Chapter 6

External SIM Card Reader CAE–2

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Summary

The CAE–2 external SIM card reader is designed for the Nokia 6081 GSM car telephone with type designation NME–2A and the handset with type designation HSE–6XA.

The card reader is designed for a ID–1 SIM card (IC–card) in accordance with GSM recommendation 11.11 and ISO standard ISO–7816–1,2,3. All cards which do not comply to the GSM11.11 and ISO–7816 will be rejected by the CAE–2. Only one card at a time can be used in the external card reader.

The card reader is connected to the telephone via the system cable and an extension cable, through one of its modular connectors. The handset is connected directly to the card reader through the second modular connector. The two modular connectors are connected in parallel, so the handset and the extension cable can be connected to any of the two connectors.

The CAE–2 works in parallel with the internal card reader in the 6081. If a card is inserted in the internal card reader, and there is no card in the external, then the 6081 will function as normal. If a card is inserted in the external card reader, and there is no card in the internal, then the 6081 will work as if a card was inserted in the internal reader. The external reader has the highest priority, so if a SIM card is inserted in both the internal and the external card reader, then the external will handle all the GSM operations, and the internal SIM card interface will be disabled. If a conversation already was established when a card is inserted in the external card reader, that conversation is interrupted, the internal card reader is disabled, and the telephone will log onto the network using the SIM card in external reader.

Modes of Operation

The CAE–2 has two modes of operations which is, with or without a SIM card inserted in the card reader.

Card Out Mode

The card reader will be in this mode when no SIM card is inserted, and 12V DC is connected via the modular connector, and this is the case even if the MBUS connection is missing. The LED is iluminated when the reader is in the card out mode.

The card reader first sends a MBUS registration message (as a slave unit) to the telephone (which is the master). The telephone responds by sending a registration acknowledge message to the card reader. When the acknowledge is received, the reader starts looking for a SIM card. If the MBUS connection is missing it will never start looking for a SIM card, because of the missing registration acknowledge, so the LED will stay on even if a card is inserted in the reader.

Card In Mode

When a SIM card is inserted in the reader, then the LED is turned off, and it enters the card in mode. The card reader will do read and write operations requested either from the telephone or SIM card itself. All SIM operations, which are available from the user interface in the telephone can can be done with a SIM card in the internal card reader, can now be executed using the SIM card in the external card reader. Phone calls can be initiated as soon as the telephone is in service.

If the SIM card is drawn out from the card reader, the SIM interface will be disabled and the CAE–2 will enter the card out mode.

Installation of the CAE–2

The CAE–2 (10 is installed using a extension cable (11) which is plugged into one of the modular connectors on the card reader and into the connector on the system cable (5) normally used for the handset (2). The handset is then connected to the second modular connector on the card reader.

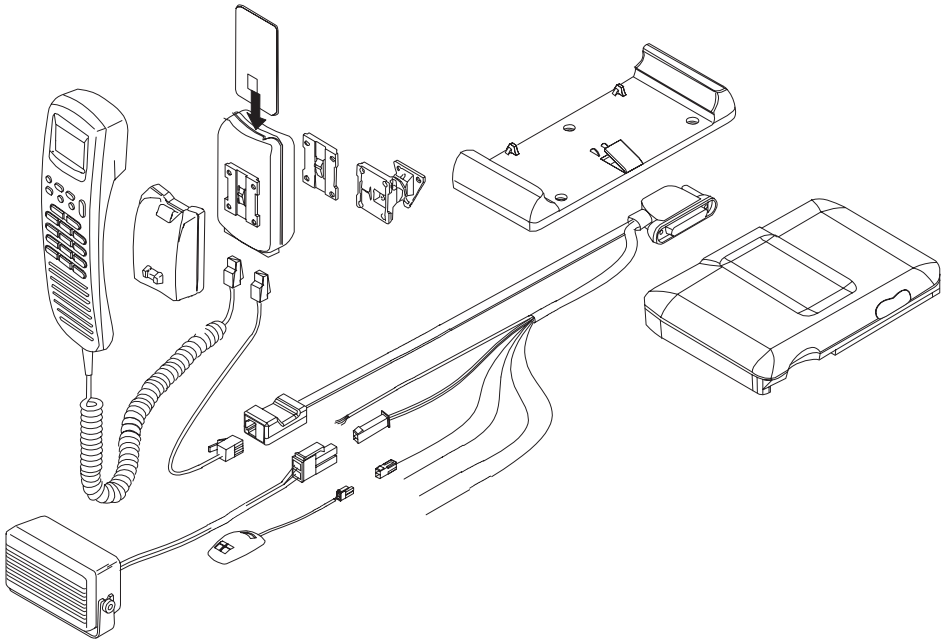

Figure 1: Interconnection Diagram

After power up the system is ready for insertion of a SIM card. The SIM card is inserted with the arrow on the SIM card facing the light guide for the LED on the CAE–2. If the card is inserted upside down it will be rejected by the card reader, and the message *CARD REJECTED* is written in the display of the handset. If this happens, draw out the SIM card and insert it in the right way.

Block Description

Overview

The card reader consists of four different blocks. A Power block, MBUS interface, SIM interface and the MCU. The block diagram of the card reader can be seen in figure 2.

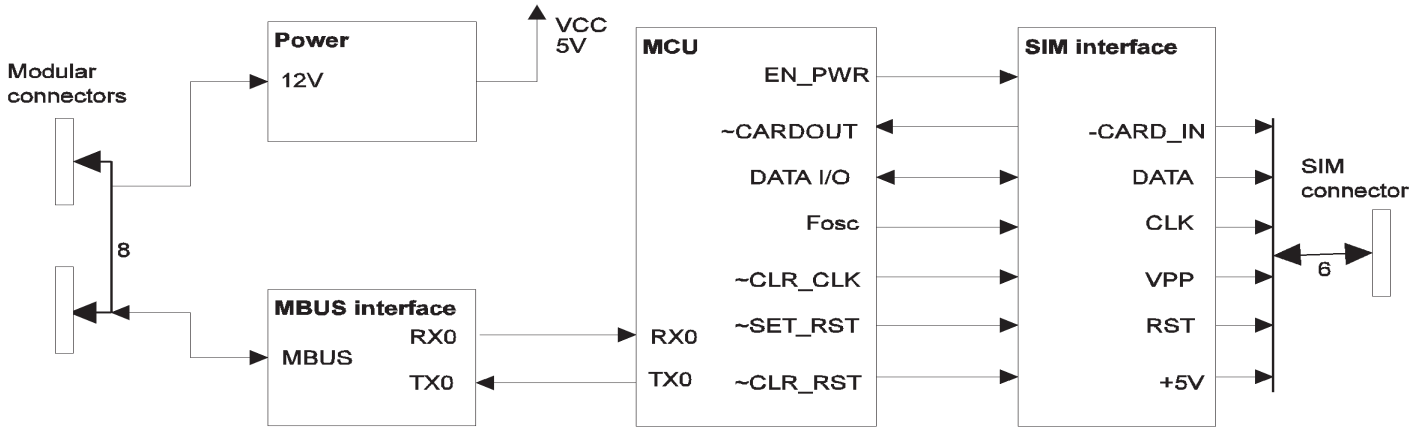

Figure 2: Block Diagram

Power Block

The power block is responsible for converting the 12V DC from the transceiver (see item 1 in figure 1) to 5V DC used for all the electronics in the card reader except for the power to SIM card.

MBUS Interface

This block converts messages to the card reader on the bi–directional one wire MBUS, to RX signals which can be read by the MCU. Messages from the card reader to the transceiver, are also converted from the MCU's TX line to the bi–directional MBUS.

SIM Interface

The SIM card is provided with the prober signals in accordance with the ISO 7816–3 standard through the SIM interface. It handles all control signals from the MCU and do level shifting, power switching and clock dividing for the SIM card. The +5V and VPP is controlled by the ~EN_PWR. RST can be set and reset by respectively ~SET_RST and

~CLR_RST. DATA and DATA I/O is identical signals, and is the bi–directional halfduplex data line on the SIM card. The CLK signal is derived from the MCU oscillator Fosc. It can be stopped by the ~CLR_CLK signal. –CARD_IN is a sense input for SIM card insertion, and it signals this event to the MCU trough the ~CARDOUT signal.

MCU Block

The MCU block consists mainly of the MCU which is controlling the card reader. The LEDs used for operation mode indication is also part of this block. The MCU has 2 UART's, one for the SIM interface and one for the MBUS interface. For explanation of the various signals to/from the MCU block, see the two former paragraphs.

Hardware Description

The diagram in the *Schematic – detailed* paragraph is used as the basis for this description of the hardware.

Signals on Modular Connectors

The modular connectors are wired in parallel and the various signals on these connectors (and the system cable and handset cable) is shown in the following table. All signals in bold are used in the card reader.

PIN	NAME	SIGNAL EXPLANATION
1	HS LSP	Loudspeaker (not used)
2	ON/OFF KEY	Power switch (not used)
3	**MBUS**	Bi–directional data line
4	AGND	Audio ground (not used)
5	**DGND**	Digital ground
6	HS MIC	Microphone (not used)
7	**12V DC**	Vbat_sw from transceiver
8	EARPHONE	Earphone (not used)

Signals on SIM Connector

The SIM card is connected via the X3 flex foil connector.

PIN	NAME	SIGNAL EXPLANATION
1	–CARD_IN	SIM insertion sense. Connected to hw switch in card reader mechanics.
2	+CARD_IN	VCC for hw switch in card reader mechanics
3	DATA	Bi–directional half–duplex SIM data line
4	CLK	Clock signal for SIM card
5	VPP	Programming voltage for SIM card
6	RST	Reset signal to SIM card
7	GND	Ground for SIM card. Connected to DGND
8	+5V	Power for SIM card

Power Block

The power block consists of a low dropout voltage regulator LP2951ACM (N1), used for converting the incomming 12V DC (Vbat_sw) from the transceiver to the VCC (5V DC) used for all the electronics in the card reader, except the DC power connection for the SIM card.

SIGNAL	IN/OUT	VALUE	MIN	MAX
12V	In	12V DC current 1.5A	10.8 V DC	15.6 V DC
VCC	Out	5V DC 100mA	4.93 V DC	5.07 V DC

MBUS Interface

The MBUS is used for communications between all the units. It is a bi–directional halfduplex signal line, with a transmission speed of 9600 baud. The MBUS signal is converted to RX signal to the MCU and TX signal from the MCU via the sense resistor R19 and the open collector output made by transistor V4 and inverter V5. The pull–up resistor for the MBUS is placed in the transceiver. It also includes the EMC filter for the MBUS line.

SIM Interface

The SIM interface is responsible for generating all the necessary signal for the SIM card. It is controlled by the MCU block. It consists of three parts. A power switch made by V2, a divide by 2 for the SIM clock made by toggle D–FF D1 and a D–FF used as a set/reset handler for the SIM reset signal. The HC74 D–FF is also necessary for converting the output levels of the MCU to the signal levels needed by the SIM card. The SIM interface also includes the EMC filters for the SIM connections.

The D1a D–FF divide the MCU oscillator frequency of 7.3728 Mhz to 3.6864 Mhz which is used as SIM clock. The SIM clock can be disabled by the MCU signal ~CLR_CLK and it will always stop on a low value (’0’). The clock should have a duty cycle of 45% to 55% and a rise and fall time of not more than 24 ns. When the power to the SIM is removed, the reset input of the CLK FF is kept at a low signal via another switch.

The D1b D–FF controls the reset signal (RST) for the SIM card. The RST can be set by the MCU signal ~CLR_RST and set by ~SET_RST. It will also be in reset state when power is removed from the SIM card.

The _CARD_IN signal is low when there is no SIM card inserted. The ~CARD_IN will raise to a high (’1’) if a SIM card is inserted. The inserted SIM card will shunt a mechanical switch, which is connected at the flex foil connector X3’s pin 1 and 2. The –CARD_IN signal is used as a output signal from the SIM interface to the MCU where it is called ~CARDOUT.

The transistor V2 is used as a power switch for the SIM card. It is controlled by the MCU signal ~EN_PWR. The output +5V is supplying both the VPP and the VCC pin on the SIM card. The regulation on the +5V is supplying both the VPP and the VCC pin on the SIM card. The regulation on the +5V must not fall below 4.5 V DC.

The ~EN_PWR signal also controls 3 HC4066 switches. Two of them are used to reset the RST and CLK FF’s, when no power is applied to the SIM card. The third is grounding the SIM DATA line when the power is removed, in conjunction with R10. R10 serves as a pull up resistor when power is applied to the SIM card, and a pull down when power is removed.

When power is applied to the SIM card the HC4066 switch in the SIM DATA line is activated, and the MCU’s RX and TX is connected to the SIM card.

For all the different signal levels on the SIM interface, see the ISO 7816–3 standard.

MCU Block

The MCU is a DS87C520 from Dallas Semiconducters. It controls the SIM and MBUS interface, and all communications with the two interfaces is done with respectively UART 1 and UART 0. The MCU handles the power up reset automatically, and it also monitors the VCC in order to disable the SIM interface in case of a low voltage on VCC (<4.25 VDC).

Without any SIM card inserted in card reader the LED's V6 and V7 will be turned on by the MCU. Approx 9 mA is used for the LED's. If a SIM card is inserted the MCU will turn off the LED's and enable the SIM interface in accordance with the ISO 7816–3 standard.

In the following table an explanation of the signals in the MCU block is given.

SIGNAL	IN/OUT	EXPLANATION
~TEST	In	Only for test purposes
~SET_RST	Out	When low, the RST on SIM is high
~CLR_RST	Out	When low, the RST on SIM is low
~CLR_CLK	Out	When low, the clock for SIM card is stopped at a low value
~EN_PWR	Out	Enables the +5V DC for the SIM card
~CARDOUT	In	A low on this will interrupt the MCU, and indicate that the SIM card is removed
RX1	In	SIM data is received via this pin
TX1	Out	MCU transmit data to the SIM card via this pin
INTO	In	Used for software purposes
P1.4	In	Used for software purposes
RX0	In	MBUS messages are received via this pin
TX0	Out	MCU transmit to MBUS via this pin
T2EX	In	Used for software purposes
P1.6	Out	LED controlling pin

Circuit Diagram of GM8S

Layout Diagram

Parts List of CAE–2 (EDMS: Issue 4.2)

ITEM	CODE	DESCRIPTION		VALUE TYPE
R001	1430151	Chip resistor	10	5 % 0.063 W 0603
R002	1430087	Chip resistor	100 k	5 % 0.063 W 0603
R003	1430065	Chip resistor	10 k	5 % 0.063 W 0603
R006	1430087	Chip resistor	100 k	5 % 0.063 W 0603
R008	1430065	Chip resistor	10 k	5 % 0.063 W 0603
R009	1430065	Chip resistor	10 k	5 % 0.063 W 0603
R010	1430065	Chip resistor	10 k	5 % 0.063 W 0603
R011	1430298	Chip resistor	1.0 M	2 % 0.063 W 0603
R012	1430071	Chip resistor	22 k	5 % 0.063 W 0603
R016	1430071	Chip resistor	22 k	5 % 0.063 W 0603
R017	1430087	Chip resistor	100 k	5 % 0.063 W 0603
R018	1430087	Chip resistor	100 k	5 % 0.063 W 0603
R021	1430144	Chip jumper		0603
R022	1430144	Chip jumper		0603
R030	1430087	Chip resistor	100 k	5 % 0.063 W 0603
R031	1430065	Chip resistor	10 k	5 % 0.063 W 0603
C001	2604103	Tantalum cap.	4.7 u	20 % 35 V 7.3x4.4x2.8
C002	2310784	Ceramic cap.	100 n	10 % 25 V 0805
C003	2320059	Ceramic cap.	100 p	5 % 50 V 0603
C004	2320107	Ceramic cap.	10 n	5 % 50 V 0603
C005	2310784	Ceramic cap.	100 n	10 % 25 V 0805
C006	2310784	Ceramic cap.	100 n	10 % 25 V 0805
C007	2604431	Tantalum cap.	10 u	20 % 16 V 6.0x3.2x2.5
C008	2320045	Ceramic cap.	27 p	5 % 50 V 0603
C009	2320045	Ceramic cap.	27 p	5 % 50 V 0603
C010	2320045	Ceramic cap.	27 p	5 % 50 V 0603
C011	2320059	Ceramic cap.	100 p	5 % 50 V 0603
C012	2320059	Ceramic cap.	100 p	5 % 50 V 0603
C013	2320059	Ceramic cap.	100 p	5 % 50 V 0603
C014	2320059	Ceramic cap.	100 p	5 % 50 V 0603
C015	2320059	Ceramic cap.	100 p	5 % 50 V 0603
C016	2320045	Ceramic cap.	27 p	5 % 50 V 0603
C017	2310784	Ceramic cap.	100 n	10 % 25 V 0805
C018	2320059	Ceramic cap.	100 p	5 % 50 V 0603
B001	4510036	Crystal	7.3728 M +–50PPM	12x6x3mm
V002	4200909	Transistor	BC858B/BCW30	pnp 30 V 100 mA SOT23
V003	4200917	Transistor	BC848B/BCW32	npn 30 V 100 mA SOT23

V004	4200917	Transistor	BC848B/BCW32	npn 30 V 100 mA	SOT23
V005	4200917	Transistor	BC848B/BCW32	npn 30 V 100 mA	SOT23
V006	4102998	Led	Green	2.2 V 1206	
V007	4102998	Led	Green	2.2 V 1206	
D001	4309375	IC, 2 x D–flip–flop	74HC74	SO14S	
D002	4309488	IC, 4 x bi.switch	74HC4066	SO14S	
N001	4301062	IC, regulator	LP2951AC	SO8S	
N002	0240426	MCU SW Module			
	4370169	MCU DS87C520			
	8400470	ROM Code			
	9380149	Sticker Brady LAT–2–747 9.5X9.5			
X001	5416518	Modular jack 8 pole smd			
X002	5416518	Modular jack 8 pole smd			
X003	5431702	Flexfoil connect 1x08	1mm smd		
P001	9854153	PC board GM8S	80.8x58.2x1.6 d 4/pa		
	9854153	PCB GM8S 80.8X58.2X1.6 D 4/PA			

Exploded View of CAE–2

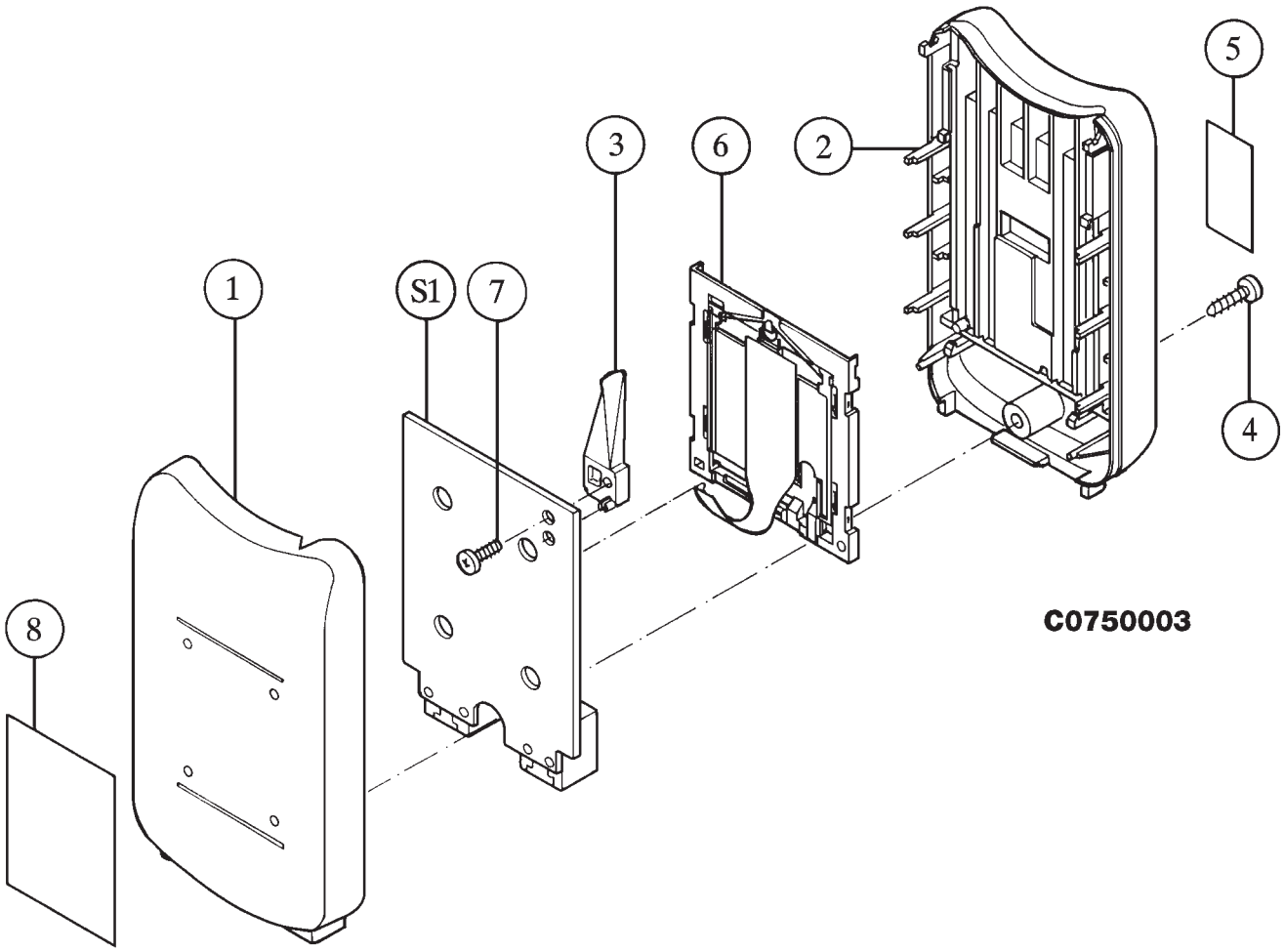

Figure 5: Exploded View of CAE–2

Mechanical Items

ITEM	CODE	DESCRIPTION	VALUE	TYPE
1	9450019	Front Cover	CAE–2	1D21141
2	9450018	Bottom Cover	CAE–2	3D21142
3	9450017	Light Guide	CAE–2	3D21143
4	6292279	PT–screw		KB30x10 WN1442 FEXN BLU
5	9380154	Label blank		4D21745
6	5408803	Chip card reader push		
7	6291917	PT–screw		KB25x5 WN1442
8	9380112	Cover sticker		4D21434
S1	0201013	GM8S module		