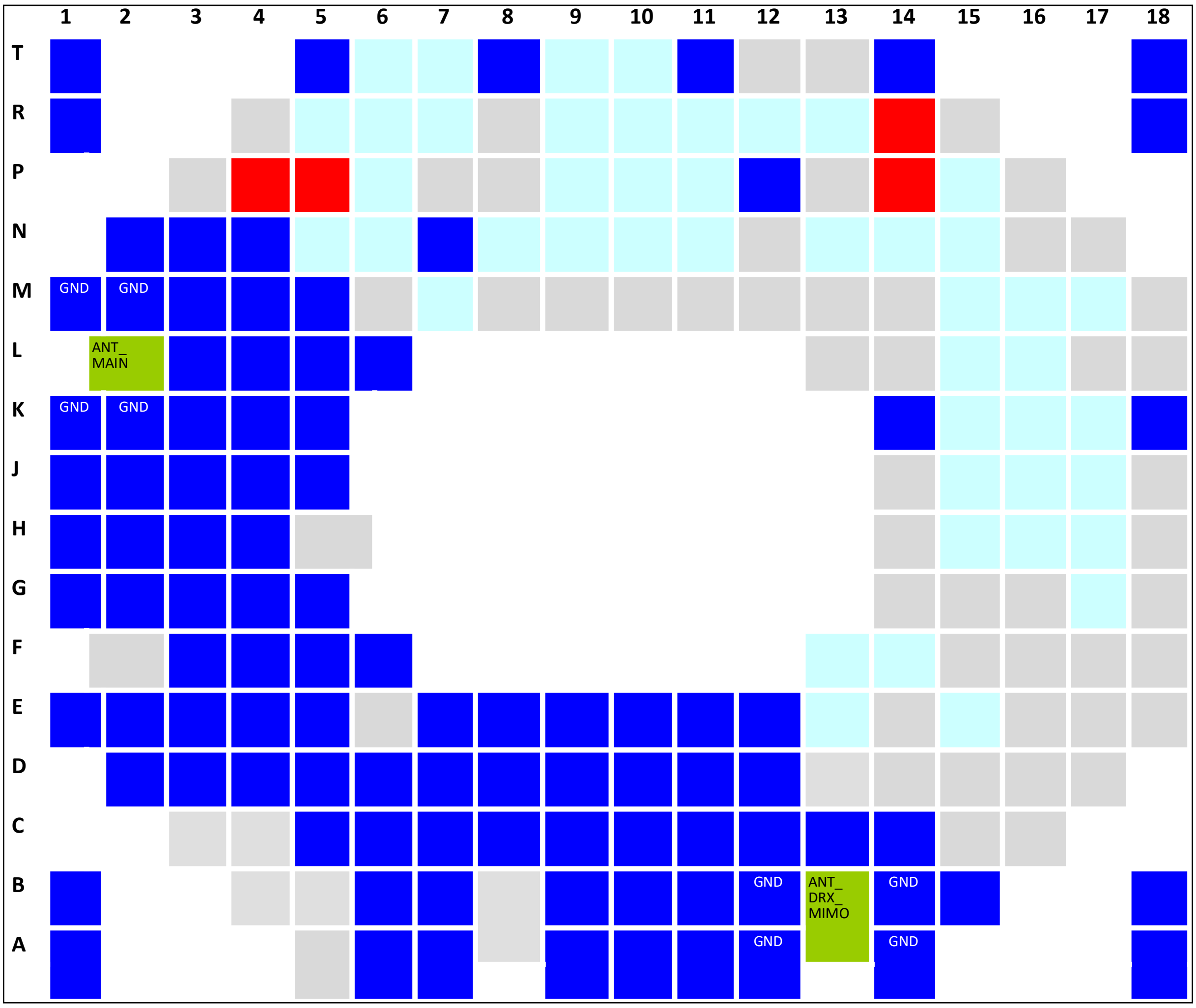
Parameter		Conditions	Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ω Load (**ROPR=8**, i.e., max. reduction)	GPRS, 1 TX	GSM 850 / E-GSM 900		33		dBm
		GSM 1800 / GSM 1900		30		dBm
	EDGE, 1 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		26		dBm
	GPRS, 2 TX	GSM 850 / E-GSM 900		30		dBm
		GSM 1800 / GSM 1900		27		dBm
	EDGE, 2 TX	GSM 850 / E-GSM 900		24		dBm
		GSM 1800 / GSM 1900		23		dBm
	GPRS, 3 TX	GSM 850 / E-GSM 900		28.2		dBm
		GSM 1800 / GSM 1900		25.2		dBm
	EDGE, 3 TX	GSM 850 / E-GSM 900		22.2		dBm
		GSM 1800 / GSM 1900		21.2		dBm
	GPRS, 4 TX	GSM 850 / E-GSM 900		27		dBm
		GSM 1800 / GSM 1900		24		dBm
	EDGE, 4 TX	GSM 850 / E-GSM 900		21		dBm
		GSM 1800 / GSM 1900		20		dBm

1. At restricted temperature range no active power reduction is implemented - any deviations are hardware related.
2. Applies also to UMTS/LTE Rx diversity/MIMO antenna.

2.2.2. Antenna Installation

The antenna is connected by soldering the antenna pads (ANT_MAIN; ANT_DRX_MIMO) and their neighboring ground pads directly to the application's PCB.

Figure 13: Antenna pads (bottom view)



The distance between the antenna pads and their neighboring GND pads has been optimized for best possible impedance. To prevent mismatch, special attention should be paid to these pads on the application' PCB.The wiring of the antenna connection, starting from the antenna pad to the application's antenna must result in a 50Ω line impedance. Line width and distance to the GND plane need to be optimized with regard to the PCB's layer stack. Related instructions are given in Section 2.2.3..

To prevent receiver desensitization due to interferences generated by fast transients like high speed clocks on the external application PCB, it is recommended to realize the antenna connection line using embedded Stripline rather than Micro-Stripline technology. Please see Section 2.2.3. for instructions of how to design the antenna connection in order to achieve the required 50Ω line impedance.

For type approval purposes (i.e., FCC KDB 996369 related to modular approval requirements), an external application must connect the RF signal in one of the following ways:

- Via 50Ω coaxial antenna connector (common connectors are U-FL or SMA) placed as close as possible to the module's antenna pad.
- By soldering the antenna to the antenna connection line on the application's PCB (without the use of any connector) as close as possible to the module's antenna pad.
- By routing the application PCB's antenna to the module's antenna pad in the shortest possible way.

2.2.3. RF Line Routing Design

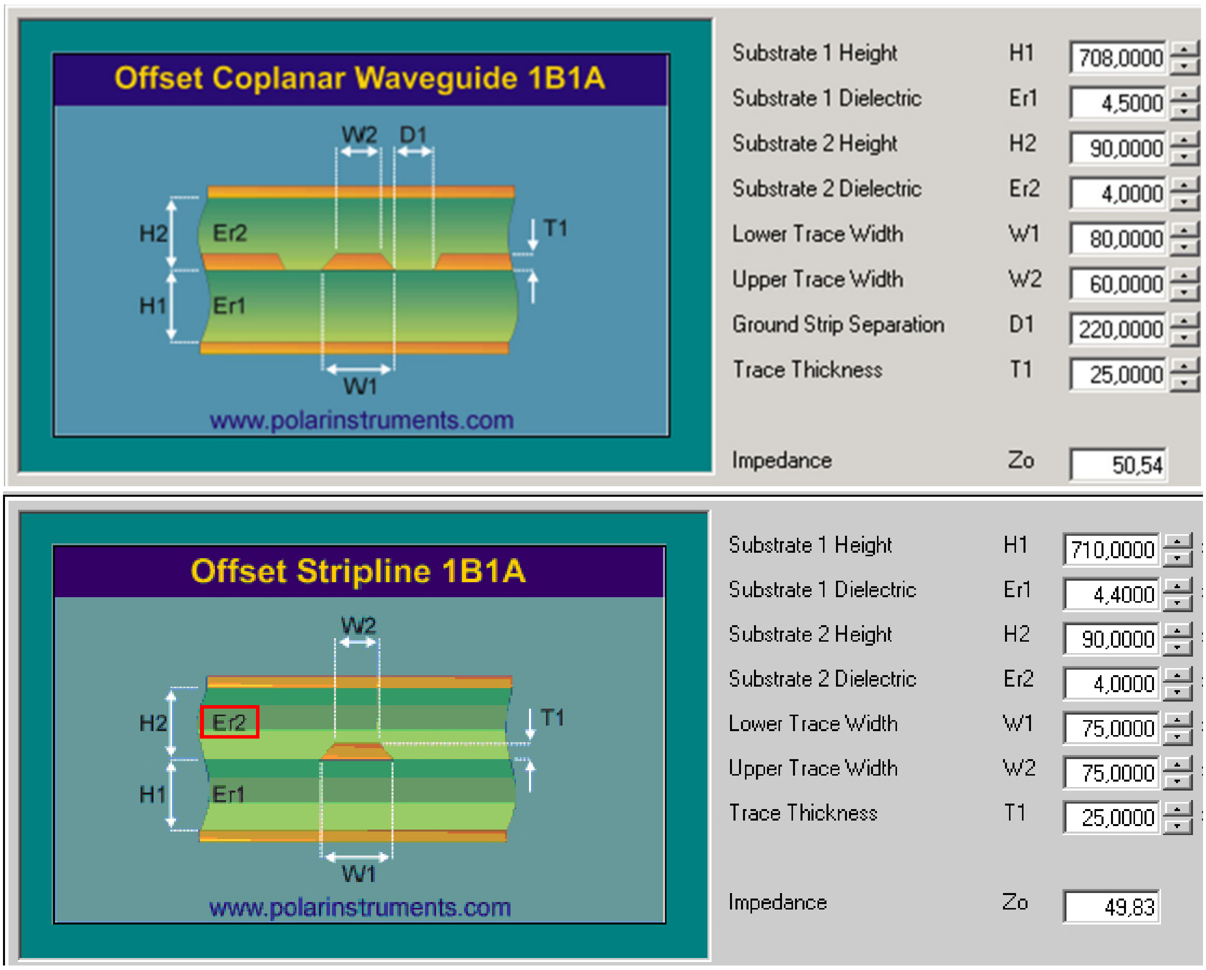
2.2.3.1. Line Arrangement Instructions

Several dedicated tools are available to calculate line arrangements for specific applications and PCB materials - for example from http://www.polarinstruments.com/ (commercial software) or from http://web.awrcorp.com/Usa/Products/Optional-Products/TX-Line/ (free software).

Embedded Stripline

This below figure shows line arrangement examples for embedded stripline.

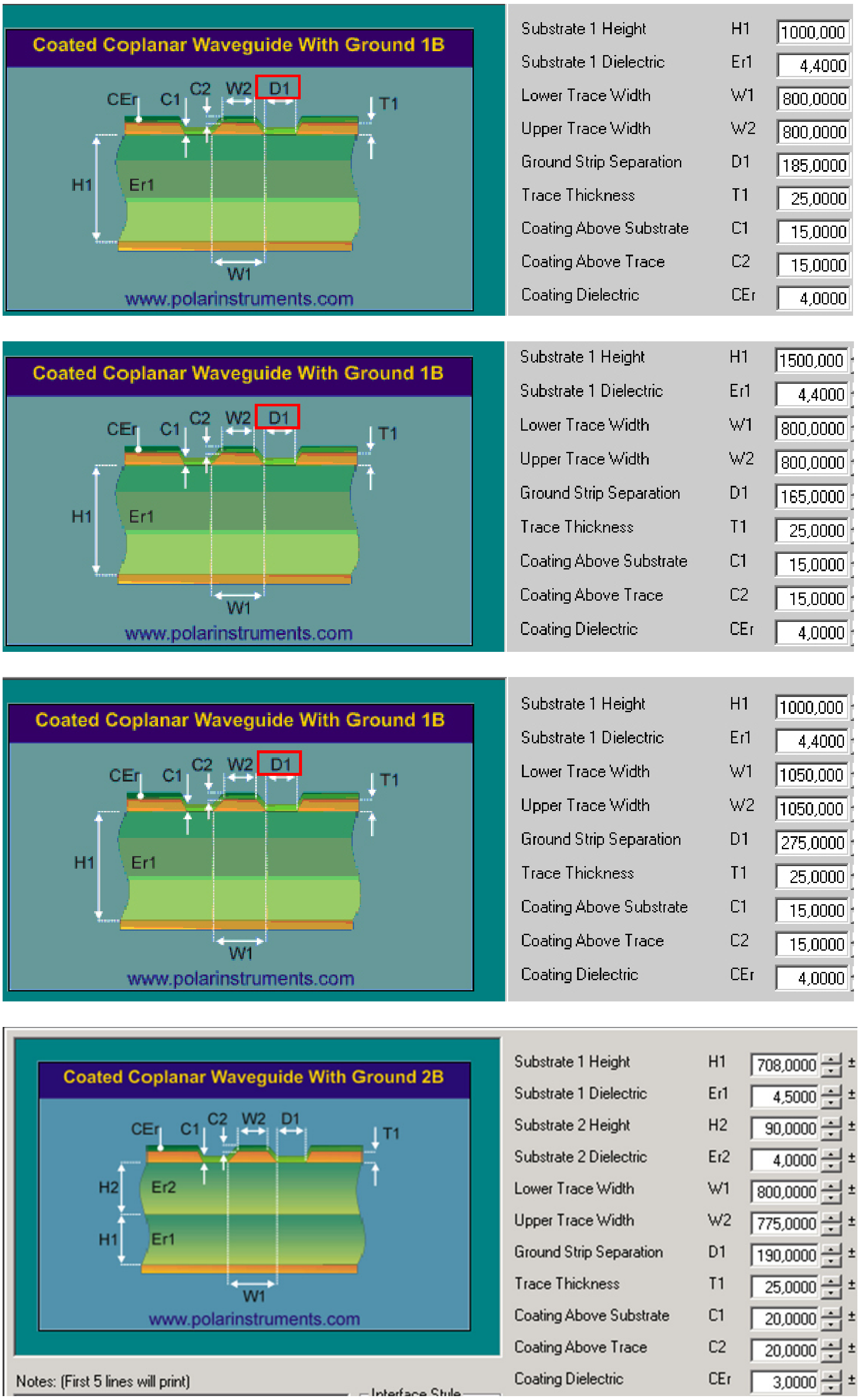
Figure 14: Embedded Stripline line arrangement



Micro-Stripline

This section gives two line arrangement examples for micro-stripline.

Figure 15: Micro-Stripline line arrangement samples



2.2.3.2. Routing Examples

Interface to RF Connector

Figure 16 shows a sample connection of a module's antenna pad at the bottom layer of the module PCB with an application PCB's coaxial antenna connector. Line impedance depends on line width, but also on other PCB characteristics like dielectric, height and layer gap. The sample stripline width of 0.40mm is recommended for an application with a PCB layer stack resembling the one of the ALAS3K-US evaluation board. For different layer stacks the stripline width will have to follow stripline routing rules, avoiding 90 degree corners and using the shortest distance to the PCB's coaxial antenna connector.

Figure 16: Routing to application's RF connector

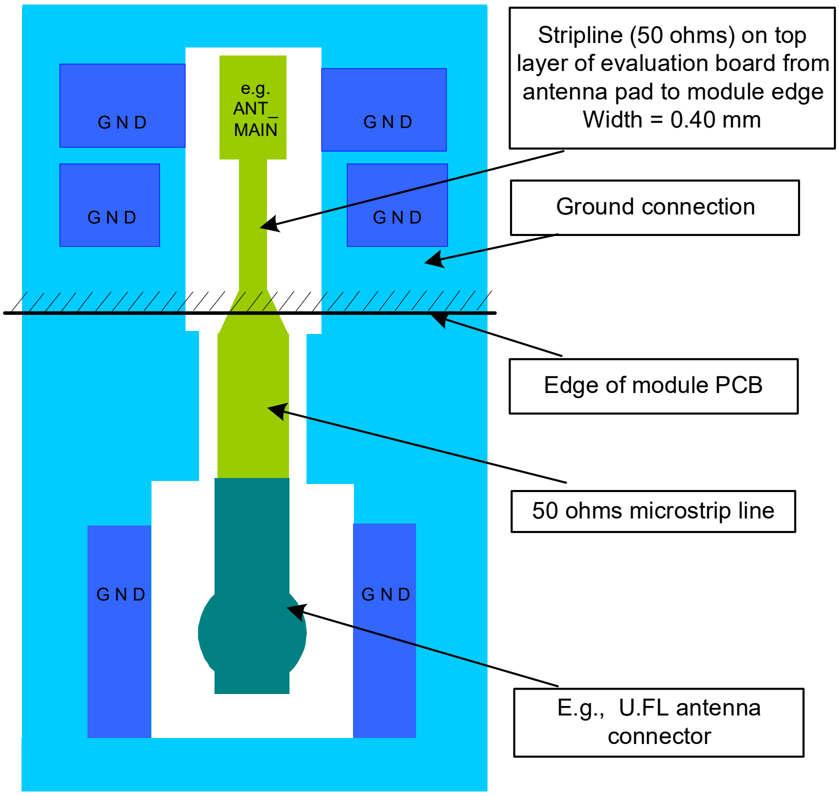
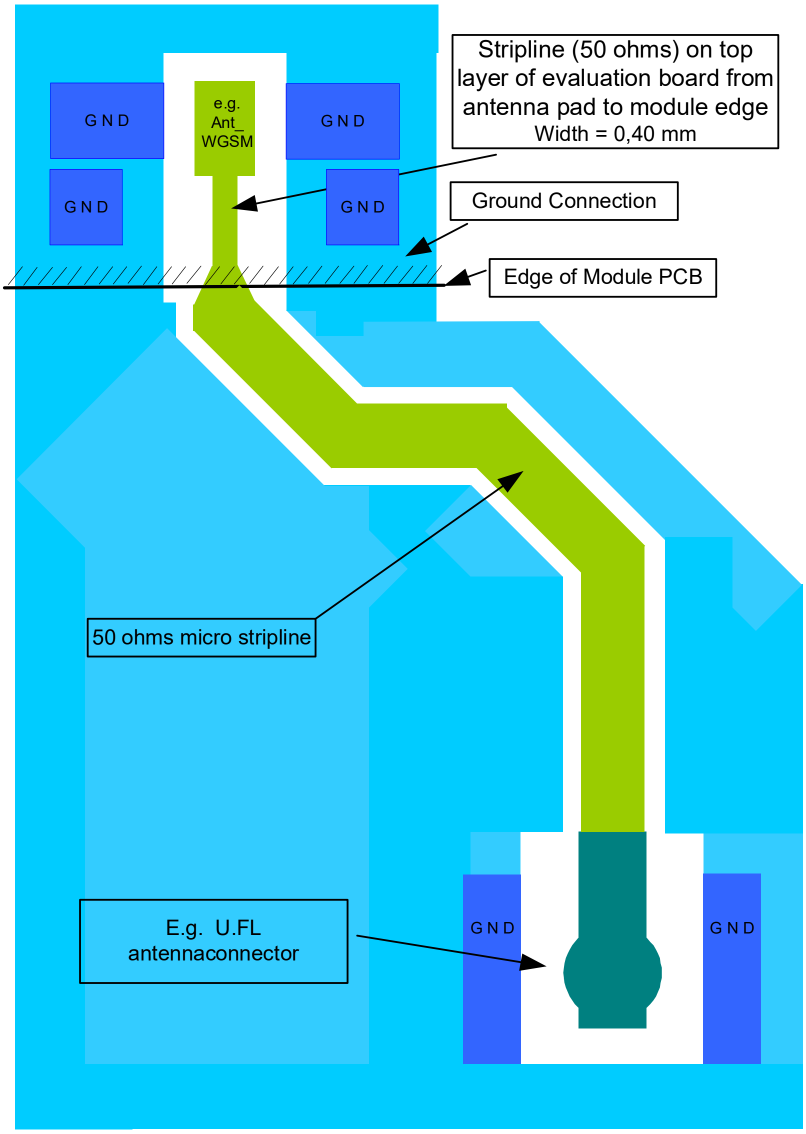


Figure 17 shows a further sample connection of an evaluation module's antenna pad at the bottom layer of the ALAS3K-US evaluation module PCB with the PCB's coaxial antenna connector. The ALAS3K-US evaluation module is part of the reference equipment used by Kontron for type approval (see also Section 5.3.).

Figure 17: Routing to ALAS3K-US evaluation module's RF connector



2.2.4. RF Antenna Diagnostic

RF antenna (GSM/UMTS/LTE) diagnosis requires the implementation of an external antenna detection circuit. An example for such a circuit is illustrated in Figure 19. It allows to check the presence and the connection status of 1 or 2 RF antennas.

To properly detect the antenna and verify its connection status the antenna feed point must have a DC resistance R_{ANT} of 9kΩ (±3kΩ).

A positive or negative voltage drop (referred to as $V_{disturb}$) on the ground line may occur without having any impact on the measuring procedure and the measuring result. A peak deviation ($V_{disturb}$) of ≤ 0.8V from ground is acceptable.
$V_{disturb}$ (peak) = ± 0.8V (maximum); $f_{disturb}$ = 0Hz … 5kHz

Waveform: DC, sinus, square-pulse, peak-pulse (width = 100µs)
$R_{disturb}$ = 5Ω

To make sure that the antenna detection operates reliably, the capacitance at the module's antenna pad (i.e., the cable capacitance plus the antenna capacitance (C_{ANT})) should not be greater than 1000pF. Some types of antennas (for example "inverted F antenna" or "half loop antenna") need an RF short circuit between the antenna structure and ground to work properly. In this case the RF short circuit has to be realized via a capacitance (C_{ANT}) . For C_{ANT} we recommend a capacitance lower than 100pF (see Figure 18).

Figure 18: Resistor measurement used for antenna detection

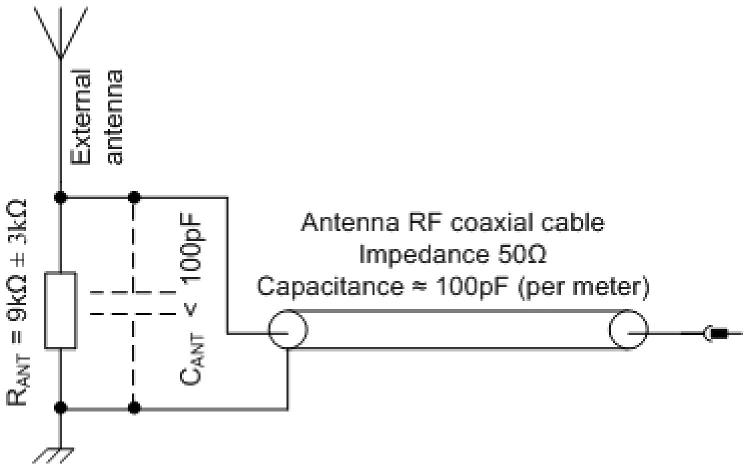
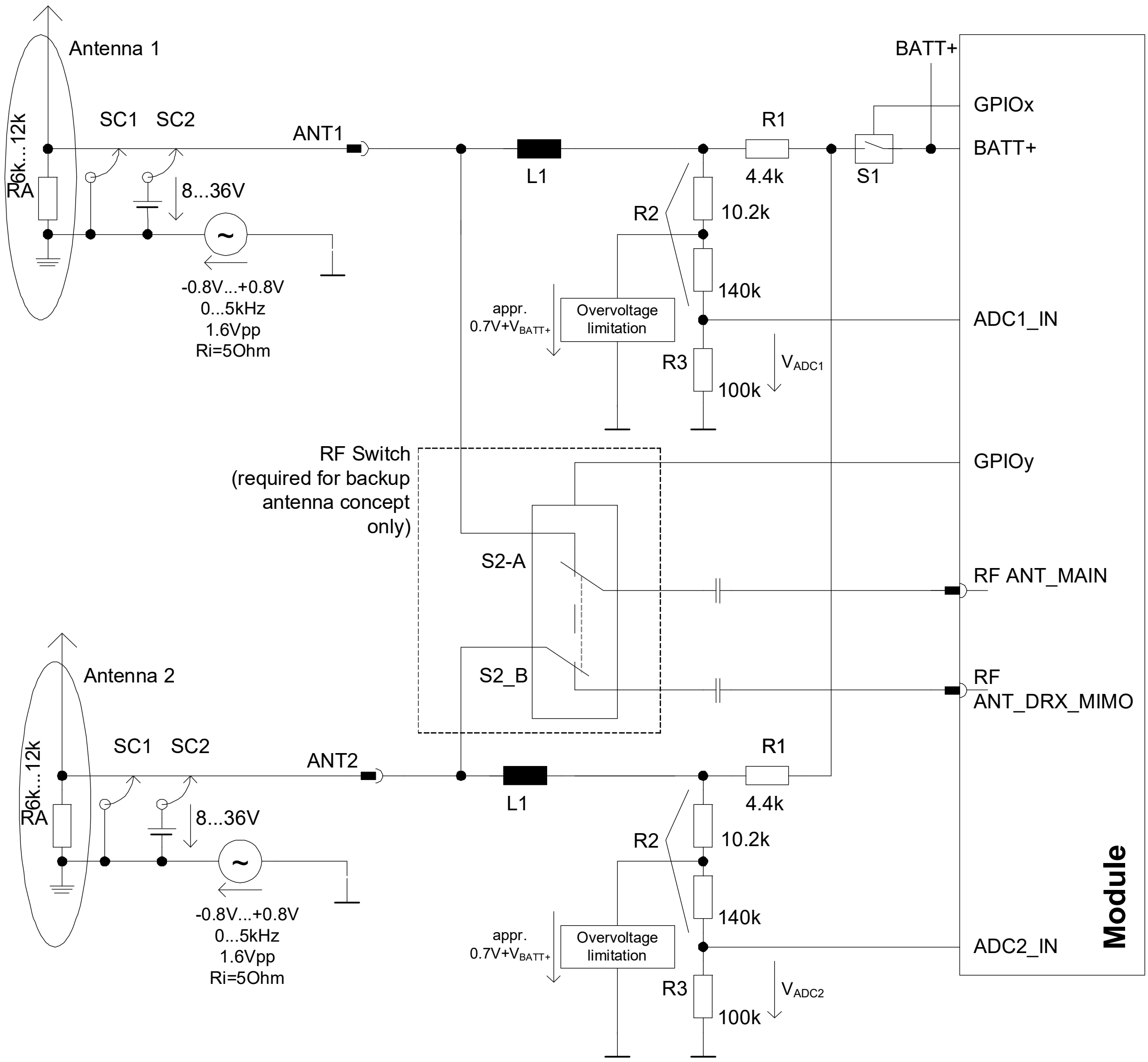


Figure 19 shows the basic principles of an antenna detection circuit that is able to detect two antennas and verify their connection status. The GPIO pads can be employed to enable the antenna detection, the ADCx_IN pads can be used to measure the voltage of external devices connected to these ADC input pads - thus determining R_{ANT} values. The AT^SRADC write command configures the parameters required for ADC measurement and returns the measurement result(s) - for command details see [1].

Figure 19: Basic layout sample for antenna detection



The following Table 11 lists possible signal states for the GPIOx and GPIOy signal lines in case these lines are configured and used for antenna detection. For GPIO configuration and control commands see [1].

Table 11: Possible GPIOx and GPIOy signal states if used for antenna diagnosis

Signal state	Meaning
GPIOx: Input Pull down or Output low Output high	Antenna detection control (S1 in above figure): Off (diagnostic measurement is off) On (diagnostic measurement is on)
GPIOy: Input Pull down or Output low Output high	Antenna switch control (RF switch in above figure): Antenna 1 Antenna 2

Table 12 lists assured antenna diagnostic states depending on the measured R_{ANT} values. Note that the R_{ANT} ranges not mentioned in the below table, i.e., 1kΩ...6kΩ and 12kΩ...40kΩ are tolerance ranges. Within these tolerance ranges a decision threshold for a diagnostic application may be located. For more details on the sample antenna detection circuit please refer to Section 2.3.2..

Table 12: Assured antenna diagnostic states

Antenna state	R_{ANT} range
Normal operation, antenna connected (resistance at feed point as required)	R_{ANT} = 6kΩ...12kΩ
Antenna pad short-circuited to GND	R_{ANT} = 0...1kΩ
Antenna not properly connected, or resistance at antenna feed point wrong or not present	R_{ANT} = 40kΩ...∞Ω
Antenna pad is short-circuited to the supply voltage of the host application, for example the vehicle's on-board power supply voltage	max. 36V

Measuring procedure for the basic layout sample given in Figure 19:
The battery current flows through R1 and RA. The voltage drop on RA is divided by R3/(R3+R2) and measured by the ADCx_IN input. For the ADCx_IN voltage V_{ADCx} (monitored using AT^SRADC) and the BATT+ supply voltage V_{BATT+} (monitored using AT^SBV) several measuring samples should be taken for averaging. The measured and averaged value V_{ADCx} will then be compared to three decision thresholds. The decision thresholds depend on BATT+:

Table 13: GSM/UMTS/LTE antenna diagnostic decision threshold

Decision threshold[1]		V_{ADCx}	Result
Short to GND	Appr. 0,176*V_{BATT+} (580mV...738mV)	<	Short-circuited to ground
		>	Antenna connected
No antenna	Appr. 0,337*V_{BATT+} (1111mV...1414mV)	<	
		>	Antenna nor properly connected
Short to power	0.146+0.405*V_{BATT+} (1482mV...1888mV)	<	
		>	Short-circuited to power

1. The decision thresholds depends on BATT+ and has to be calculated separately for each decision (the BATT+ voltage level V_{BATT+} is known to the system: $3.3V \leq V_{BATT+} \leq 4.2V$).

2.3. Sample Application

Figure 20 shows a typical example of how to integrate an ALAS3K-US module with an application.

The PWR_IND line is an open collector that needs an external pull-up resistor which connects to the voltage supply VCC µC of the microcontroller. Low state of the open collector pulls the PWR_IND signal low and indicates that the ALAS3K-US module is active, high level notifies the Power Down mode.

If the module is in Power Down mode avoid current flowing from any other source into the module circuit, for example reverse current from high state external control lines. Therefore, the controlling application must be designed to prevent reverse flow.

While developing SMT applications it is strongly recommended to provide test points for certain signals, i.e., lines to and from the module - for debug and/or test purposes. The SMT application should allow for an easy access to these signals. For details on how to implement test points see [3].

The EMC measures are best practice recommendations. In fact, an adequate EMC strategy for an individual application is very much determined by the overall layout and, especially, the position of components.

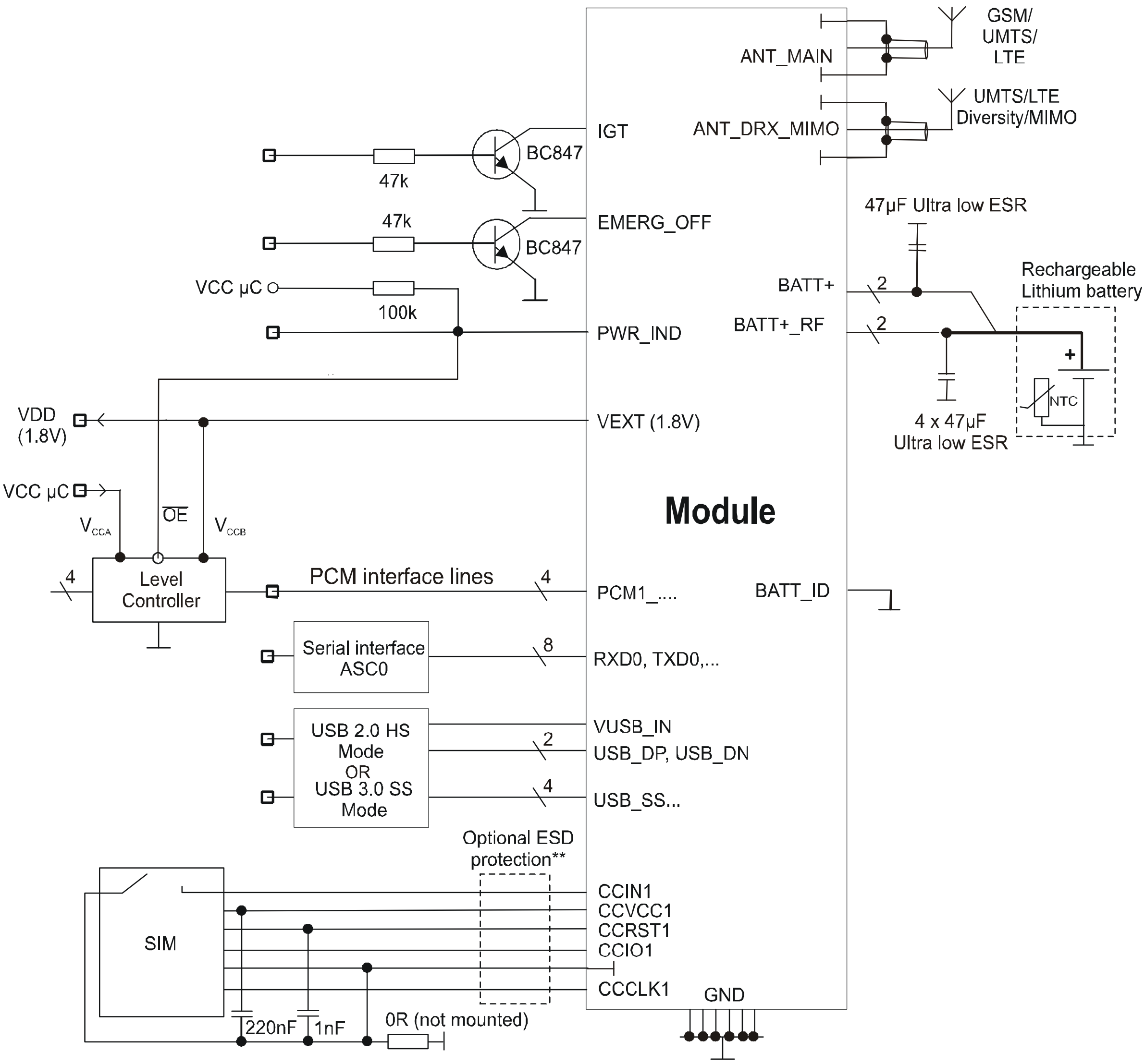
Some LGA pads are connected to clocks or high speed data streams that might interfere with the module's antenna. The RF receiver would then be blocked at certain frequencies (self interference). The external application's PCB tracks connected to these pads should therefore be well shielded or kept away from the antenna. This applies especially to the USB and UICC/SIM interfaces.

Depending on the micro controller used by an external application ALAS3K-US's digital input and output lines may require level conversion. Section 2.3.1. shows a possible sample level conversion circuit.

The analog-to-digital converter (ADCx_IN lines) can be used for antenna diagnosis. A sample antenna detection circuit can be found in Figure 22 and Figure 23.

Disclaimer:
No warranty, either stated or implied, is provided on the sample schematic diagram shown in Figure 20 and the information detailed in this section. As functionality and compliance with national regulations depend to a great amount on the used electronic components and the individual application layout manufacturers are required to ensure adequate design and operating safeguards for their products using ALAS3K-US modules.

Figure 20: ALAS3K-US sample application



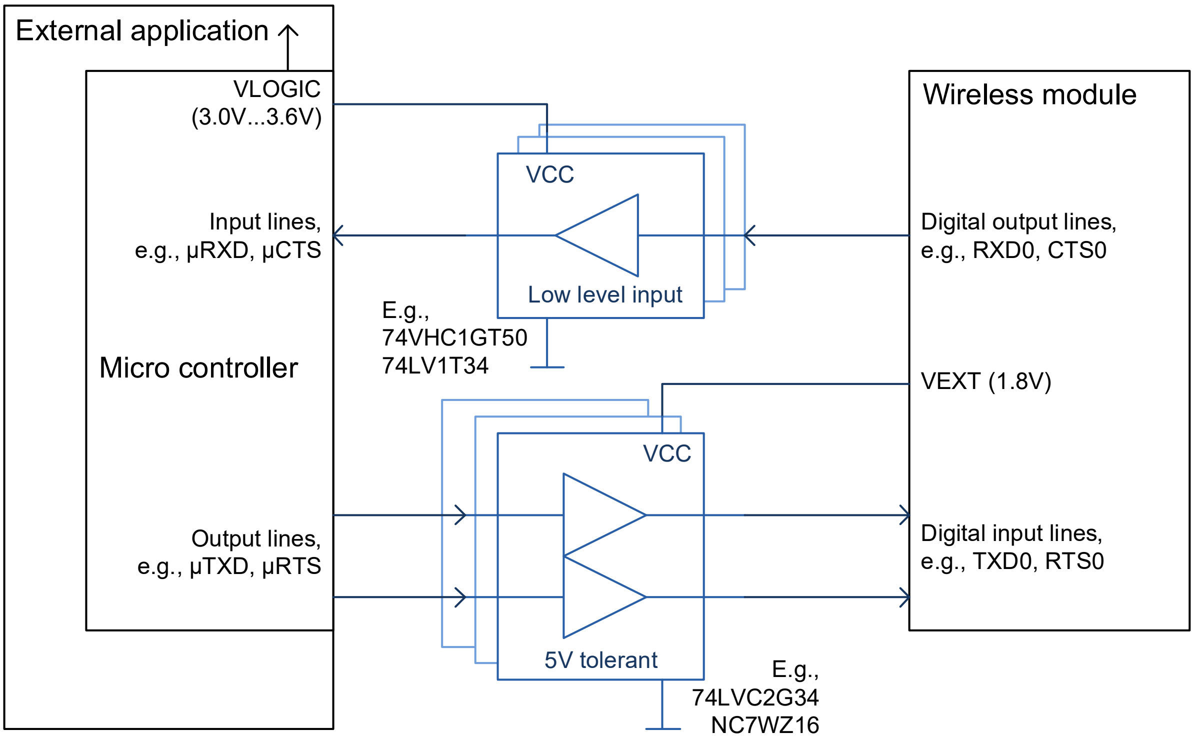
All SIM components shall be close to card holder.
Keep SIM wires low capacitive.

** See Section 2.1.6. for details on enhanced ESD protection

2.3.1. Sample Level Conversion Circuit

Depending on the micro controller used by an external application ALAS3K-US's digital input and output lines (i.e., ASC0 lines) may require level conversion. The following Figure 21 shows a sample circuit with recommended level shifters for an external application's micro controller (with VLOGIC between 3.0V...3.6V). The level shifters can be used for digital input and output lines with V_{OH}max=1.85V or V_{IH}max =1.85V.

Figure 21: Sample level conversion circuit



2.3.2. Sample Circuit for Antenna Detection

The following figures explain how an RF antenna detection circuit may be implemented for ALAS3K-US to be able to detect 1 or 2 antennas (for basic circuit and diagnostic principles - including usage of GPIO and ADCx_IN pads - please refer to Section 2.2.4.). Figure 22 gives a general overview, Figure 23 depicts the actual antenna detection layout and shows how ESD protection, i.e., the RF/DC bridge, will have to be handled. The switch driver and antenna switch mentioned in Figure 22 will have to be realized by the application manufacturer.

Properties for the components mentioned in Figure 22 and Figure 23 are given in Table 14 - parts list.

Figure 22: Antenna detection circuit sample - overview

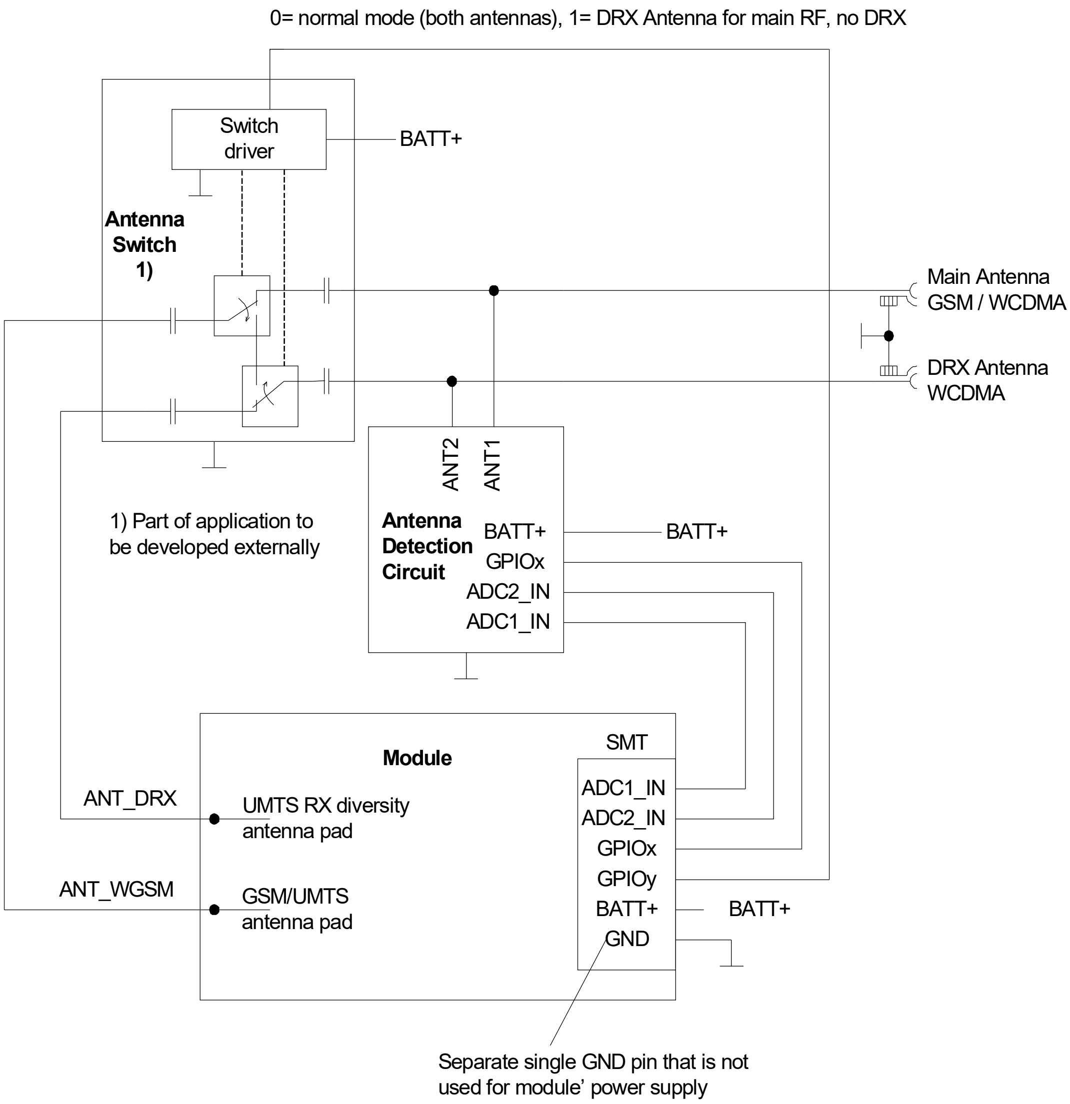


Figure 23: Antenna detection circuit sample - schematic

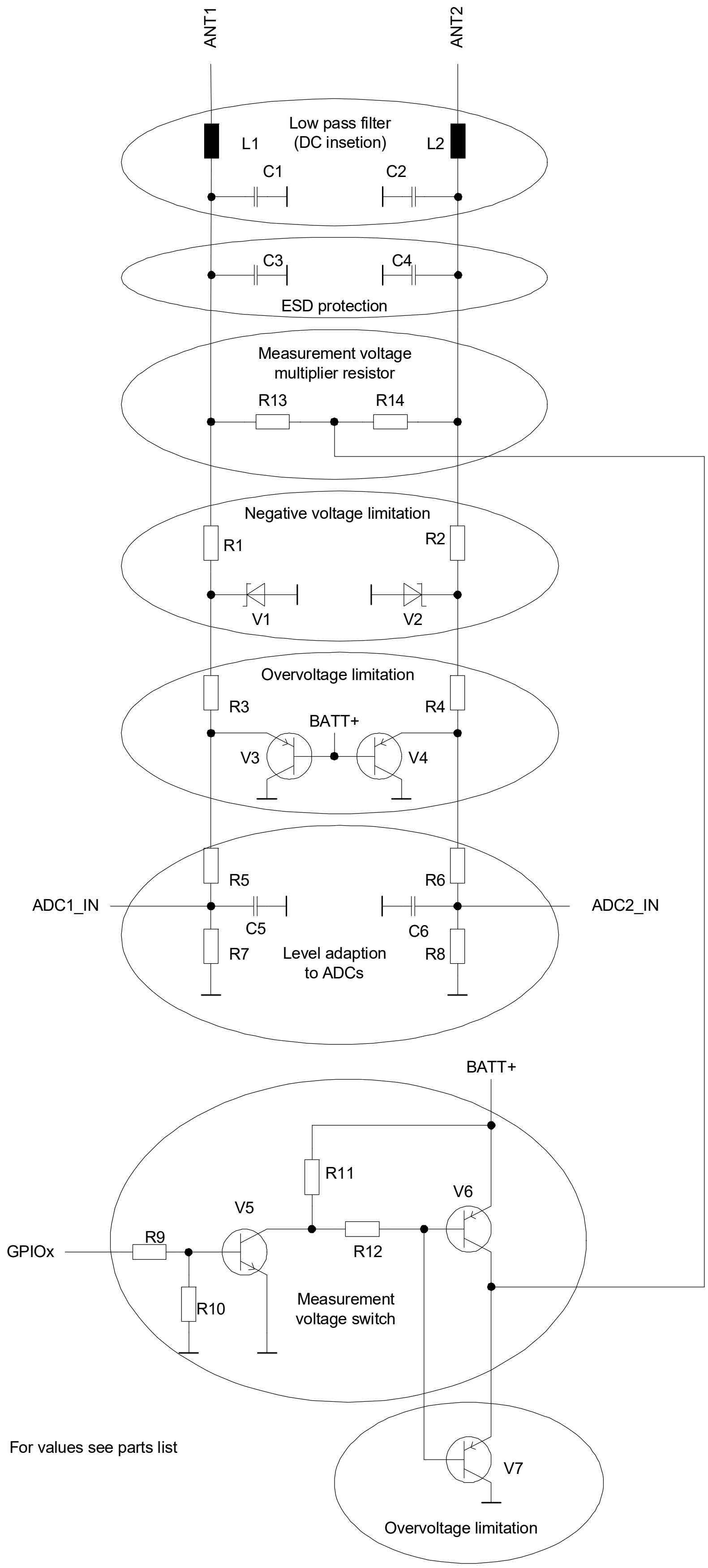


Table 14: Antenna detection reference circuit - parts list

Reference	Part	Value	Tolerance	Conditions	Size
R1,2	Resistor	22R			
R3,4	Resistor	10k		≥ 125mW	
R5,6	Resistor	140k	1%		
R7,8	Resistor	100k	1%		
R9,10	Resistor	100k			
R11,12	Resistor	10k		≥ 125mW	
R13,14	Resistor	4k4 (e.g., 2x2k2 or 4x1k1)	1%	≥ 300mW	
C1,2	Capacitor	22p		50V	≤ 0402
C3,4	Capacitor	100n		50V	
C5,6	Capacitor	100n		10V	
V1,2	Schottky diode	RB520-40		40V	
V3,4,6,7	Transistor	BC857			
V5	Transistor	BC847			
L1,2	Inductor	39nH		Wire wound High Q	0402

3/ Operating Characteristics

3.1. Operating Modes

The table below briefly summarizes the various operating modes referred to throughout the document.

Table 15: Overview of operating modes

Mode	Function	
Normal operation	GSM / GPRS / UMTS / HSPA /LTE SLEEP	Power saving set automatically when no call is in progress and the USB connection is detached and no active communication via ASC0.
	GSM / GPRS / UMTS / HSPA / LTE IDLE	Power saving disabled or an USB connection active, but no data transfer in progress.
	GPRS DATA	GPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink / downlink data rates and GPRS configuration (e.g. used multislot settings).
	EGPRS DATA	EGPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink / downlink data rates and EGPRS configuration (e.g. used multislot settings).
	UMTS DATA	UMTS data transfer in progress. Power consumption depends on network settings (e.g. TPC Pattern) and data transfer rate.
	HSPA DATA	HSPA data transfer in progress. Power consumption depends on network settings (e.g. TPC Pattern) and data transfer rate.
	LTE DATA	LTE data transfer in progress. Power consumption depends on network settings (e.g. TPC Pattern) and data transfer rate.
Power Down	Normal shutdown after sending the AT^SMSO command. Software is not active. Interfaces are not accessible. Operating voltage (connected to BATT+) remains applied. Only a voltage regulator is active for powering the RTC, as long as operating voltage applied at BATT+ does not drop below approx. 1.4V.	
Airplane mode	Airplane mode shuts down the radio part of the module, causes the module to log off from the GSM/GPRS network and disables all AT commands whose execution requires a radio connection. Airplane mode can be controlled by AT command (see [1]).	

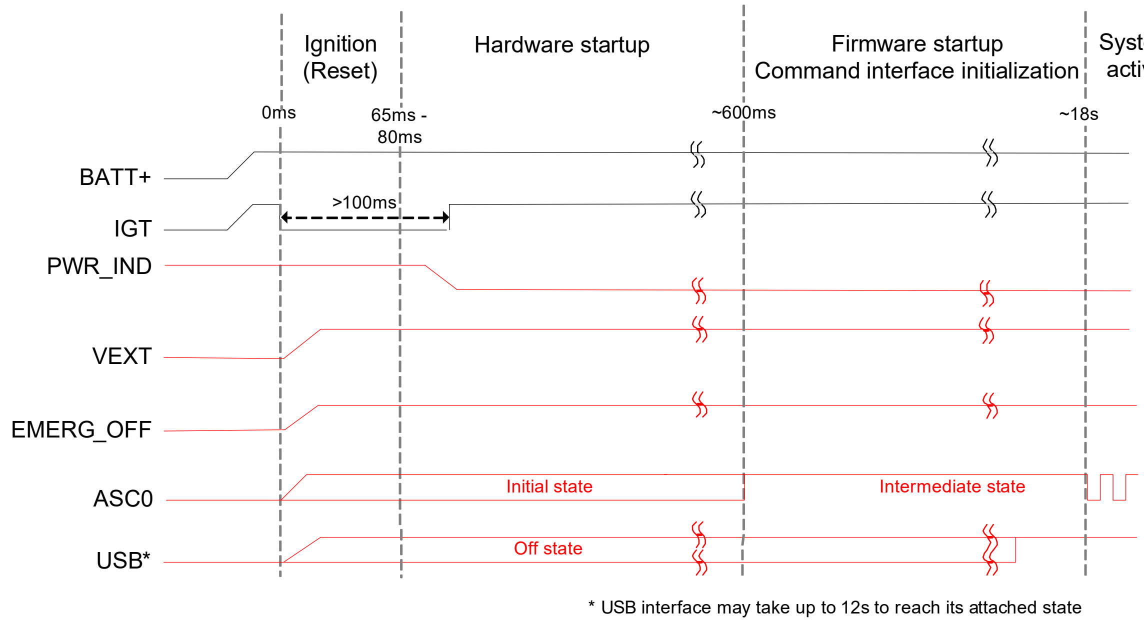
3.2. Power Up/Power Down Scenarios

In general, be sure not to turn on ALAS3K-US while it is beyond the safety limits of voltage (see Section 2.1.2.1.) and temperature (see Section 3.5..). ALAS3K-US immediately switches off after having started and detected these inappropriate conditions. In extreme cases this can cause permanent damage to the module.

3.2.1. Turn on ALAS3K-US

When the ALAS3K-US module is in Power Down mode, it can be started to Normal mode by driving the IGT (ignition) line to ground. It is required to use an open drain/collector driver to avoid current flowing into this signal line. Pulling this signal low triggers a power-on sequence. To turn on ALAS3K-US, it is recommended to keep IGT active at least 100 milliseconds. After turning on ALAS3K-US, IGT should be set inactive to prevent the module from turning on again after a shut down by AT command or EMERG_OFF. For details on signal states during startup see also Section 3.2.2..

Figure 24: Power-on with IGT



Note: After power up IGT should remain high. Also note that with a USB connection the USB host may take some seconds to set up the virtual COM port connection.

After startup or mode change the following URCs are sent to every port able to receive AT commands indicating the module's ready state (this may take up to 18s):

- "^SYSSTART" indicates that the module has entered Normal mode.
- "^SYSSTART AIRPLANE MODE" indicates that the module has entered Airplane mode.

These URCs notify the external application that the first AT command can be sent to the module. If these URCs are not used to detect then the only way of checking the module's ready state can be checked by polling, e.g., send characters (e.g. "at") until the module is responding.

3.2.2. Signal States after First Startup

Table 16 describes the various states each interface signal passes through after startup and during operation.

Signals are in an initial state while the module is initializing. Once the startup initialization has completed, i.e. when the software is running, all signals are in defined state. The state of several signals will change again once the respective interface is activated or configured by AT command.

Table 16: Signal states

Signal name	Reset phase (ignition) 65-80ms	Startup phase Hardware approx. 520ms Firmware approx. 17.4s	System active After approx. 18s
CCIN1	PD and PU (24k)	PU and PU (24k)[1]	I, PU(24k)
CCIN2	PD	PD [1]	I, PU
CCRSTx	Not driven (similar PD)	Not driven (similar PD)	O, L[2]
			O, H[3]
CCIO1	PD(10k)	PD(10k)	PD(10k)[2]
			I/O PU(10k)[3]
CCIO2	Not driven (similar PD)	Not driven (similar PD)	O, L[2]
			O, H[3]
CCCLKx	Not driven (similar PD)	Not driven (similar PD)	O, L[2]
			Clock[3]
CCVCCx	Off	Off	Off[2]
			1.8V/3V[3]
RXD0	PD	PU	O, H
TXD0	PD	PD	I, PU
CTS0	PD	PD	O, L
RTS0	PU and PD	PD	I, PU
DTR0	PD	PD	I, PU
DCD0	PD	PU[4]	O, H
DSR0	PD	PD	O, H
RING0	PD	PD	O, H
DCD0	PD	PD[5]	PD
PCM_IN	PU	PD	PD
PCM_CLK	PD	PD	PD
PCM_FSC	PD	PD	PD
PCM_OUT	PD	PD	PD
PWR_IND	High-Z	O, L	O, L
EMERG_OFF	PU	I, PU	I, PU
IGT	I, PU	I, PU	I, PU
GPIO1...10	PD	PD[6]	PD (if unused)

1. After approx. 13s the signal changes to I, PU.
2. If CCINx = High level
3. If CCINx = Low level, and the SIM card interface is configured by the AT^SCFG="SIM/..:" command
4. No external pull down allowed during this phase.
5. In the time period between 300-600ms after triggering ignition there is a short 30ms PU on DCD0. If the line is driven low during this interval, the module enters a special Download Mode.
6. No external pull up or high signal on GPIO1 during this phase.

L = Low level H = High level I = Input O = Output	PD = Pull down resistor between 18k...65k PD(...k) = Pull down resistor with ...k PU = Pull up resistor between 18k...65k PU(...k) = Pull up resistor with ...k, Z = High impedance

3.2.3. Turn off or Restart ALAS3K-US

To switch off or restart the module the following procedures may be used:

- *Software controlled shutdown procedure*: Software controlled by sending an AT command over the serial application interface. See Section 3.2.3.1..
- *Software controlled restart procedure*: Software controlled by sending an AT command over the serial application interface. See Section 3.2.3.2..
- *Hardware controlled shutdown procedure*: Hardware controlled shutdown by IGT line. See Section 3.2.3.3..
- *Hardware controlled shutdown or restart procedure*: Hardware controlled shutdown or restart by EMERG_OFF line. See Section 3.2.3.4..
- *Automatic shutdown (software controlled)*: See Section 3.2.4.
    - Takes effect if ALAS3K-US board temperature exceeds a critical limit.

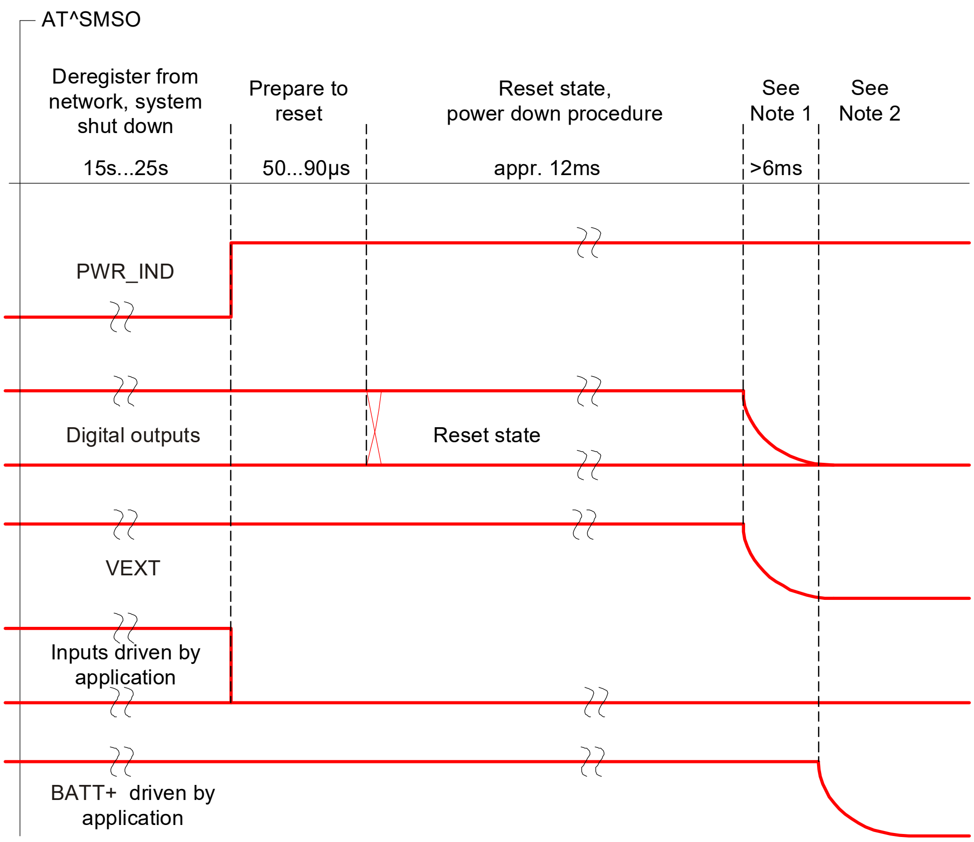
3.2.3.1. Switch off ALAS3K-US Using AT Command

The best and safest approach to powering down ALAS3K-US is to issue the AT^SMSO command. This procedure lets ALAS3K-US log off from the network and allows the software to enter into a secure state and save data before disconnecting the power supply. The mode is referred to as Power Down mode. After sending AT^SMSO do not enter any other AT commands. While powering down the module may still send some URCs. The AT commands “OK” response indicates that the data has been stored non-volatile and the module will turn down in a few seconds. To verify that the module definitely turned off, it is possible to monitor the PWR_IND signal. A high state of the PWR_IND signal line indicates that the module is being switched off as shown in Figure 25.

Be sure not to disconnect the supply voltage V_{BATT+} before the module’s switch off procedure has been completed and the VEXT signal has gone low. Otherwise you run the risk of losing data. Signal states during switch off are shown in Figure 25.

While ALAS3K-US is in Power Down mode the application interface is switched off and must not be fed from any other source. Therefore, your application must be designed to avoid any current flow into any digital signal lines of the application interface. No special care is required for the USB interface which is protected from reverse current.

Figure 25: Signal states during turn-off procedure



Note 1: Depending on capacitance load from host application

Note 2: The power supply voltage (BATT+) may be disconnected or switched off only after the VEXT went low.

Note 3: After module shutdown by means of AT command is completed, please allow for a time period of at least 1 second before restarting the module.

3.2.3.2. Restart ALAS3K-US Using AT Command

The best and safest approach to restart ALAS3K-US is by AT command. For more information on the AT^CFUN command please refer to is described in detail in [1].

3.2.3.3. Turn off ALAS3K-US Using IGT Line

The IGT line can be configured for use in two different switching modes: You can set the IGT line to switch on the module only, or to switch it on and off. The switching mode is determined by the parameter "MEShutdown/OnIgnition" of the AT^SCFG command. This approach is useful for external application manufacturers who wish to have an ON/OFF switch installed on the host device.

By factory default, the ON/OFF switch mode of IGT is disabled:

at^scfg=meshutdown/onignition ^SCFG: "MEShutdown/OnIgnition","off" OK	# Query the current status of IGT. # IGT can be used only to switch on ALAS3K-US. IGT works as described in Section 3.2.1..

To configure IGT for use as ON/OFF switch:

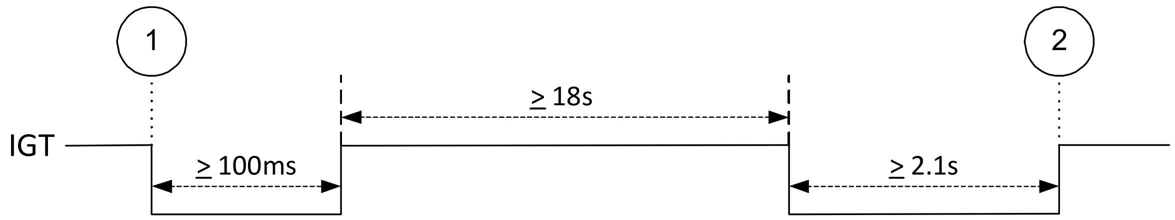
at^scfg=meshutdown/onignition ^SCFG: "MEShutdown/OnIgnition","on" OK	# Enable the ON/OFF switch mode of IGT. # IGT can be used to switch on and off ALAS3K-US.

Take great care before changing the switching mode of the IGT line. To ensure that the IGT line works properly as ON/OFF switch it is of vital importance that the following conditions are met:

Switch-on condition: If the ALAS3K-US is off, the IGT line must be asserted for at least 100 milliseconds before being released.

Switch-off condition: If the ALAS3K-US is on, the IGT line must be asserted for at least 2.1 seconds before being released. The module switches off after the line is released. The switch-off routine is identical with the procedure initiated by AT^SMSO, i.e. the software performs an orderly shutdown as described in Section 3.2.3.1..
Before switching off the module wait at least 18 seconds after startup.

Figure 26: Timing of IGT if used as ON/OFF switch



1 – Triggers switch ON routine
2 – Triggers switch OFF routine

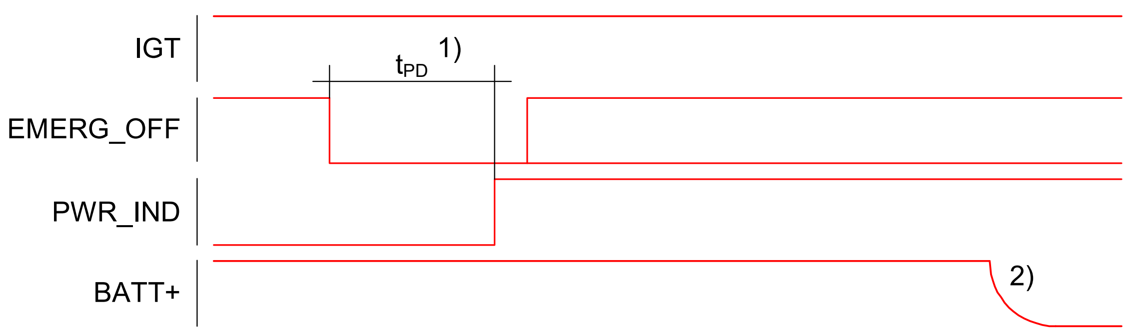
3.2.3.4. Turn off or Restart ALAS3K-US in Case of Emergency

Caution: Use the EMERG_OFF line only when, due to serious problems, the software is not responding for more than 5 seconds. Pulling the EMERG_OFF line causes the loss of all information stored in the volatile memory. Therefore, this procedure is intended only for use in case of emergency, e.g. if ALAS3K-US does not respond, if reset or shutdown via AT command fails.

The EMERG_OFF line is available on the application interface and can be used to turn off or to restart the module. In any case the EMERG_OFF line must be pulled to ground until the Power Down mode is reached, as indicated by PWR_IND=high. To control the EMERG_OFF line it is required to use an open drain / collector driver. EMERG_OFF is pulled high internally.

Now, to permanently turn off the module, the IGT line has to be set to high (inactive) before the EMERG_OFF line is released. The module will then switch off and needs to be restarted at a later time. This switch off behavior is shown in Figure 27.

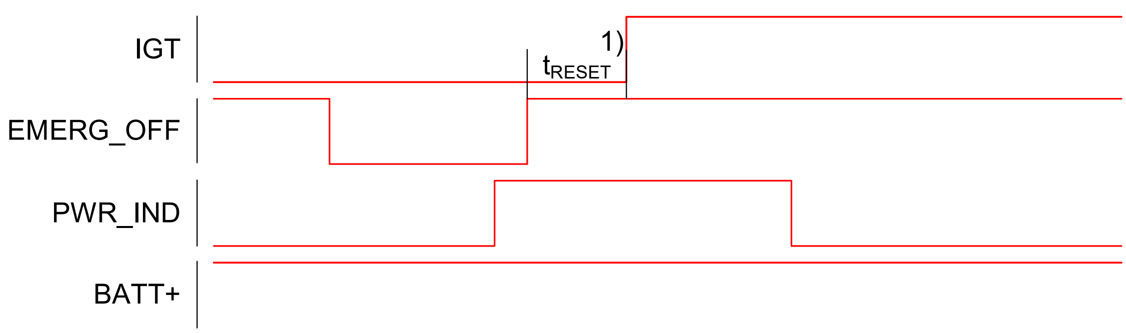
Figure 27: Shutdown by EMERG_OFF signal



1) The time to Power Down mode (t_{PD}) depends on the operating state and may lie between 120µs and 2200ms.
2) The the power supply voltage (BATT+) may be disconnected only after having reached Power Down mode as indicated by the PWR_IND signal going high. The power supply has to be avail-

To simply restart the module, the IGT line has to continue to be driven low (active) for at least 100ms after having released the EMERG_OFF line. The module will then switch off and restart automatically. This restart behavior is shown in Figure 28.

Figure 28: Restart by EMERG_OFF signal



1) The time to module reset (t_{RESET}) must be ≥ 100ms

3.2.4. Automatic Shutdown

Automatic shutdown takes effect if:

- The ALAS3K-US board is exceeding the critical limits of overtemperature
- Undervoltage or overvoltage is detected

The automatic shutdown procedure is equivalent to the power down initiated with the AT^SMSO command, i.e. ALAS3K-US logs off from the network and the software enters a secure state avoiding loss of data.

Alert messages transmitted before the device switches off are implemented as Unsolicited Result Codes (URCs). The presentation of the temperature URCs can be enabled or disabled with the AT commands AT^SCTM. The URC presentation mode varies with the condition, please see Section 3.2.4.1. to Section 3.2.4.4. for details. For further instructions on AT commands refer to [1].

3.2.4.1. Thermal Shutdown

The board temperature is constantly monitored by an internal NTC resistor located on the PCB. The values detected by the NTC resistor are measured directly on the board and therefore, are not fully identical with the ambient temperature.

Each time the board temperature goes out of range or back to normal, ALAS3K-US instantly displays an alert (if enabled).

- URCs indicating the level "1" or "-1" allow the user to take appropriate precautions, such as protecting the module from exposure to extreme conditions. The presentation of the URCs depends on the settings selected with the AT^SCTM write command:
  AT^SCTM=1: Presentation of URCs is always enabled.
  AT^SCTM=0 (default): Presentation of URCs is enabled during the 2 minutes guard period after start-up of ALAS3K-US. After expiry of the 2 minutes guard period, the presentation will be disabled, i.e. no URCs with alert levels "1" or "-1" will be generated.
- URCs indicating the level "2" are instantly followed by an orderly shutdown. The presentation of these URCs is always enabled, i.e. they will be output even though the factory setting AT^SCTM=0 was never changed.

The (maximum) temperature ratings are stated in Section 3.5.. Temperature limits and associated URCs are listed in the below Table 17.

Table 17: Board temperature warning and switch off level

Parameter	Temperature	URC	Notes
High temperature switch off active	≥ +97°C	^SCTM_B: 2	Modules will switch off in the range: >+95°C up to ≤+99°C
High temperature switch off release	≤ +96°C	^SCTM_B: 1	
High temperature warning active	≥ +86°C	^SCTM_B: 1	
High temperature warning release	≤ +85°C	^SCTM_B: 0	
Operating temperature range	-30°C...+85°C	---	
Low temperature warning release	≥ -30°C	^SCTM_B: 0	
Low temperature warning active	≤ -31°C	^SCTM_B: -1	
Low temperature switch off	---	---	Modules do not switch off nor send a switch off URC when exceeding the undertemperature limit, i.e., -40°C.

The AT^SCTM command can also be used to check the present status of the board. Depending on the selected mode, the read command returns the current board temperature in degrees Celsius or only a value that indicates whether the board is within the safe or critical temperature range. See [1] for further instructions.

3.2.4.2. Deferred Shutdown at Extreme Temperature Conditions

In the following cases, automatic shutdown will be deferred if a critical temperature limit is exceeded:

- While an emergency call is in progress.
- During a two minute guard period after power-up. This guard period has been introduced in order to allow for the user to make an emergency call. The start of any one of these calls extends the guard period until the end of the call. Any other network activity may be terminated by shutdown upon expiry of the guard time.

While in a "deferred shutdown" situation, ALAS3K-US continues to measure the temperature and to deliver alert messages, but deactivates the shutdown functionality. Once the 2 minute guard period is expired or the call is terminated, full temperature control will be resumed. If the temperature is still out of range, ALAS3K-US switches off immediately (without another alert message).

Caution: Automatic shutdown is a safety feature intended to prevent damage to the module. Extended usage of the deferred shutdown facilities provided may result in damage to the module, and possibly other severe consequences.

3.2.4.3. Undervoltage Shutdown

If the measured battery voltage is no more sufficient to set up a call the following URC will be presented:

^SBC: Undervoltage.

The URC indicates that the module is close to the undervoltage threshold. If undervoltage persists the module keeps sending the URC several times before switching off automatically.

This type of URC does not need to be activated by the user. It will be output automatically when fault conditions occur.

3.2.4.4. Overvoltage Shutdown

The overvoltage shutdown threshold is 100mV above the maximum supply voltage V_{BATT+} specified in Table 2.

When the supply voltage approaches the overvoltage shutdown threshold the module will send the following URC:

^SBC: Overvoltage warning

This alert is sent once.

When the overvoltage shutdown threshold is exceeded the module will send the following URC

^SBC: Overvoltage shutdown

before it shuts down cleanly.

This type of URC does not need to be activated by the user. It will be output automatically when fault conditions occur.

Keep in mind that several ALAS3K-US components are directly linked to BATT+ and, therefore, the supply voltage remains applied at major parts of ALAS3K-US, even if the module is switched off. Especially the power amplifier is very sensitive to high voltage and might even be destroyed.

3.3. Power Saving

ALAS3K-US is able to reduce its functionality to a minimum (during the so-called SLEEP mode) in order to minimize its current consumption. The following sections explain the module's network dependent power saving behavior.The power saving behavior is further configurable by AT command:

- AT^SCFG= "MEopMode/PwrSave": The power save mode is by default enabled. While inactive, the module stays in power save (SLEEP) state, waking up only upon any of the following events:
  - Cyclically to meet basic technical demands, e.g. network requirements (such as regularly listening to paging messages from the base station as described in Section 3.3.1., Section 3.3.2. and Section 3.3.3..
  - Cyclically after expiry of a configured power saving period.
  - Data at any interface port, e.g., URCs for incoming calls.
  - A level state transition at GPIO1, GPIO3, GPIO4, GPIO5 and GPIO9.
- AT^SCFG= "MEopMode/ExpectDTR": Power saving will take effect only if there is no transmission data pending on any of the module's USB ports. The expect DTR AT command ensures that data becoming pending on any USB port before an external application has signaled its readiness to receive the data is discarded. By default this behavior is enabled for all available USB CDC ACM and CDC ECM ports.
- AT^SCFG="Radio/OutputPowerReduction": Output power reduction is possible for the module in GPRS multislot scenarios to reduce its output power according to 3GPP 45.005 section.

Please refer to [1] for more information on the above AT commands used to configure the module's power saving behavior.

The implementation of the USB host interface also influences the module's power saving behavior and therefore its current consumption. For more information see Section 2.1.3.. Also note that the command AT^SBV, which allows to monitor the module's power supply, is only available if the module is not in SLEEP mode. This means, the shorter the power saving periods, the faster and more precise the module's power supply monitoring is going to be (see also Section 3.4.3.).

3.3.1. Power Saving while Attached to GSM Networks

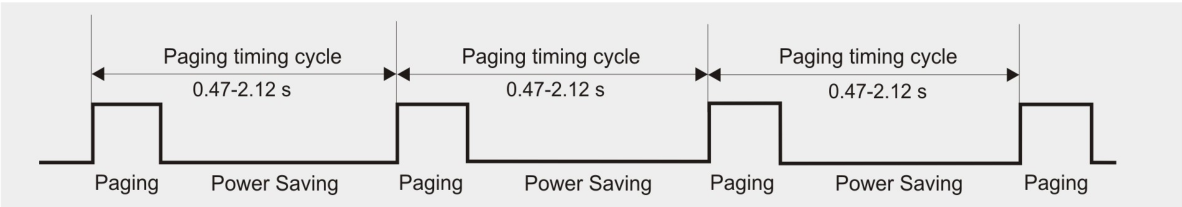
The power saving possibilities while attached to a GSM network depend on the paging timing cycle of the base station. The duration of a paging timing cycle can be calculated using the following formula:

t = 4.615 ms (TDMA frame duration) * 51 (number of frames) * DRX value.

DRX (Discontinuous Reception) is a value from 2 to 9, resulting in paging timing cycles between 0.47 and 2.12 seconds. The DRX value of the base station is assigned by the GSM network operator.

Now, a paging timing cycle consists of the actual fixed length paging plus a variable length pause before the next paging. In the pauses between listening to paging messages, the module resumes power saving, as shown in Figure 29.

Figure 29: Power saving and paging in GSM networks



The varying pauses explain the different potential for power saving. The longer the pause the less power is consumed.

Generally, power saving depends on the module’s application scenario and may differ from the above mentioned normal operation. The power saving interval may be shorter than 0.47 seconds or longer than 2.12 seconds.

3.3.2. Power Saving while Attached to WCDMA Networks

The power saving possibilities while attached to a WCDMA network depend on the paging timing cycle of the base station.

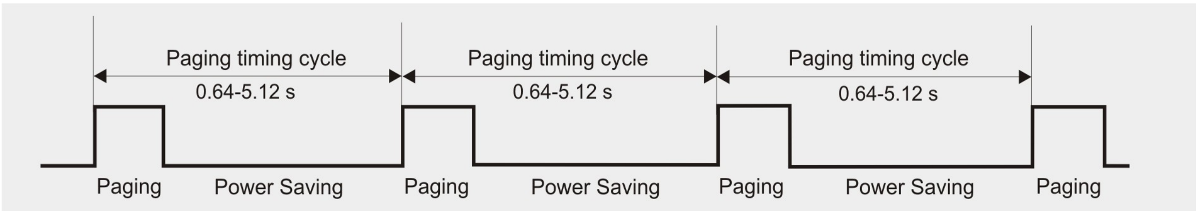
During normal WCDMA operation, i.e., the module is connected to a WCDMA network, the duration of a paging timing cycle varies. It may be calculated using the following formula:

$t = 2^{\text{DRX value}} * 10$ ms (WCDMA frame duration).

DRX (Discontinuous Reception) in WCDMA networks is a value between 6 and 9, thus resulting in paging timing cycles between 0.64 and 5.12 seconds. The DRX value of the base station is assigned by the WCDMA network operator.

Now, a paging timing cycle consists of the actual fixed length paging plus a variable length pause before the next paging. In the pauses between listening to paging messages, the module resumes power saving, as shown in Figure 30.

Figure 30: Power saving and paging in WCDMA networks



The varying pauses explain the different potential for power saving. The longer the pause the less power is consumed.

Generally, power saving depends on the module's application scenario and may differ from the above mentioned normal operation. The power saving interval may be shorter than 0.64 seconds or longer than 5.12 seconds.

3.3.3. Power Saving while Attached to LTE Networks

The power saving possibilities while attached to an LTE network depend on the paging timing cycle of the base station.

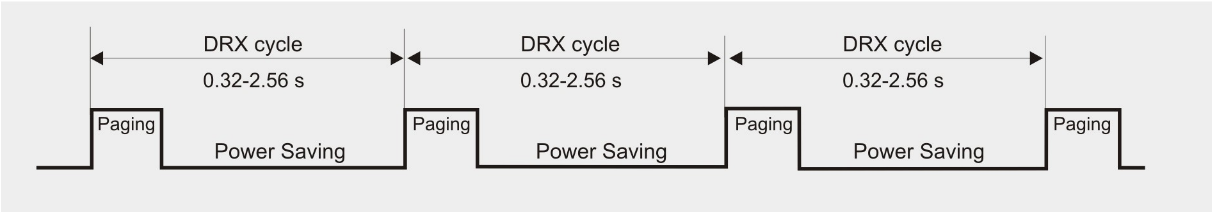
During normal LTE operation, i.e., the module is connected to an LTE network, the duration of a paging timing cycle varies. It may be calculated using the following formula:

t = DRX Cycle Value * 10 ms

DRX cycle value in LTE networks is any of the four values: 32, 64, 128 and 256, thus resulting in paging timing cycles between 0.32 and 2.56 seconds. The DRX cycle value of the base station is assigned by the LTE network operator.

Now, a paging timing cycle consists of the actual fixed length paging plus a variable length pause before the next paging. In the pauses between listening to paging messages, the module resumes power saving, as shown in Figure 31.

Figure 31: Power saving and paging in LTE networks



The varying pauses explain the different potential for power saving. The longer the pause the less power is consumed.

Generally, power saving depends on the module's application scenario and may differ from the above mentioned normal operation. The power saving interval may be shorter than 0.32 seconds or longer than 2.56 seconds.

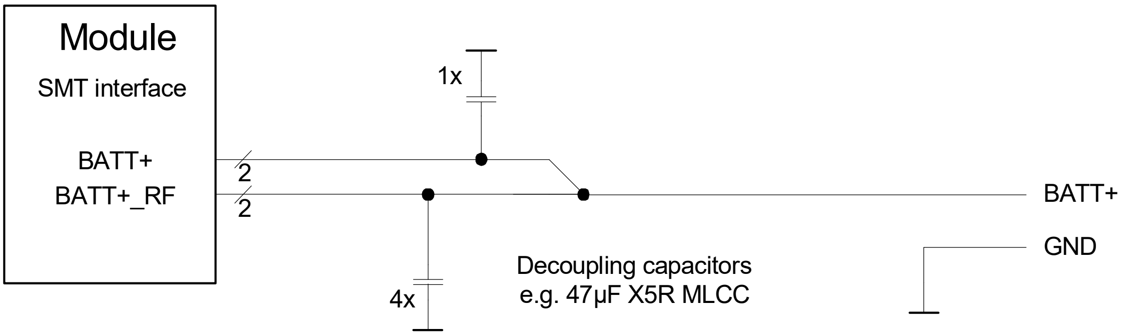
3.4. Power Supply

ALAS3K-US needs to be connected to a power supply at the SMT application interface - 4 lines BATT+, and GND. There are two separate voltage domains for BATT+:

- BATT+_RF with 2 lines for the RF power amplifier supply
- BATT+ with 2 lines for the general power management.

The main power supply from an external application has to be a single voltage source and has to be expanded to two sub paths (star structure). Each voltage domain must be decoupled by application with low ESR capacitors (≥ 47µF MLCC @ BATT+; ≥ 4x47µF MLCC @ BATT+_RF) as close as possible to LGA pads. Figure 32 shows a sample circuit for decoupling capacitors for BATT+.

Figure 32: Decoupling capacitor(s) for BATT+



The power supply of ALAS3K-US must be able to provide the peak current during the uplink transmission.

All key functions for supplying power to the device are handled by the power management IC. It provides the following features:

- Stabilizes the supply voltages for the baseband using switching regulators and low drop linear voltage regulators.
- Switches the module's power voltages for the power-up and -down procedures.
- Delivers, across the VEXT line, a regulated voltage for an external application.
- LDO to provide SIM power supply.

3.4.1. Power Supply Ratings

Table 18 and Table 19 assemble various voltage supply and current consumption ratings of the module. Please note that the given ratings are preliminary and will have to be confirmed.

Table 18: Voltage supply ratings

	Description	Conditions	Min	Typ	Max	Unit
BATT+	Supply voltage	Directly measured at Module. Voltage must stay within the min/max values, including voltage drop, ripple, spikes	3.3	3.8	4.2	V
	Maximum allowed voltage drop during transmit burst	Normal condition, power control level for Pout max			400	mV
	Voltage ripple	Normal condition, power control level for Pout max @ f <= 250 kHz @ f > 250 kHz			 120 90	 mV_{pp} mV_{pp}

Table 19: Current consumption ratings

	Description	Conditions		Typical rating	Unit
I_{BATT+}[1]	OFF State supply current	Power Down		40	µA
	Average GSM / GPRS supply current	SLEEP[2] @ DRX=9 (no communication via UART)	USB disconnected	1.8	mA
			USB suspended	2.1	mA
		SLEEP[2] @ DRX=5 (no communication via UART)	USB disconnected	2.0	mA
			USB suspended	2.3	mA
		SLEEP[2] @ DRX=2 (no communication via UART)	USB disconnected	2.9	mA
			USB suspended	3.2	mA
		IDLE @ DRX=2 UART active, but no communication	USB disconnected	35	mA
			USB active	45	mA
		GPRS Data transfer GSM850/ 900; PCL=5; 1Tx/4Rx	ROPR=8 (max. reduction)	320	mA
			ROPR=4 (no reduction)		
		GPRS Data transfer GSM850/ 900; PCL=5; 2Tx/3Rx	ROPR=8 (max. reduction)	430	mA
			ROPR=4 (no reduction)	540	
		GPRS Data transfer GSM850/ 900; PCL=5; 4Tx/1Rx	ROPR=8 (max. reduction)	650	mA
			ROPR=4 (no reduction)	930	
			@total mismatch	1100	

Table 19: Current consumption ratings

	Description	Conditions		Typical rating	Unit
I_{BATT+} [1]	Average GSM / GPRS supply current	EDGE Data transfer GSM850/900; PCL=5; 1Tx/4Rx	ROPR=8 (max. reduction)	220	mA
			ROPR=4 (no reduction)		
		EDGE Data transfer GSM850/900; PCL=5; 2Tx/3Rx	ROPR=8 (max. reduction)	340	mA
			ROPR=4 (no reduction)	360	
		EDGE Data transfer GSM850/900; PCL=5; 4Tx/1Rx	ROPR=8 (max. reduction)	600	mA
			ROPR=4 (no reduction)	630	
		GPRS Data transfer GSM1800/1900; PCL=0; 1Tx/4Rx	ROPR=8 (max. reduction)	230	mA
			ROPR=4 (no reduction)		
		GPRS Data transfer GSM1800/1900; PCL=0; 2Tx/3Rx	ROPR=8 (max. reduction)	340	mA
			ROPR=4 (no reduction)	390	
		GPRS Data transfer GSM1800/1900; PCL=0; 4Tx/1Rx	ROPR=8 (max. reduction)	500	mA
			ROPR=4 (no reduction)	640	
		EDGE Data transfer GSM1800/1900; PCL=0; 1Tx/4Rx	ROPR=8 (max. reduction)	190	mA
			ROPR=4 (no reduction)		
		EDGE Data transfer GSM1800/1900; PCL=0; 2Tx/3Rx	ROPR=8 (max. reduction)	300	mA
			ROPR=4 (no reduction)	330	
		EDGE Data transfer GSM1800/1900; PCL=0; 4Tx/1Rx	ROPR=8 (max. reduction)	470	mA
			ROPR=4 (no reduction)	510	
	Peak current during GSM transmit burst	Data transfer GSM850/900; PCL=5	@50Ω	2.2	A
		Data transfer GSM1800/1900; PCL=0	@50Ω	1.5	A

Table 19: Current consumption ratings

	Description	Conditions		Typical rating	Unit
I_{BATT+}[1]	Average UMTS supply current Data transfers measured @maximum Pout	SLEEP[2] @ DRX=9	USB disconnected	1.6	mA
			USB suspend	1.9	
		SLEEP[2] @ DRX=8	USB disconnected	1.8	mA
			USB suspend	2.1	
		SLEEP[2] @ DRX=6	USB disconnected	2.4	mA
			USB suspend	2.7	
		IDLE @ DRX=6	USB disconnected	35	mA
			USB active	45	
		UMTS Data transfer Band II		640	mA
		UMTS Data transfer Band IV		610	mA
		UMTS Data transfer Band V		470	mA
		HSDPA Data transfer Band II		640	mA
		HSDPA Data transfer Band IV		610	mA
		HSDPA Data transfer Band V		450	mA
	Average LTE supply current[3] Data transfers measured @maximum Pout	SLEEP[2] @ "Paging Occasions" = 256	USB disconnected	2.0	mA
			USB suspend	2.3	
		SLEEP[2] @ "Paging Occasions" = 128	USB disconnected	2.4	mA
			USB suspend	2.7	
		SLEEP[2] @ "Paging Occasions" = 64	USB disconnected	3.1	mA
			USB suspend	3.4	
		SLEEP[2] @ "Paging Occasions" = 32	USB disconnected	4.5	mA
			USB suspend	4.8	
		IDLE [4]	USB disconnected	35	mA
			USB active	45	mA
		LTE Data transfer Band 2		690	mA
		LTE Data transfer Band 4		640	mA
		LTE Data transfer Band 5		530	mA
		LTE Data transfer Band 12 <MFBI Bd17>		560	mA
I_{VUSB_IN}	USB typical and maximum ratings are mentioned in Table 2: VUSB_IN.				

1. With an impedance of Z_{LOAD}=50Ω at the antenna pads. Measured at 25°C and 4.2V - except for Power Down ratings that were measured at 3.4V.
2. Measurements start 6 minutes after switching ON the module,
   Averaging times: SLEEP mode - 3 minutes, transfer modes - 1.5 minutes
   Communication tester settings:no neighbor cells, no cell reselection etc,
   RMC (Reference Measurement Channel)
3. Communication tester settings:
   - Channel Bandwidth: 5MHz
   - Number of Resource Blocks: 25 (DL), 1 (UL)
   - Modulation: QPSK
4. Power save mode is disabled with AT^SCFG=”MEopMode/PwrSave”,”disabled”.

3.4.2. Minimizing Power Losses

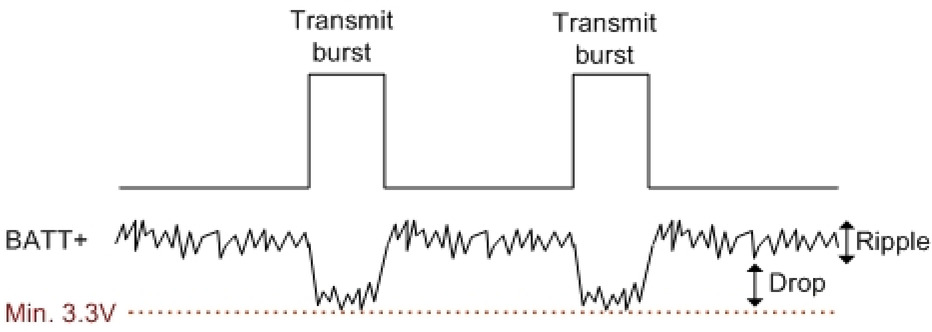
When designing the power supply for your application please pay specific attention to power losses. Ensure that the input voltage V_{BATT+} never drops below 3.3V on the ALAS3K-US board, not even in a transmit burst where current consumption can rise to typical peaks of 2A. It should be noted that ALAS3K-US switches off when exceeding these limits. Any voltage drops that may occur in a transmit burst should not exceed 400mV to ensure the expected RF performance in 2G networks.

The module switches off if the minimum battery voltage (V_{BATT}min) is reached.

Example:
$V_I$min = 3.3V
Dmax = 0.4V

V_{BATT}min = $V_I$min + Dmax
V_{BATT}min = 3.3V + 0.4V = 3.7V

Figure 33: Power supply limits during transmit burst



3.4.3. Monitoring Power Supply by AT Command

To monitor the supply voltage you can use the AT^SBV command which returns the averaged value related to BATT+ and GND at the SMT application interface.

As long as not in SLEEP mode, the module measures the voltage periodically every 110 milliseconds. The maximum time the module remains in SLEEP mode can be limited with the AT command AT^SCFG=”MeOpMode/PwrSave” (see [1]). The displayed voltage (in mV) is an average of the last eight measurement results before the AT^SBV command was executed.

3.5. Operating Temperatures

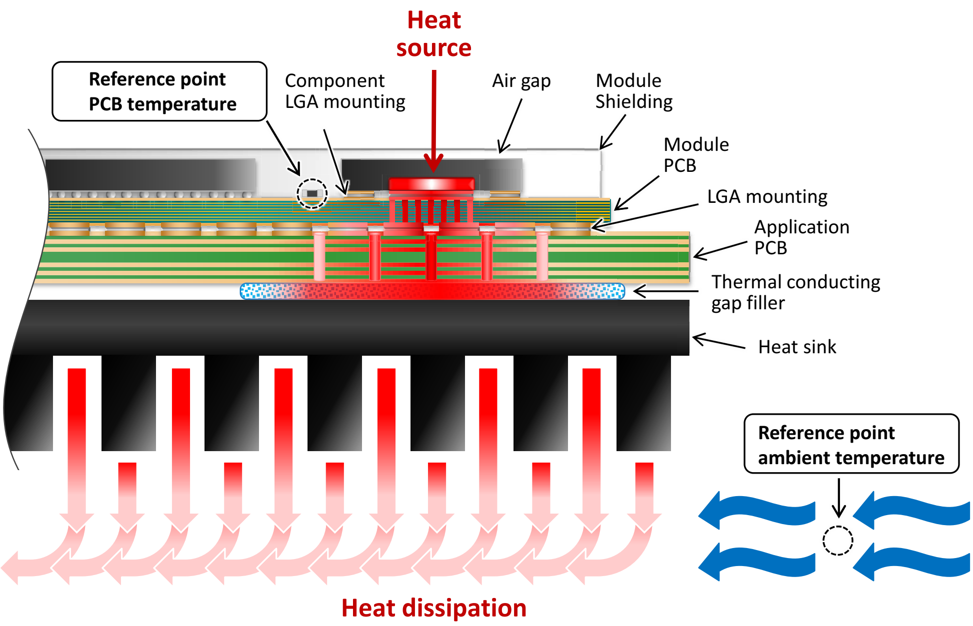
Table 20: Board temperature

Parameter	Min	Typ	Max	Unit
Operating temperature range	-30	+25	+85	°C
Restricted temperature range[1]	-40		+95	°C
Automatic shutdown[2] Temperature measured on ALAS3K-US board	---	---	>+95	°C

1. Restricted operation allows normal mode data transmissions for limited time until automatic thermal shutdown takes effect. Within the restricted temperature range (outside the operating temperature range) the specified electrical characteristics may be in- or decreased.
2. Due to temperature measurement uncertainty, a tolerance on the stated shutdown thresholds may occur. The possible deviation is in the range of ± 2°C at the overtemperature limit.

Note that within the specified operating temperature ranges the board temperature may vary to a great extent depending on operating mode, used frequency band, radio output power and current supply voltage. Note also the differences and dependencies that usually exist between board (PCB) temperature and ambient temperature as shown in the following Figure 34. The possible ambient temperature range depends on the mechanical application design including the module and the PCB with its size and layout. A thermal solution will have to take these differences into account and should therefore be an integral part of application design.

Figure 34: Board and ambient temperature differences



3.6. Electrostatic Discharge

The module is not protected against Electrostatic Discharge (ESD) in general. Consequently, it is subject to ESD handling precautions that typically apply to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates a ALAS3K-US module.

Special ESD protection provided on ALAS3K-US*:*
BATT+: Inductor/capacitor
An example for an enhanced ESD protection for the SIM interface is shown in Section 2.1.6..

The remaining interfaces of ALAS3K-US with the exception of the antenna interface are not accessible to the user of the final product (since they are installed within the device) and are therefore only protected according to the ANSI/ESDA/ JEDEC JS-001-2011 requirements.

ALAS3K-US has been tested according to the following standards. Electrostatic values can be gathered from the following table.

Table 21: Electrostatic values

Specification / Requirements	Contact discharge	Air discharge
ANSI/ESDA/JEDEC JS-001-2011		
All SMT interfaces	± 1kV Human Body Model	n.a.
JESD22-C101-F (Class C1)		
All SMT interfaces	± 250V Charged Device Model (CDM)	n.a.
ETSI EN 301 489-1/7		
BATT+	± 4kV	± 8kV

Note: The values may vary with the individual application design. For example, it matters whether or not the application platform is grounded over external devices like a computer or other equipment, such as the Kontron reference application described in Section 5.3..

3.7. Reliability Characteristics

The test conditions stated below are an extract of the complete test specifications.

Table 22: Summary of reliability test conditions

Type of test	Conditions	Standard
Vibration	Frequency range: 10-20Hz; acceleration: 5g Frequency range: 20-500Hz; acceleration: 20g Duration: 20hper axis; 3 axes	DIN IEC 60068-2-6[1]
Shock half-sinus	Acceleration: 500g Shock duration: 1ms 1 shock per axis 6 positions (± x, y and z)	DIN IEC 60068-2-27
Dry heat	Temperature: +70 ±2°C Test duration: 16h Humidity in the test chamber: < 50%	EN 60068-2-2 Bb ETS 300 019-2-7
Temperature change (shock)	Low temperature: -40°C ±2°C High temperature: +85°C ±2°C Changeover time: < 30s (dual chamber system) Test duration: 1h Number of repetitions: 100	DIN IEC 60068-2-14 Na ETS 300 019-2-7
Damp heat cyclic	High temperature: +55°C ±2°C Low temperature: +25°C ±2°C Humidity: 93% ±3% Number of repetitions: 6 Test duration: 12h + 12h	DIN IEC 60068-2-30 Db ETS 300 019-2-5
Cold (constant expo-sure)	Temperature: -40 ±2°C Test duration: 16h	DIN IEC 60068-2-1

1. For reliability tests in the frequency range 20-500Hz the Standard's acceleration reference value was increased to 20g.

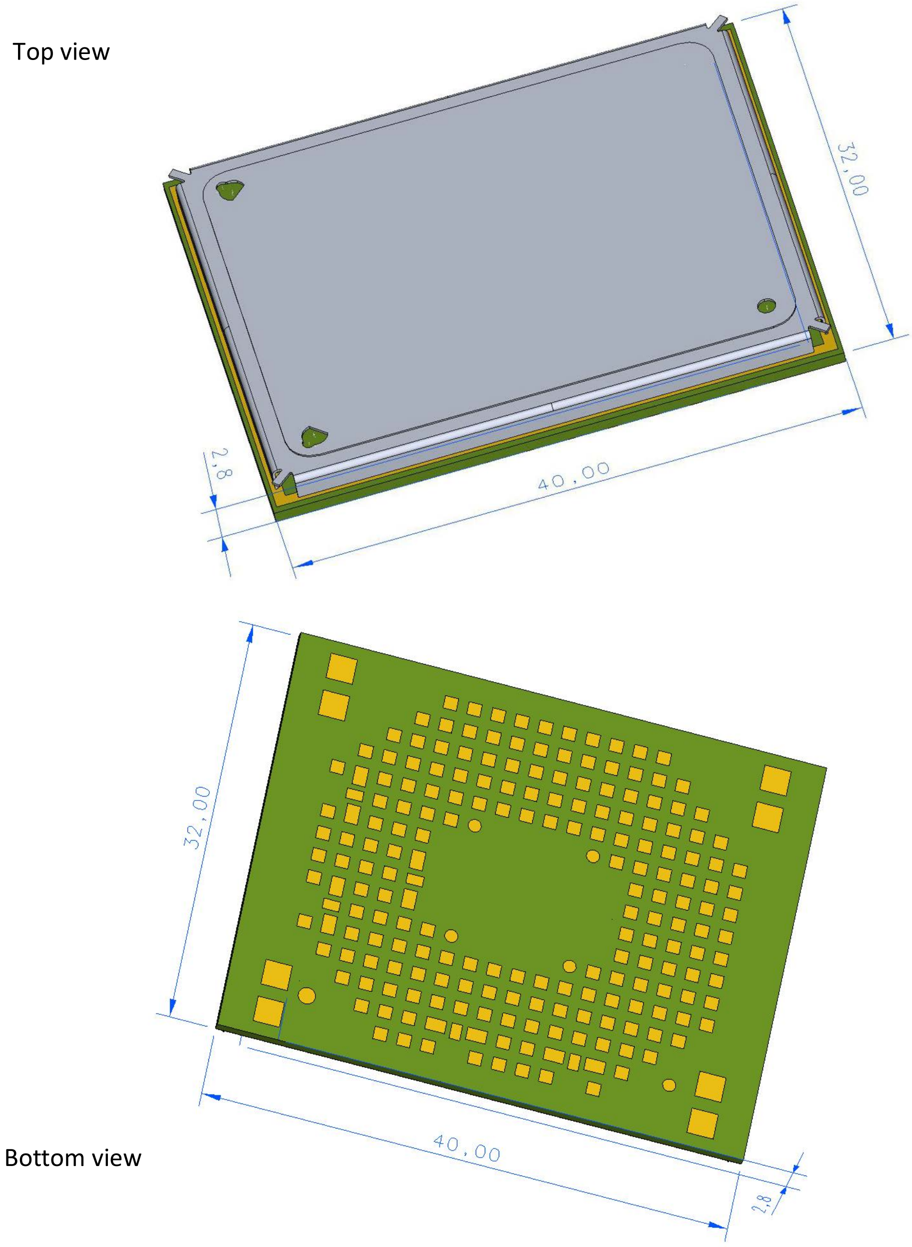
4/ Mechanical Dimensions, Mounting and Packaging

4.1. Mechanical Dimensions of ALAS3K-US

Figure 35 shows a 3D view[1] of ALAS3K-US and provides an overview of the board's mechanical dimensions. For further details see Figure 36.

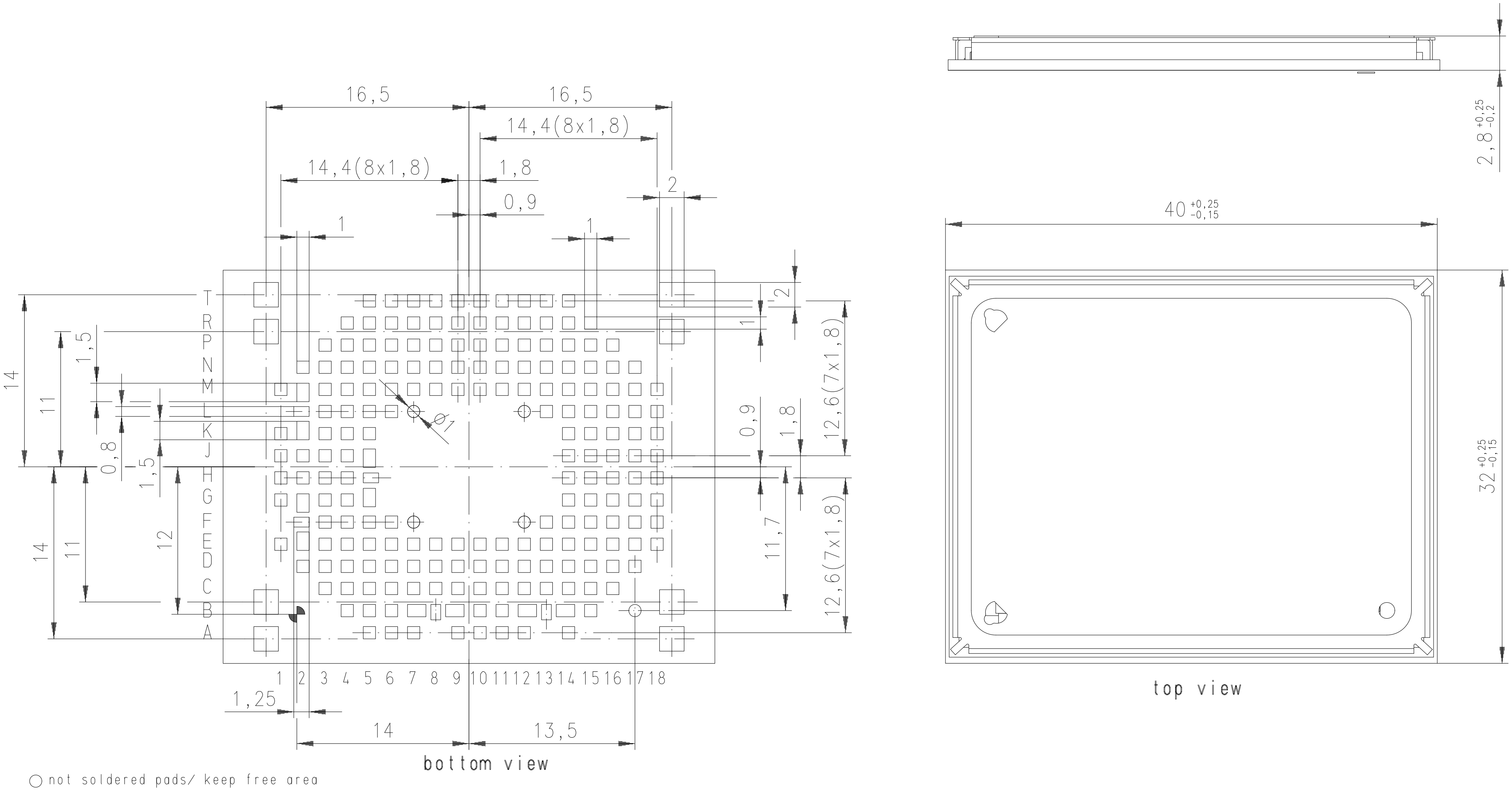
Length: 40mm
Width: 32mm
Height: 2.8mm

Figure 35: ALAS3K-US – top and bottom view



[1] The coloring of the 3D view does not reflect the module's real color.

Figure 36: Dimensions of ALAS3K-US (all dimensions in mm)



4.2. Mounting ALAS3K-US onto the Application Platform

This section describes how to mount ALAS3K-US onto the PCBs, including land pattern and stencil design, board-level characterization, soldering conditions, durability and mechanical handling. For more information on issues related to SMT module integration see also [3].

Note: Kontron strongly recommends to solder all connecting pads for mechanical stability and
heat dissipation. Not only must all supply pads and signals be connected appropriately, but all pads denoted as "Do not use" should also be soldered (but not electrically connected). Note also that in order to avoid short circuits between signal tracks on an external application's PCB and various markings at the bottom side of the module, it is recommended not to route the signal tracks on the top layer of an external PCB directly under the module, or at least to ensure that signal track routes are sufficiently covered with solder resist.

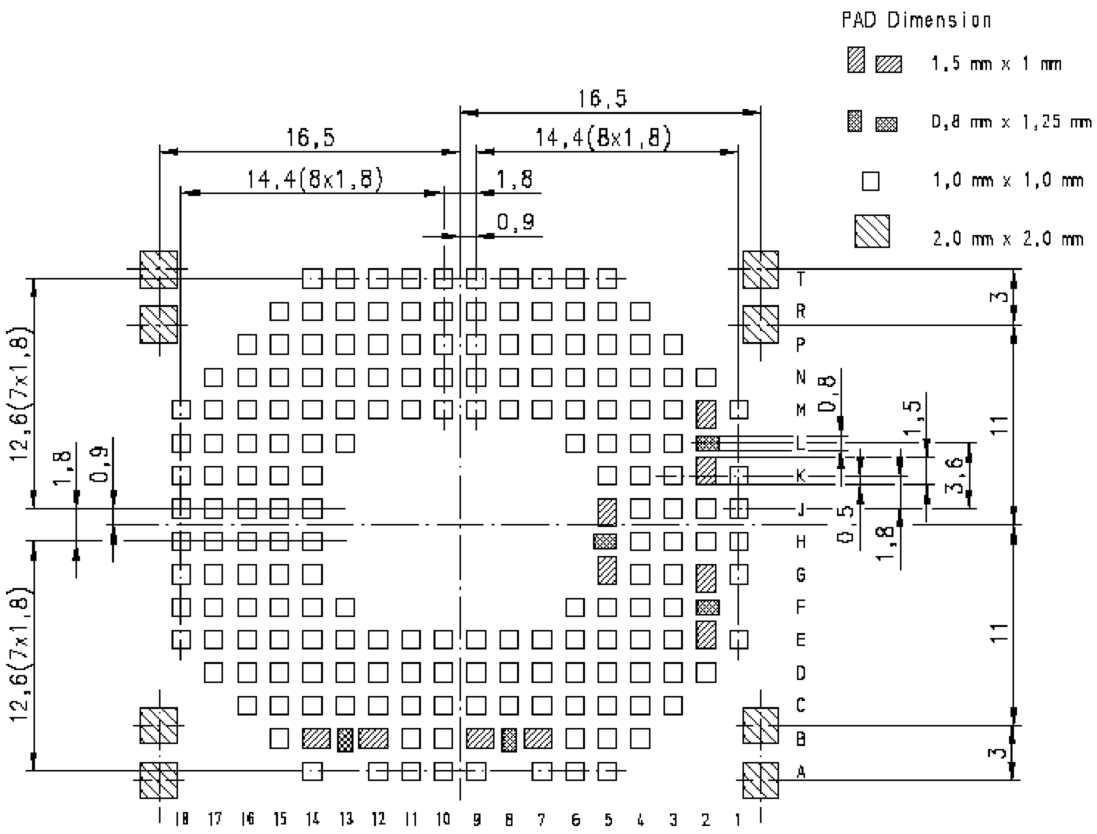
4.2.1. SMT PCB Assembly

4.2.1.1. Land Pattern and Stencil

The land pattern and stencil design as shown below is based on Kontron characterizations for lead-free solder paste on a four-layer test PCB and a 110 micron-thick stencil.

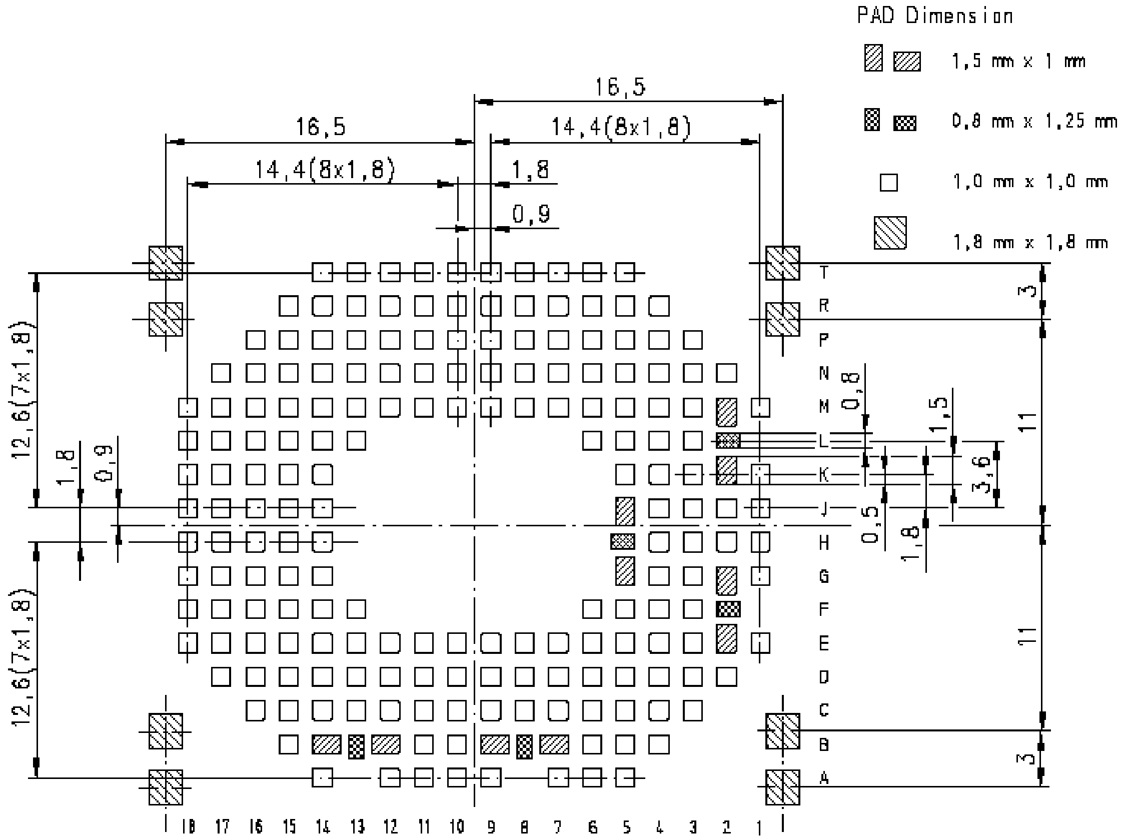
The land pattern given in Figure 37 reflects the module's pad layout, including signal pads and ground pads (for pad assignment see Section 2.1.1.). Besides these pads there are ground areas on the module's bottom side that must not be soldered, e.g., the position marker. To prevent short circuits, it has to be ensured that there are no wires on the external application side that may connect to these module ground areas.

Figure 37: Land pattern (top layer)



The stencil design illustrated in Figure 38 is recommended by Kontron as a result of extensive tests with Kontron Daisy Chain modules.

Figure 38: Recommended design for 110 micron thick stencil (top layer)



4.2.1.2. Board Level Characterization

Board level characterization issues should also be taken into account if devising an SMT process.

It is recommended to characterize land patterns before an actual PCB production, taking individual processes, materials, equipment, stencil design, and reflow profile into account. For land and stencil pattern design recommendations see also Section 4.2.1.1.. Optimizing the solder stencil pattern design and print process is necessary to ensure print uniformity, to decrease solder voids, and to increase board level reliability.

Daisy chain modules for SMT characterization are available on request. For details refer to [3].

Generally, solder paste manufacturer recommendations for screen printing process parameters and reflow profile conditions should be followed. Maximum ratings are described in Section 4.2.3..

4.2.2. Moisture Sensitivity Level

ALAS3K-US comprises components that are susceptible to damage induced by absorbed moisture.

Kontron's ALAS3K-US module complies with the latest revision of the IPC/JEDEC J-STD-020 Standard for moisture sensitive surface mount devices and is classified as MSL 4.

For additional moisture sensitivity level (MSL) related information see Section 4.2.4. and Section 4.3.2..

4.2.3. Soldering Conditions and Temperature

4.2.3.1. Reflow Profile

Figure 39: Reflow Profile

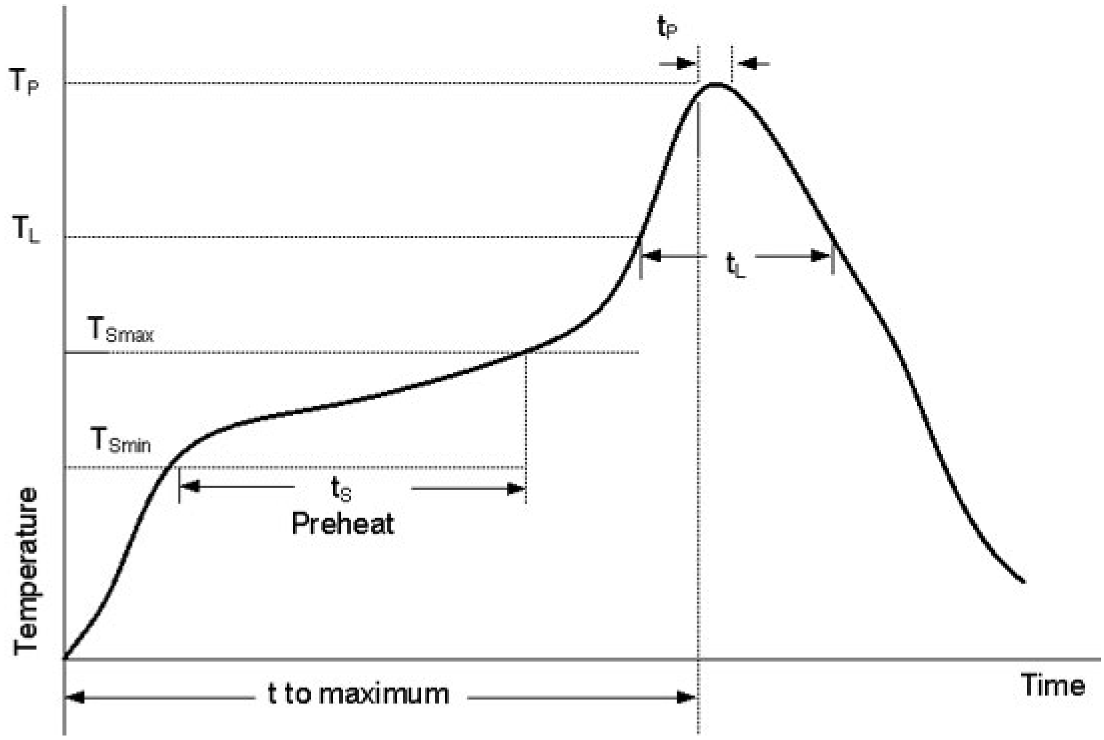
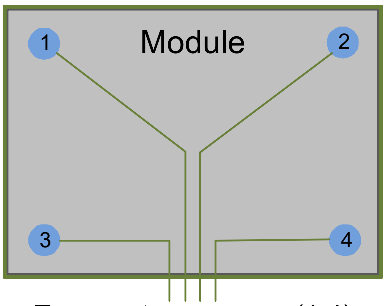


Table 23: Reflow temperature recommendations[1]

Profile Feature	Pb-Free Assembly
Preheat & Soak Temperature Minimum (T_{Smin}) Temperature Maximum (T_{Smax}) Time (t_{Smin} to t_{Smax}) (t_S)	 150°C 200°C 60-120 seconds
Average ramp up rate (T_L to T_P)	3K/second max. [2]
Liquidous temperature (T_L) Time at liquidous (t_L)	217°C 60-90 seconds
Peak package body temperature (T_P)	245°C +0/-5°C
Time (t_P) within 5 °C of the peak package body temperature (T_P)	30 seconds max.
Average ramp-down rate - Limited ramp-down rate between 225°C and 200°C	6K/second max.[2] 3K/second max.[2]
Time 25°C to maximum temperature	8 minutes max.

1. Please note that the listed reflow profile features and ratings are based on the joint industry standard IPC/JEDEC J-STD-020D.1, and are as such meant as a general guideline. For more information on reflow profiles and their optimization please refer to [3].
2. Temperatures measured on shielding at each corner. See also [3].



4.2.3.2. Maximum Temperature and Duration

The following limits are recommended for the SMT board-level soldering process to attach the module:

- A maximum module temperature of 245°C. This specifies the temperature as measured at the module's top side.
- A maximum duration of 30 seconds at this temperature.
- Ramp-down rate from T_P to 200°C should be controlled in order to reduce thermally induced stress during the solder solidification phase (see Table 23 - limited ramp-down rate). Therefore, a cool-down step in the oven's temperature program between 200°C and 180°C should be considered. For more information on reflow profiles and their optimization see [3].

Please note that while the solder paste manufacturers' recommendations for best temperature and duration for solder reflow should generally be followed, the limits listed above must not be exceeded.

ALAS3K-US is specified for one soldering cycle only. Once ALAS3K-US is removed from the application, the module will very likely be destroyed and cannot be soldered onto another application.

4.2.4. Durability and Mechanical Handling

4.2.4.1. Storage Conditions

ALAS3K-US modules, as delivered in tape and reel carriers, must be stored in sealed, moisture barrier anti-static bags. The conditions stated below in Table 24 are only valid for modules in their original packed state in a non-condensing atmospheric environment. The shelf life in a sealed moisture bag under these conditions is an estimated 12 months.

Table 24: Storage conditions

Type	Condition	Unit	Reference
Air temperature: Low High	-25 +40	°C	IPC/JEDEC J-STD-033A
Humidity relative: Low High	10 90 at 40°C	%	IPC/JEDEC J-STD-033A
Air pressure: Low High	70 106	kPa	IEC TR 60271-3-1: 1K4 IEC TR 60271-3-1: 1K4
Movement of surrounding air	1.0	m/s	IEC TR 60271-3-1: 1K4
Water: rain, dripping, icing and frosting	Not allowed	---	---
Radiation: Solar Heat	1120 600	W/m^2	ETS 300 019-2-1: T1.2, IEC 60068-2-2 Bb ETS 300 019-2-1: T1.2, IEC 60068-2-2 Bb
Chemically active substances	Not recommended		IEC TR 60271-3-1: 1C1L
Mechanically active substances	Not recommended		IEC TR 60271-3-1: 1S1
Vibration sinusoidal: Displacement Acceleration Frequency range	 1.5 5 2-9 9-200	 mm m/s^2 Hz	IEC TR 60271-3-1: 1M2
Shocks: Shock spectrum Duration Acceleration	 Semi-sinusoidal 1 50	 ms m/s^2	IEC 60068-2-27 Ea

4.2.4.2. Processing Life

ALAS3K-US must be soldered to an application within 72 hours after opening the moisture barrier bag (MBB) it was stored in.

As specified in the IPC/JEDEC J-STD-033 Standard, the manufacturing site processing the modules should have ambient temperatures below 30°C and a relative humidity below 60%.

4.2.4.3. Baking

Baking conditions are specified on the moisture sensitivity label attached to each MBB (see Figure 44 for details):

- It is *not necessary* to bake ALAS3K-US, if the conditions specified in Section 4.2.4.1. and Section 4.2.4.2. were not exceeded.
- It is *necessary* to bake ALAS3K-US, if any condition specified in Section 4.2.4.1. and Section 4.2.4.2. was exceeded.

If baking is necessary, the modules must be put into trays that can be baked to at least 125°C. Devices should not be baked in tape and reel carriers at any temperature.

4.2.4.4. Electrostatic Discharge

Electrostatic discharge (ESD) may lead to irreversible damage for the module. It is therefore advisable to develop measures and methods to counter ESD and to use these to control the electrostatic environment at manufacturing sites.

Please refer to Section 3.6. for further information on electrostatic discharge.

4.3. Packaging

4.3.1. Tape and Reel

The single-feed tape carrier for ALAS3K-US is illustrated in Figure 40. The figure also shows the proper part orientation. The tape width is 56mm and the ALAS3K-US modules are placed on the tape with a 40mm pitch. The reels are 330mm in diameter with 100mm hubs. Each reel contains 250 modules.

4.3.1.1. Orientation

Figure 40: Carrier tape dimensions

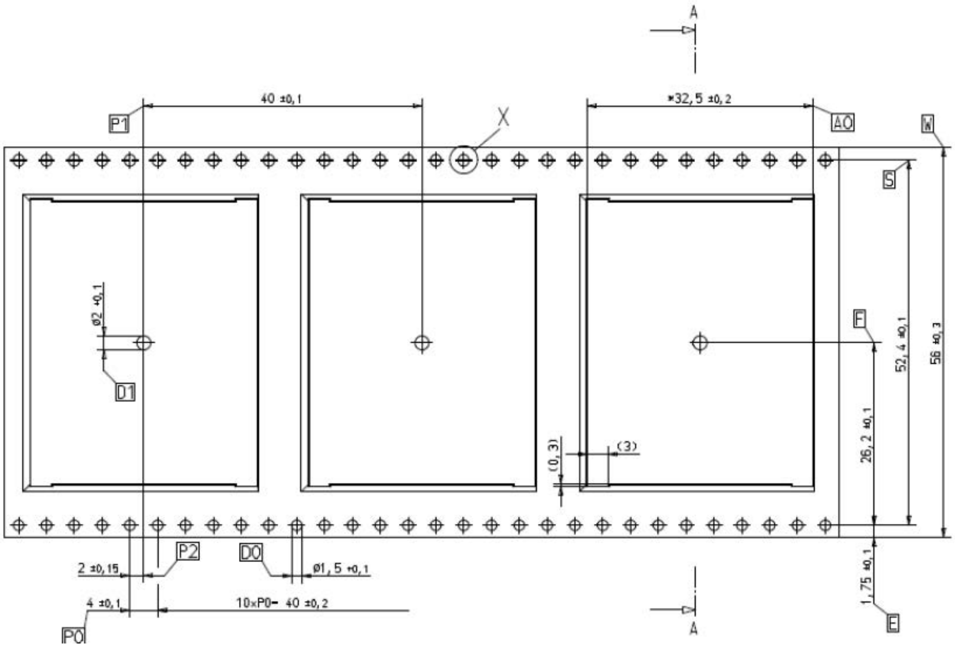
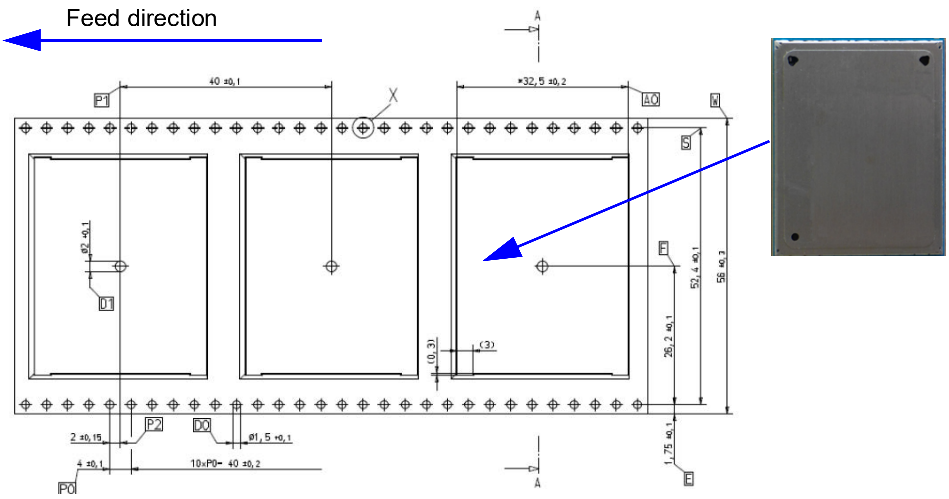
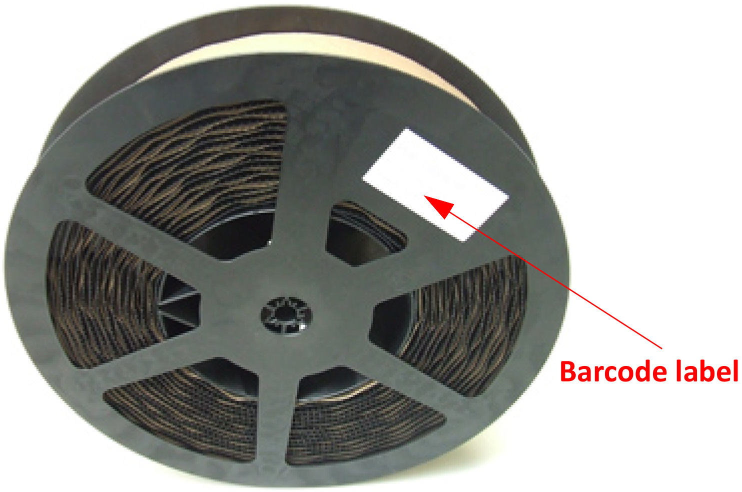


Figure 41: Feed direction



4.3.1.2. Barcode Label
A barcode label provides detailed information on the tape and its contents. It is attached to the reel.

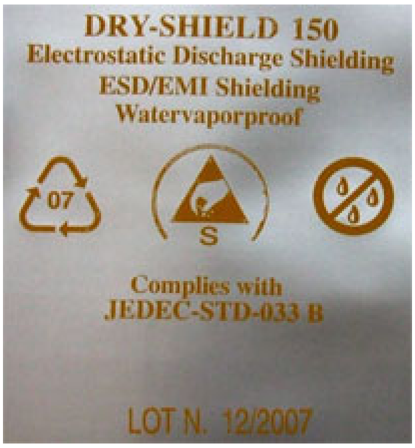
Figure 42: Barcode label on tape reel



4.3.2. Shipping Materials
ALAS3K-US is distributed in tape and reel carriers. The tape and reel carriers used to distribute ALAS3K-US are packed as described below, including the following required shipping materials:
- Moisture barrier bag, including desiccant and humidity indicator card
- Transportation bag

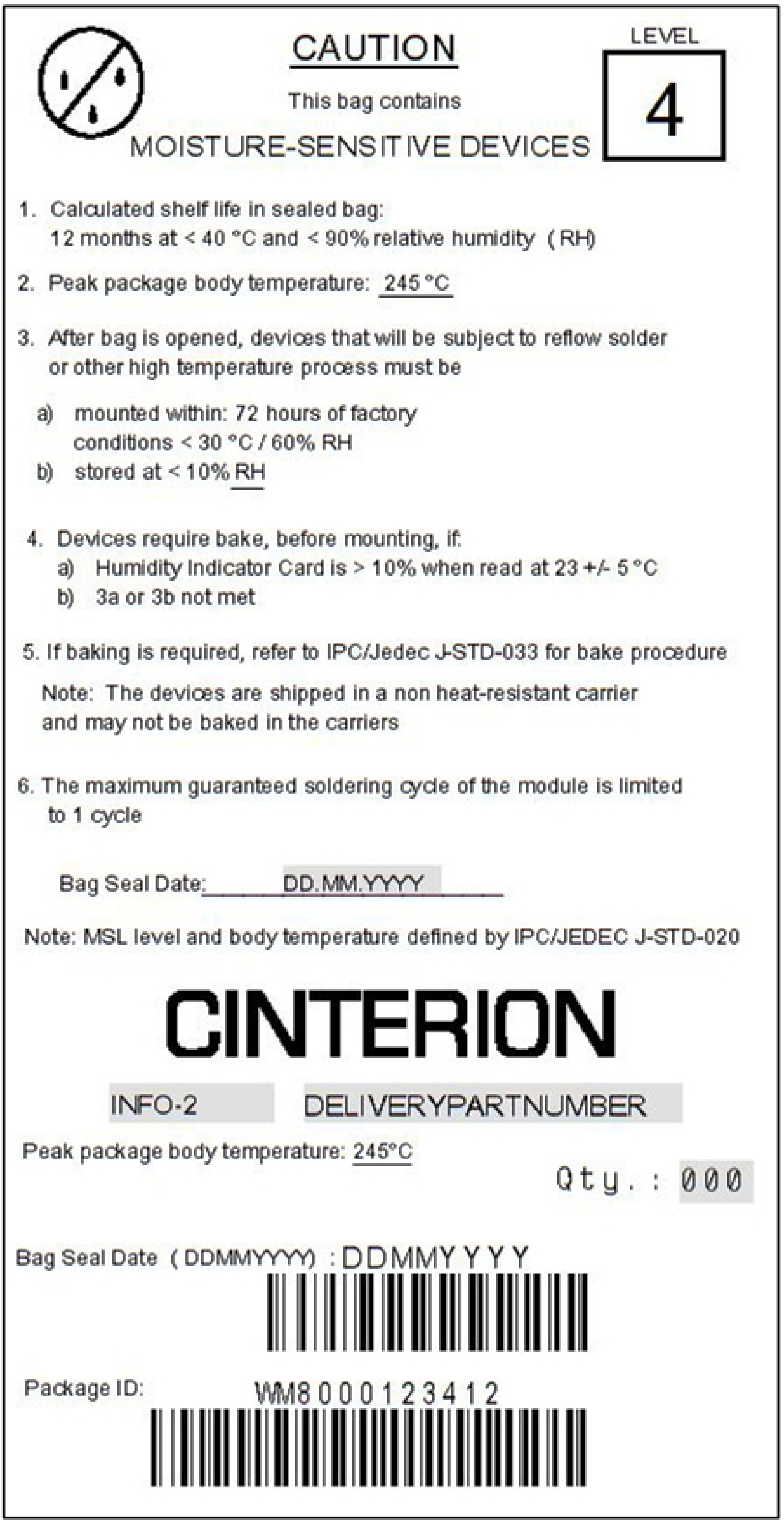
4.3.2.1. Moisture Barrier Bag
The tape reels are stored inside an MBB, together with a humidity indicator card and desiccant pouches - see Figure 43. The bag is ESD protected and delimits moisture transmission. It is vacuum-sealed and should be handled carefully to avoid puncturing or tearing. The bag protects the ALAS3K-US modules from moisture exposure. It should not be opened until the devices are ready to be soldered onto the application.

Figure 43: Moisture barrier bag (MBB) with imprint



The label shown in Figure 44 summarizes requirements regarding moisture sensitivity, including shelf life and baking requirements. It is attached to the outside of the moisture barrier bag.

Figure 44: Moisture Sensitivity Label

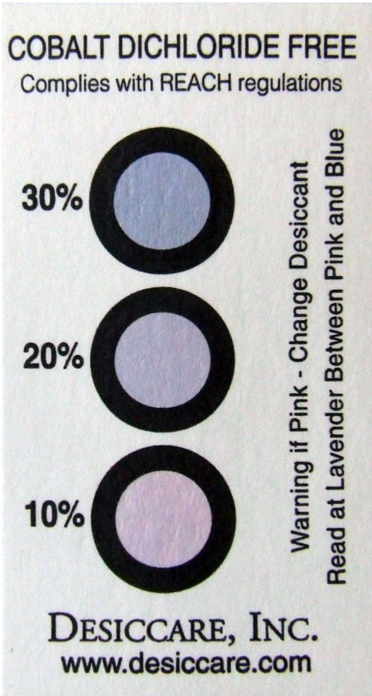


MBBs contain one or more desiccant pouches to absorb moisture that may be in the bag. The humidity indicator card described below should be used to determine whether the enclosed components have absorbed an excessive amount of moisture.

The desiccant pouches should not be baked or reused once removed from the MBB.

The humidity indicator card is a moisture indicator and is included in the MBB to show the approximate relative humidity level within the bag. Sample humidity cards are shown in Figure 45. If the components have been exposed to moisture above the recommended limits, the units will have to be rebaked.

Figure 45: Humidity Indicator Card - HIC



A baking is required if the humidity indicator inside the bag indicates 10% RH or more.

4.3.2.2. Transportation Box

Tape and reel carriers are distributed in a box, marked with a barcode label for identification purposes. A box contains 2 reels with 250 modules each.

5/ Regulatory and Type Approval Information

5.1. Directives and Standards

ALAS3K-US has been designed to comply with the directives and standards listed below.

It is the responsibility of the application manufacturer to ensure compliance of the final product with all provisions of the applicable directives and standards as well as with the technical specifications provided in the "ALAS3K-US Hardware Interface Description".[1]

Table 25: Directives

2014/53/EU	Directive of the European Parliament and of the council of 16 April 2014 on the harmonization of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/ 05/EC. The product is labeled with the CE conformity mark.
2002/95/EC (RoHS 1) 2011/65/EC (RoHS 2)	Directive of the European Parliament and of the Council of 27 January 2003 (and revised on 8 June 2011) on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)

Table 26: Standards of North American type approval

CFR Title 47	Code of Federal Regulations, Part 22, Part 24; US Equipment Authorization FCC
OET Bulletin 65 (Edition 97-01)	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
UL 60 950-1	Product Safety Certification (Safety requirements)
NAPRD.03 V5.31	Overview of PCS Type certification review board Mobile Equipment Type Certification and IMEI control PCS Type Certification Review board (PTCRB)
RSS132, RSS133, RSS139	Canadian Standard

Table 27: Standards of European type approval

3GPP TS 51.010-1	Digital cellular telecommunications system (Release 7); Mobile Station (MS) conformance specification;
ETSI EN 301 511 V12.5.1	Global System for Mobile communications (GSM); Mobile Stations (MS) equipment; Harmonized Standard covering the essential requirements of article 3.2 of Directive 2014/53/ EU
GCF-CC V3.65	Global Certification Forum - Certification Criteria
ETSI EN 301 489-01 V2.2.0	Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements; Harmonized Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU and the essential requirements of article 6 of Directive 2014/30/EU
Draft ETSI EN 301 489-52 V1.1.0	Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 52: Specific conditions for Cellular Communication Mobile and portable (UE) radio and ancillary equipment; Harmonized Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU
ETSI EN 301 908-01 V11.1.1	IMT cellular networks; Harmonized Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 1: Introduction and common requirements
ETSI EN 301 908-02 V11.1.1	IMT cellular networks; Harmonized Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 2: CDMA Direct Spread (UTRA FDD) User Equipment (UE)

1. Manufacturers of applications which can be used in the US shall ensure that their applications have a PTCRB approval. For this purpose they can refer to the PTCRB approval of the respective module.

Table 27: Standards of European type approval

ETSI EN 301 908-13 V11.1.1	IMT cellular networks; Harmonized Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 13: Evolved Universal Terrestrial Radio Access (E-UTRA) User Equipment (UE)
EN 60950-1:2006/ A11:2009+A1:2010+ A12:2011+A2:2013	Safety of information technology equipment

Table 28: Requirements of quality

IEC 60068	Environmental testing
DIN EN 60529	IP codes

Table 29: Standards of the Ministry of Information Industry of the People's Republic of China

SJ/T 11363-2006	"Requirements for Concentration Limits for Certain Hazardous Substances in Electronic Information Products" (2006-06).
SJ/T 11364-2006	"Marking for Control of Pollution Caused by Electronic Information Products" (2006-06). According to the "Chinese Administration on the Control of Pollution caused by Electronic Information Products" (ACPEIP) the EPUP, i.e., Environmental Protection Use Period, of this product is 20 years as per the symbol shown here, unless otherwise marked. The EPUP is valid only as long as the product is operated within the operating limits described in the Hardware Interface Description. Please see Table 30 for an overview of toxic or hazardous substances or elements that might be contained in product parts in concentrations above the limits defined by SJ/T 11363-2006.

Table 30: Toxic or hazardous substances or elements with defined concentration limits

部件名称 Name of the part	有毒有害物质或元素 Hazardous substances					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
金属部件 (Metal Parts)	o	o	o	o	o	o
电路模块 (Circuit Modules)	x	o	o	o	o	o
电缆及电缆组件 (Cables and Cable Assemblies)	o	o	o	o	o	o
塑料和聚合物部件 (Plastic and Polymeric parts)	o	o	o	o	o	o

o:
表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006 标准规定的限量要求以下。
Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006.

X:
表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006标准规定的限量要求。
Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part *might exceed* the limit requirement in SJ/T11363-2006.

5.2. SAR requirements specific to portable mobiles

Mobile phones, PDAs or other portable transmitters and receivers incorporating a GSM module must be in accordance with the guidelines for human exposure to radio frequency energy. This requires the Specific Absorption Rate (SAR) of portable ALAS3K-US based applications to be evaluated and approved for compliance with national and/or international regulations.

Since the SAR value varies significantly with the individual product design manufacturers are advised to submit their product for approval if designed for portable use. For US and European markets the relevant directives are mentioned below. It is the responsibility of the manufacturer of the final product to verify whether or not further standards, recommendations or directives are in force outside these areas.

Products intended for sale on US markets

ES 59005/ANSI C95.1	Considerations for evaluation of human exposure to electromagnetic fields (EMFs) from mobile telecommunication equipment (MTE) in the frequency range 30MHz - 6GHz

Products intended for sale on European markets

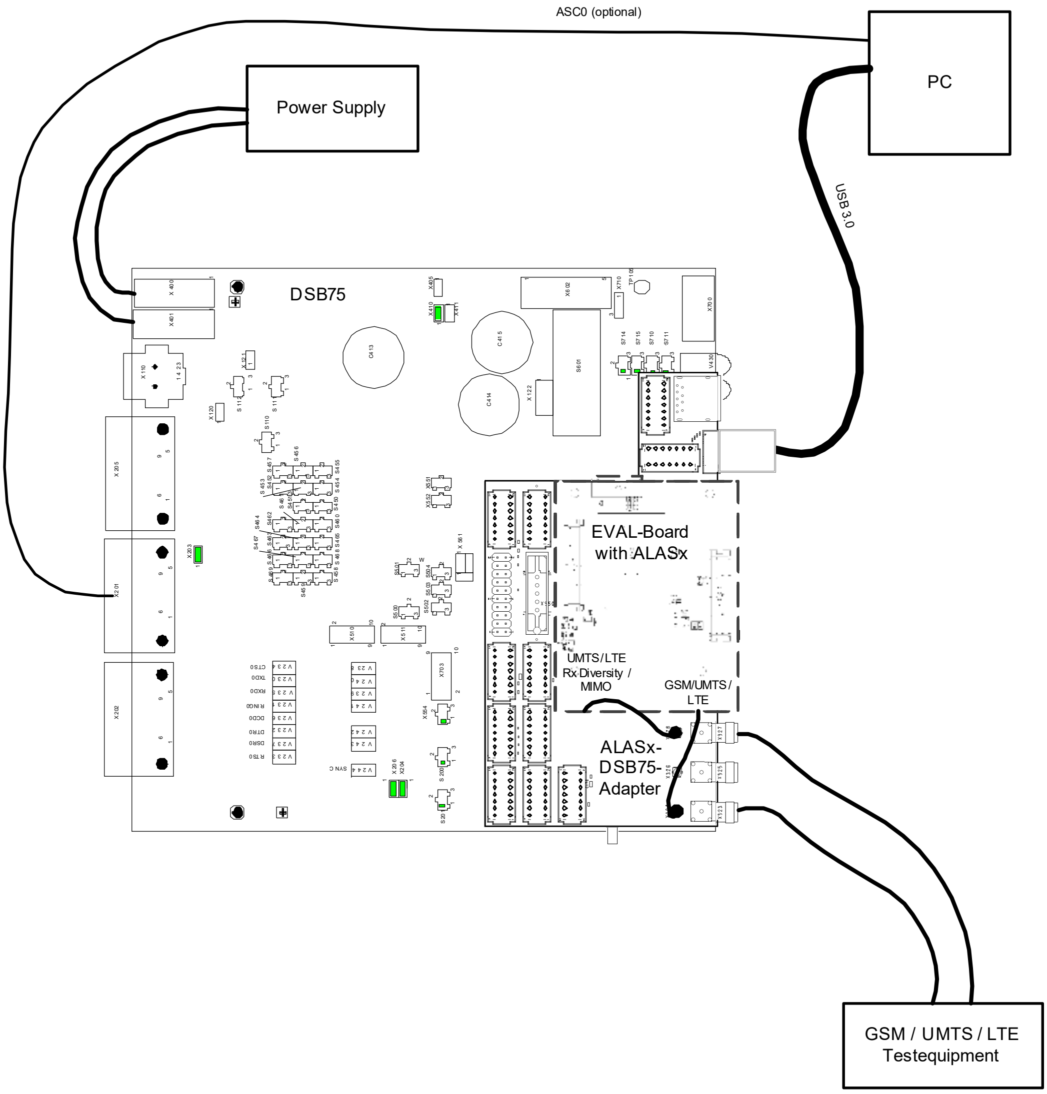
EN 50360	Product standard to demonstrate the compliance of mobile phones with the basic restrictions related to human exposure to electromagnetic fields (300MHz - 3GHz)
EN 62311:2008	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)

IMPORTANT:
Manufacturers of portable applications based on ALAS3K-US modules are required to have their final product certified and apply for their own FCC Grant and Industry Canada Certificate related to the specific portable mobile.

5.3. Reference Equipment for Type Approval

The Kontron general reference setup submitted to type approve ALAS3K-US is shown in the figure below: Figure 46 illustrates the setup for general tests and evaluation purposes. The evaluation module can be plugged directly onto the ALAS6A-DSB75 adapter. The GSM/UMTS/LTE test equipment is still connected via SMA connectors on the ALAS6A-DSB75 adapter. The PC is connected via USB interface (but may also be connected via ASC0 interface).

Figure 46: Reference equipment for type approval



Please note that for EMC and RF performance tests, slightly different reference equipment configurations are used. If necessary, please contact Kontron for further details.

5.4. Compliance with FCC and ISED Rules and Regulations

The Equipment Authorization Certification for the Kontron modules reference application described in Section 5.3. will be registered under the following identifiers:

- ALAS3K-US:
  FCC Identifier 2AATHALAS3K-US
  Industry Canada Certification Number: 9927C-ALAS3KUS
  Granted to Kontron Europe GmbH

Manufacturers of mobile or fixed devices incorporating ALAS3K-US modules are authorized to use the FCC Grants and Industry Canada Certificates of the ALAS3K-US modules for their own final products according to the conditions referenced in these documents. In this case, the FCC label of the module shall be visible from the outside, or the host device shall bear a second label stating "Contains FCC ID: 2AATHALAS3K-US" and accordingly “Contains IC: 9927C-ALAS3KUS“. The integration is limited to fixed or mobile categorized host devices, where a separation distance between the antenna and any person of min. 20cm can be assured during normal operating conditions.

For mobile and fixed operation configurations the antenna gain, including cable loss, must not exceed the limits listed in the following Table 31 for FCC and IC.

Table 31: Antenna gain limits for FCC and IC

Maximum gain in operating band	FCC limit	IC limit	Unit
Band12, 700MHz (LTE)	10.2	7.1	dBi
Band 5, 850MHz (GSM/WCDMA/LTE)	4.0	0.7	dBi
Band 4, 1700MHz (WCDMA/LTE)	12.5	8.8	dBi
Band 2, 1900MHz (GSM/WCDMA/LTE)	9.5	6.0	dBi

IMPORTANT:
Manufacturers of portable applications incorporating ALAS3K-US modules are required to have their final product certified and apply for their own FCC Grant and Industry Canada Certificate related to the specific portable mobile. This is mandatory to meet the SAR requirements for portable mobiles (see Section 5.2. for detail).

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules and with Industry Canada license-exempt RSS standard(s). These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This Class B digital apparatus complies with Canadian ICES-003.

If Canadian approval is requested for devices incorporating ALAS3K-US modules the above note will have to be provided in the English and French language in the final user documentation. Manufacturers/OEM Integrators must ensure that the final user documentation does not contain any information on how to install or remove the module from the final product.

6/ Document Information

6.1. Revision History

Preceding document: "ALAS3K-US Hardware Interface Description" Version 01.003b
New document: "ALAS3K-US Hardware Interface Description" Version **v01.003c**

Chapter	What is new
--	Updated layout (because of company name change).

Preceding document: "ALAS3K-US Hardware Interface Description" Version 01.003a
New document: "ALAS3K-US Hardware Interface Description" Version 01.003b

Chapter	What is new
3.4.1.	Revised some current consumption ratings.
4.2.4.1.	Added air temperature as storage condition.

Preceding document: "ALAS3K-US Hardware Interface Description" Version 01.003
New document: "ALAS3K-US Hardware Interface Description" Version 01.003a

Chapter	What is new
2.1.2.	Revised characteristics for IGT, EMERG_OFF, and VUSB_IN.
2.1.2.1.	Revised ratings for USB 2.0/3.0 lines.
2.1.9.	Removed description of alarm function.

Preceding document: "ALAS3K-US Hardware Interface Description" Version 01.000
New document: "ALAS3K-US Hardware Interface Description" Version 01.003

Chapter	What is new
5.1.	Revised version numbers for some standards.

New document: "ALAS3K-US Hardware Interface Description" Version 01.000

Chapter	What is new
--	Initial document setup.

6.2. Related Documents

[1] ALAS3K-US AT Command Set
[2] ALAS3K-US Release Note
[3] Application Note 48: SMT Module Integration
[4] Universal Serial Bus Specification Revision 3.0
[5] Universal Serial Bus Specification Revision 2.0

6.3. Terms and Abbreviations

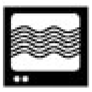
Abbreviation	Description
ANSI	American National Standards Institute
ARP	Antenna Reference Point
CA	Carrier Aggregation
CE	Conformité Européene (European Conformity)
CS	Coding Scheme
CS	Circuit Switched
CSD	Circuit Switched Data
DL	Download
dnu	Do not use
DRX	Discontinuous Reception
DSB	Development Support Board
DTX	Discontinuous Transmission
EDGE	Enhanced Data rates for GSM Evolution
EGSM	Extended GSM
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission (U.S.)
FDD	Frequency Division Duplex
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HiZ	High Impedance
HSDPA	High Speed Downlink Packet Access
I/O	Input/Output
IMEI	International Mobile Equipment Identity
ISO	International Standards Organization
ITU	International Telecommunications Union
kbps	kbits per second
LED	Light Emitting Diode
LGA	Land Grid Array
LTE	Long term evolution
MBB	Moisture barrier bag

Abbreviation	Description
Mbps	Mbits per second
MCS	Modulation and Coding Scheme
MFBI	Multiple Frequency Band Indicator
MIMO	Multiple Input Multiple Output
MLCC	Multi Layer Ceramic Capacitor
MO	Mobile Originated
MS	Mobile Station, also referred to as TE
MSL	Moisture Sensitivity Level
MT	Mobile Terminated
nc	Not connected
NTC	Negative Temperature Coefficient
PCB	Printed Circuit Board
PCL	Power Control Level
PCS	Personal Communication System, also referred to as GSM 1900
PD	Pull Down resistor
PDU	Protocol Data Unit
PS	Packet Switched
PSK	Phase Shift Keying
PU	Pull Up resistor
QAM	Quadrature Amplitude Modulation
R&TTE	Radio and Telecommunication Terminal Equipment
RF	Radio Frequency
rfu	Reserved for future use
ROPR	Radio Output Power Reduction
RTC	Real Time Clock
Rx	Receive Direction
SAR	Specific Absorption Rate
SELV	Safety Extra Low Voltage
SIM	Subscriber Identification Module
SMD	Surface Mount Device
SMS	Short Message Service
SMT	Surface Mount Technology
SRAM	Static Random Access Memory
SRB	Signalling Radio Bearer
TE	Terminal Equipment
TPC	Transmit Power Control
TS	Technical Specification
Tx	Transmit Direction
UL	Upload
UMTS	Universal Mobile Telecommunications System

Abbreviation	Description
URC	Unsolicited Result Code
USB	Universal Serial Bus
UICC	USIM Integrated Circuit Card
USIM	UMTS Subscriber Identification Module
WCDMA	Wideband Code Division Multiple Access

6.4. Safety Precaution Notes

The following safety precautions must be observed during all phases of the operation, usage, service or repair of any cellular terminal or mobile incorporating ALAS3K-US. Manufacturers of the cellular terminal are advised to convey the following safety information to users and operating personnel and to incorporate these guidelines into all manuals supplied with the product. Failure to comply with these precautions violates safety standards of design, manufacture and intended use of the product. Kontron assumes no liability for customer’s failure to comply with these precautions.

	When in a hospital or other health care facility, observe the restrictions on the use of mobiles. Switch the cellular terminal or mobile off, if instructed to do so by the guidelines posted in sensitive areas. Medical equipment may be sensitive to RF energy. The operation of cardiac pacemakers, other implanted medical equipment and hearing aids can be affected by interference from cellular terminals or mobiles placed close to the device. If in doubt about potential danger, contact the physician or the manufacturer of the device to verify that the equipment is properly shielded. Pacemaker patients are advised to keep their hand-held mobile away from the pacemaker, while it is on.
	Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it cannot be switched on inadvertently. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communications systems. Failure to observe these instructions may lead to the suspension or denial of cellular services to the offender, legal action, or both.
	Do not operate the cellular terminal or mobile in the presence of flammable gases or fumes. Switch off the cellular terminal when you are near petrol stations, fuel depots, chemical plants or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmospheres can constitute a safety hazard.
	Your cellular terminal or mobile receives and transmits radio frequency energy while switched on. Remember that interference can occur if it is used close to TV sets, radios, computers or inadequately shielded equipment. Follow any special regulations and always switch off the cellular terminal or mobile wherever forbidden, or when you suspect that it may cause interference or danger.
	IMPORTANT! Cellular terminals or mobiles operate using radio signals and cellular networks. Because of this, connection cannot be guaranteed at all times under all conditions. Therefore, you should never rely solely upon any wireless device for essential communications, for example emergency calls. Remember, in order to make or receive calls, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength. Some networks do not allow for emergency calls if certain network services or phone features are in use (e.g. lock functions, fixed dialing etc.). You may need to deactivate those features before you can make an emergency call. Some networks require that a valid SIM card be properly inserted in the cellular terminal or mobile.

7/ Appendix

7.1. List of Parts and Accessories

Table 32: List of parts and accessories

Description	Supplier	Ordering information
ALAS3K-US	Kontron	Standard module Kontron IMEI: Packaging unit (ordering) number: L30960-N4130-K100 Module label number: S30960-S4130-K100-1[1]
ALAS3K-US Evaluation module	Kontron	Ordering number: L30960-Nxxxx-yyyy
DSB75 Support Box	Kontron	Ordering number: L36880-N8811-A100
Votronic Handset	VOTRONIC / Kontron	Votronic ordering number: HH-SI-30.3/V1.1/0 Votronic Entwicklungs- und Produktionsgesellschaft für elektronische Geräte mbH Saarbrücker Str. 8 66386 St. Ingbert Germany Phone: +49-(0)6 89 4 / 92 55-0 Fax: +49-(0)6 89 4 / 92 55-88 Email: contact@votronic.com
SIM card holder incl. push button ejector and slide-in tray	Molex	Ordering numbers: 91228 91236 Sales contacts are listed in Table 33.
U.FL antenna connector	Molex or Hirose	Sales contacts are listed in Table 33 and Table 34.

1. Note: At the discretion of Kontron, module label information can either be laser engraved on the module's shielding or be printed on a label adhered to the module's shielding.

Table 33: Molex sales contacts (subject to change)

Molex For further information please click: http://www.molex.com	Molex Deutschland GmbH Otto-Hahn-Str. 1b 69190 Walldorf Germany Phone: +49-6227-3091-0 Fax: +49-6227-3091-8100 Email: mxgermany@molex.com	American Headquarters Lisle, Illinois 60532 U.S.A. Phone: +1-800-78MOLEX Fax: +1-630-969-1352
Molex China Distributors Beijing, Room 1311, Tower B, COFCO Plaza No. 8, Jian Guo Men Nei Street, 100005 Beijing P.R. China Phone: +86-10-6526-9628 Fax: +86-10-6526-9730	Molex Singapore Pte. Ltd. 110, International Road Jurong Town, Singapore 629174 Phone: +65-6-268-6868 Fax: +65-6-265-6044	Molex Japan Co. Ltd. 1-5-4 Fukami-Higashi, Yamato-City, Kanagawa, 242-8585 Japan Phone: +81-46-265-2325 Fax: +81-46-265-2365

Table 34: Hirose sales contacts (subject to change)

Hirose Ltd. For further information please click: http://www.hirose.com	Hirose Electric (U.S.A.) Inc 2688 Westhills Court Simi Valley, CA 93065 U.S.A. Phone: +1-805-522-7958 Fax: +1-805-522-3217	Hirose Electric Europe B.V. German Branch: Herzog-Carl-Strasse 4 73760 Ostfildern Germany Phone: +49-711-456002-1 Fax: +49-711-456002-299 Email: info@hirose.de
Hirose Electric Europe B.V. UK Branch: First Floor, St. Andrews House, Caldecotte Lake Business Park, Milton Keynes MK7 8LE Great Britain Phone: +44-1908-369060 Fax: +44-1908-369078	Hirose Electric Co., Ltd. 5-23, Osaki 5 Chome, Shinagawa-Ku Tokyo 141 Japan Phone: +81-03-3491-9741 Fax: +81-03-3493-2933	Hirose Electric Europe B.V. Hogehill-weg 8 1101 CC Amsterdam Z-O Netherlands Phone: +31-20-6557-460 Fax: +31-20-6557-469

About Kontron

Kontron is a global leader in IoT/Embedded Computing Technology (ECT) and offers individual solutions in the areas of Internet of Things (IoT) and Industry 4.0 through a combined portfolio of hardware, software and services. With its standard and customized products based on highly reliable state-of-the-art technologies, Kontron provides secure and innovative applications for a wide variety of industries. As a result, customers benefit from accelerated time-to-market, lower total cost of ownership, extended product lifecycles and the best fully integrated applications.

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