COMPAQ

iPAQ H3000 Series Expansion Pack Developer Guide

NOTICE

The information in this document is subject to change without notice.

THE INFORMATION IN THIS PUBLICATION IS PROVIDED “AS IS” WITHOUT WARRANTY OF ANY KIND. THE ENTIRE RISK ARISING OUT OF THE USE OF THIS INFORMATION REMAINS WITH RECIPIENT. IN NO EVENT SHALL COMPAQ BE LIABLE FOR ANY DIRECT, CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER DAMAGES WHATSOEVER (INCLUDING WITHOUT LIMITATION, DAMAGES FOR LOSS OF BUSINESS PROFITS, BUSINESS INTERRUPTION OR LOSS OF BUSINESS IFORMATION), EVEN IF COMPAQ HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES AND WHETHER IN AN ACTION OF CONTRACT OR TORT, INCLUDING NEGLIGENCE.

The limited warranties for Compaq products are exclusively set forth in the documentation accompanying such products. Nothing herein should be construed as constituting a further or additional warranty.

Compaq and the Compaq logo Registered in the U.S. Patent and Trademark Office. iPAQ is a trademark of Compaq Information Technologies Group, L.P. Microsoft, ActiveSync, Outlook, Pocket Outlook, Expedia, AutoRoute Express, MapPoint, Windows, Windows NT, and the Windows logo are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

Intel and StrongARM are trademarks of Intel Corporation.

Microsoft products are licensed to OEMs by Microsoft Licensing, Inc., a wholly owned subsidiary of Microsoft Corporation.

All other product names mentioned herein are may be trademarks and/or registered trademarks of their respective companies.

iPAQ H3000 Series Expansion Pack Developer Guide

iPAQ H3000 Series Pocket PCs

7/2000.

175591-000

TABLE OF CONTENTS

chapter 1

OVERVIEW

Welcome

This document describes the technical requirements for expansion packs on the Compaq iPAQ H3000 Series Pocket PCs. The expansion pack includes an interface to the main unit. Possible expansion packs include wireless communication, extended battery life, high-end audio playback, PCMCIA/CF interface, GPS, video recorder and many non-functional expansion packs to personalize the main unit.

Figure 1 (Main Unit Sliding into an Expansion Pack) illustrates the principle of a main unit sliding onto an expansion pack (in this case, a CompactFlash expansion pack). The expansion pack and main unit eventually make electrical connection through their respective universal connector plug and receptical located near the bottoms of the expansion pack and the main unit, respectively.

FIGURE 1: Main Unit Sliding into an Expansion Pack

The intent of this document is to provide technical guidelines for all expansion packs to result in a consistent and compatible interface to the end-user. It is not the intent of this document to dictate all possible specifications and requirements. Specifications are given throughout the document, but some are omitted to allow flexibility for each expansion pack.

Symbols and Conventions

Some or all of the following format conventions may be used in this guide to distinguish elements of text:

- Names of menus, commands and icons are shown in bold type as they appear on the display, for example, **Settings**, **Power**.

⚠ Text set off in this manner indicates that failure to follow directions could result in bodily harm or loss of life.

△ Text set off in this manner indicates that failure to follow directions could result in damage to equipment or loss of information.

NOTE: Text set off in this manner presents commentary, sidelights, or interesting points of information.

chapter 2

REFERENCE DOCUMENTS

Order of Precedence

In the event of a conflict between this specification and references cited herein, this specification shall take precedence.

Reference Materials

Table 1: Reference Materials

Reference Title	Location/Author
Intel StrongARM SA-1110 Microprocessor Advanced Developer's Manual	Intel Corporation http://developer.intel.com/design/strong/manuals/
CF+ and CompactFlash Specification Revision 1.4	http://www.compactflash.org
PC Card Standard Revision 2.1	http://www.pc-card.com
8-bit AVR® Microcontroller with 4K Bytes In-System Programmable Flash	Atmel Corporation http://www.atmel.com/atmel/products/prod200.htm
Microsoft OEM Adaptation Kit	
Microsoft SDK	
Programming Windows CE	Douglas Boling
Essential Windows CE Application Programming	Robert Burdick

Software Tools Needed

1. Microsoft Embedded Visual C++ (New for Windows CE, Based on Visual Studio 6.0)
2. Microsoft Embedded Visual BASIC (New for Windows CE, Based on Visual Studio 6.0)
3. Microsoft SDK
4. Development Machine including:
   - Pentium II processor
   - Windows NT SP5 or Windows 2000
   - CD-ROM drive

Definition of Terms

This document describes Compaq's iPAQ H3000 series of products and expansion pack options. The term "main unit" refers to the iPAQ H3000 series product.

This document describes the batteries in the main unit and the expansion pack. The term main battery refers to the battery in the main unit. The term "extended battery" refers to the battery in the expansion pack.

In some parts of the text, the terms “EEPROM” and “NVRAM” are used interchangeably. Although technically not the same type of IC, both terms refer to the EEPROM on the SPI bus of the expansion pack.

The expansion pack connectors that electrically mate the main unit and the expansion pack are sometimes referred to as “universal connectors”. The plastic portion of the expansion pack that wraps around the main unit is called a “sleeve” or “base part”. The plastic portion of the expansion pack that protrudes from the back is called a “turtle shell” or “cover part”.

chapter 3

ELECTRICAL INTERFACE

Overview

The 100-pin electrical connection between the main unit and the expansion pack includes pins for two PCMCIA/CF devices, a 16/32-bit static memory/I/O interface, battery expansion, an SPI serial bus and other miscellaneous functions. The interface leverages the capability of the processor in the main unit. Figure 2 (Expansion Pack Interface on Main Unit) and Figure 3 (Expansion Pack Interface on Expansion Pack) show block diagrams of the interface on the main unit and a possible implementation of an expansion pack, respectively.

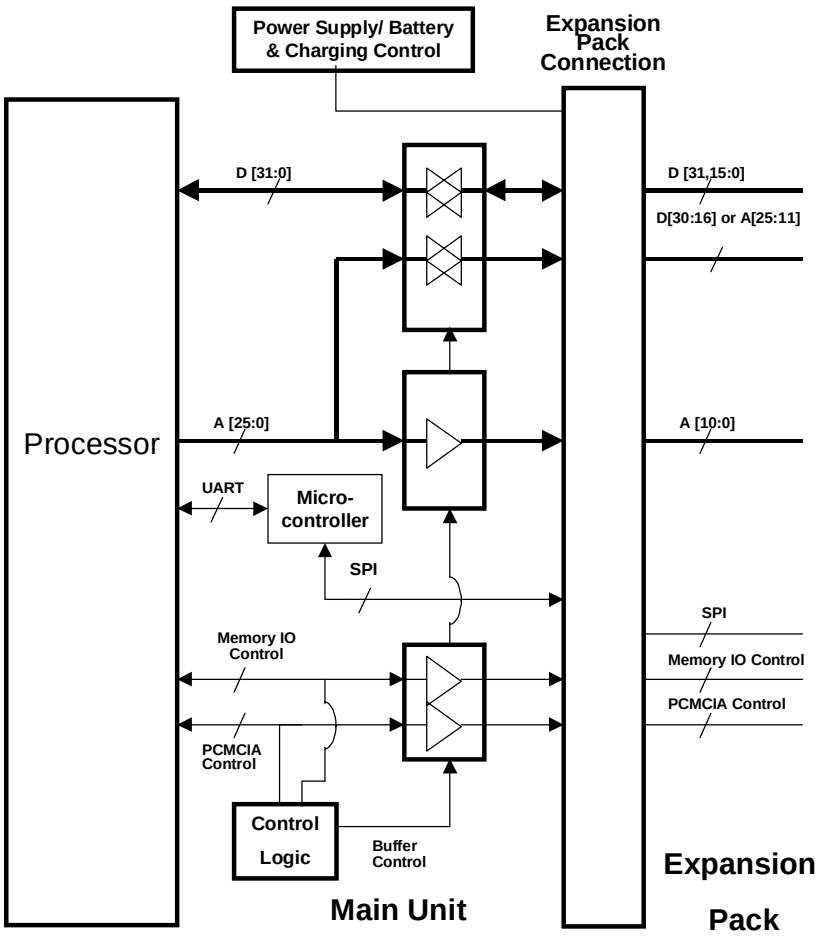
The address, data and control signals from the processor are connected to the expansion pack through isolation buffers. The isolation buffers are tri-stated when the system is in idle mode or not accessing the expansion pack. It is recommended that the expansion pack handle the tri-stating bus without excessive current draw (one recommendation is to include light pull-down or pull-up resistors on the signals). The address bus, A[25:0] and data bus, D[31:0], are used for parallel interfacing to PCMCIA/CF, static memory and I/O devices. The various control signals for PCMICA/CF, static memory and I/O enable different functions on the expansion pack. A portion of the address bus, A[25: 11], is multiplexed with most of the upper bytes of the data bus, D[30:16], to provide a 32-bit data bus interface. The 32-bit interface can perform these accesses only with an 11-bit address. The 32-bit data bus capability provides faster access for expansion packs that require high data throughput. Typically, the interface accesses 16-bit data with a 26-bit address bus.

The expansion pack interface supports two PCMCIA/CF devices in the expansion pack. If an expansion pack has two PCMCIA or CF devices, it must include buffers and control logic to isolate the signals.

The interface also supports static memory and I/O accesses through the separate control signals. The control signals include chip selects to access different memory banks on the expansion packs. Each memory bank has specific types of cycles that it supports (i.e. flash, ROM, I/O, etc.) Figure 4 (Expansion Pack Memory Map) shows the different memory banks the main unit can access on the expansion pack.

The interface also includes an SPI serial bus that provides serial access for functions on the expansion pack such as identification, battery monitoring and charge control. Each expansion pack must include an SPI EEPROM to identify itself and its features to the main unit.

FIGURE 2: Expansion Pack Interface on Main Unit



The main unit can supply up to 300 mA at 3.3V to an expansion pack. *If an expansion pack requires more than 300 mA peak or requires a voltage other than 3.3V, it must include its own battery, power supply and/or charging circuit.* The interface includes various pins to control the charging and power supplies between the main unit and expansion pack.

The interface also includes audio line-out signals, A_OUTR and A_OUTL, from the main unit. These signals correspond directly to the audio signals used for the speaker and headphone outputs of the main unit. If an expansion pack uses these signals it must amplify them for an expansion pack audio out function and connect the A_GND signal to the analog ground of the expansion pack.

The following sections in this document and the *Intel StrongARM SA-1110 Microprocessor Advanced Developer's Manual* provide more details on the interface.

FIGURE 3: Expansion Pack Interface on Expansion Pack (possible implementation)

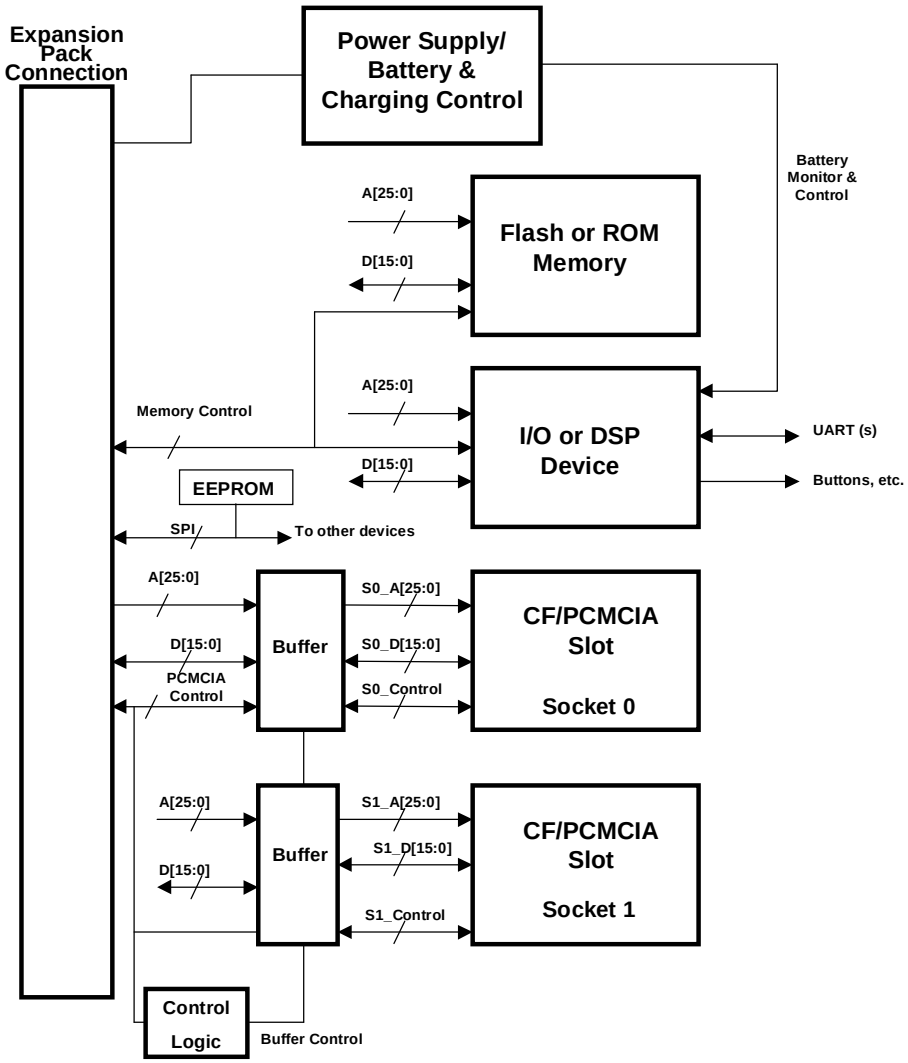
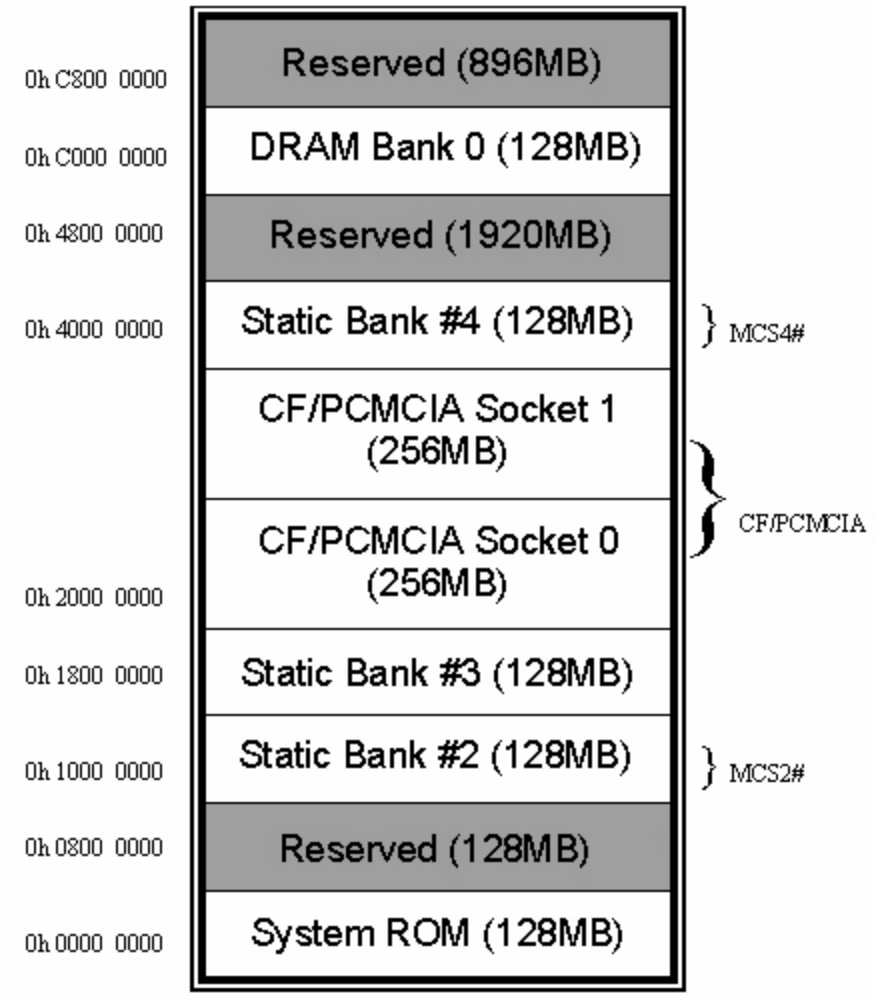


FIGURE 4: Expansion Pack Memory Map



Signals and Descriptions

The following table defines the signal names and pin out for the electrical interface between the main unit and any expansion pack.

Table 2: Expansion Pack Pin Out

Pin #	Name	Type	Description
1	CC_ETM	P/G	Trickle charge current pin
2	PCM_RESET	I	PCMCIA Reset
3	VS_EBAT	O	Extended battery sense
4	RD/WR#	I	Memory&I/O Read/Write#
5	GND	P/G	Main unit ground
6	RDY	O	Variable Latency I/O ready signal
7	CEN_ETM	OC	Charge current enable
8	RESET	I	GP reset for expansion pack
9	INT_OP	O	Expansion Pack Interrupt
10	CD_SCKT0#	O	PCMCIA 1st sckt detect
11	PSKTSEL	I	PCMCIA Socket Select
12	PCM_CE2#	I	PCMCIA card enable
13	PCM_IORD#	I	PCMCIA IO Read
14	PCM_IOWR#	I	PCMCIA IO Write
15	D11	I/O	PCMCIA/Memory Data
16	D12	I/O	PCMCIA/Memory Data
17	D13	I/O	PCMCIA/Memory Data
18	D14	I/O	PCMCIA/Memory Data
19	D15	I/O	PCMCIA/Memory Data
20	A17/D22	I/O	PCM/Mem Address/Data
21	GND	P/G	Main unit ground
22	A18/D23	I/O	PCM/Mem Address/Data
23	A19/D23	I/O	PCM/Mem Address/Data
24	A20/D25	I/O	PCM/Mem Address/Data
25	A21/D26	I/O	PCM/Mem Address/Data
26	A22/D27	I/O	PCM/Mem Address/Data
27	A23/D28	I/O	PCM/Mem Address/Data
28	A24/D29	I/O	PCM/Mem Address/Data

Table 2: Expansion Pack Pin Out

Pin #	Name	Type	Description
29	A25/D30	I/O	PCM/Mem Address/Data
30	D08	I/O	PCMCIA/Memory Data
31	GND	P/G	Main unit ground
32	D09	I/O	PCMCIA/Memory Data
33	D10	I/O	PCMCIA/Memory Data
34	D00	I/O	PCMCIA/Memory Data
35	D01	I/O	PCMCIA/Memory Data
36	D02	I/O	PCMCIA/Memory Data
37	D31	I/O	PCMCIA/Memory Data
38	PCM_REG#	I	PCMCIA IO cycle
39	PCM_WAIT#	O	PCMCIA Wait
40	SPI_DI	I	SPI Data In to expansion pack
41	SPI_CS#	I	SPI Chip Select
42	MCS2#	I	Memory Chip Select
43	MWE#	I	Memory Write Enable
44	MOE#	I	Memory Output Enable
45	GND	P/G	Main unit ground
46	EBAT_ON	O	Ext. battery power OK
47	OPT_ON	I	Expansion pack enable
48	V_ADP	P/G	Positive of AC adapter
49	V_EBAT	P/G	Positive of ext. battery
50	ODET2#	O	Expansion pack detect
51	ODET1#	O	Expansion pack detect
52	Reserved		
53	DQM3	I	Memory & I/O byte enable
54	DQM0	I	Memory & I/O byte enable
55	VDD	P/G	Main unit 3.3V power
56	DQM1	I	Memory & I/O byte enable
57	BATT_FLT	O	Extended battery fault
58	PCM_IRQ#0	O	PCMCIA sckt 0 RDY/IRQ#
59	PCM_CE1#	I	PCMCIA card enable

Table 2: Expansion Pack Pin Out

Pin #	Name	Type	Description
60	PCM_OE#	I	CF Output enable pin
61	PCM_WE#	I	PCMCIA write enable
62	CD_SCKT1#	O	PCMCIA sckt 1 detect
63	PCM_IRQ#1	O	PCMCIA sckt 1 RDY/IRQ#
64	D03	I/O	PCMCIA/Memory Data
65	D04	I/O	PCMCIA/Memory Data
66	GND	P/G	Main unit ground
67	D05	I/O	PCMCIA/Memory Data
68	D06	I/O	PCMCIA/Memory Data
69	D07	I/O	PCMCIA/Memory Data
70	A10	I	PCMCIA/Memory Address
71	A11/D16	I/O	PCM/Mem Address/Data
72	A09	I	PCMCIA/Memory Address
73	A08	I	PCMCIA/Memory Address
74	A13/D18	I/O	PCM/Mem Address/Data
75	A14/D19	I/O	PCM/Mem Address/Data
76	GND	P/G	Main unit ground
77	A16/D21	I/O	PCM/Memory Address/Data
78	A15/D20	I/O	PCM/Mem Address Data
79	A12/D17	I/O	PCM/Mem Address/Data
80	A07	I	PCMCIA/Memory Address
81	A06	I	PCMCIA/Memory Address
82	A05	I	PCMCIA/Memory Address
83	A04	I	PCMCIA/Memory Address
84	A03	I	PCMCIA/Memory Address
85	A02	I	PCMCIA/Memory Address
86	GND	P/G	Main unit ground
87	A01	I	PCMCIA/Memory Address
88	A00	I	PCMCIA/Memory Address
89	PCM_WP	O	PCMCIA WP/IOIS16#
90	A_OUTR	I	Right audio channel

Table 2: Expansion Pack Pin Out

Pin #	Name	Type	Description
91	A_OUTL	I	Left audio channel
92	A_GND	P/G	Analog GND for audio ONLY
93	Reserved		
94	MCS4#	I	Memory chip select
95	VDD	P/G	Main unit 3.3V power
96	SPI_SCK	I	SPI Clock Signal
97	MCHG_EN	I	Main battery recharging
98	V_ADP	P/G	Positive of AC adapter
99	V_EBAT	P/G	Positive of ext. battery
100	SPI_DO	O	SPI Data Out from expansion pack
NOTE: Signal type referenced to expansion pack. I = Input; O = Output; I/O = Bidirectional; P/G = Power, ground, battery or charging; OC = Open Collector. The "#" symbol denotes active low signal.			

Detailed Pin Description

Table 3: PCMCIA/CF/Memory Pin Description

Signal Name	DIR	Pin #	Description
A10 - A00 (CF mode)	I	See above	PCMCIA/CF/Memory address pins used to address card or expansion pack in Memory, I/O and True IDE.
A25 - A11 (PCMCIA/Memory mode)			PCMCIA or memory address pins used to access devices in the expansion pack. These pins are shared with D31:D16.
D15 - D00 (16-bit mode)	I/O	See above	Data pins used for 16-bit accesses in standard CF/PCMCIA, memory or I/O modes.
D31 - D16 (32-bit mode)	I/O	See above	Data pins for special accesses 32-bit read and write accesses in PCMCIA or I/O modes. These pins are shared with A25:A11.
PCM_CE1#, PCM_CE2#	I	59, 12	PCMCIA/CF card enable for 8 or 16-bit select in memory and I/O mode. Functions as CS0# and CS1# in IDE mode.
CD_SCKT0#, CD_SCKT1#	O	10, 62	PCMCIA/CF card detects pins for devices/slots 0 and 1. CD_SCKT0# represents logical OR of CD1# and CD2# of PCMCIA/CF pins for device/slot 0.
PCM_IORD#	I	13	PCMCIA/CF pin used in I/O and IDE modes as a read strobe.
PCM_IOWR#	I	14	PCMCIA/CF pin used in I/O and IDE modes as a write strobe.

Table 3: PCMCIA/CF/Memory Pin Description

Signal Name	DIR	Pin #	Description
PCM_OE#	I	60	PCMCIA/CF pin used as an output-enable strobe.
PCM_IRQ#0, PCM_IRQ#1	O	58, 63	PCMCIA/CF pins used in memory mode to determine the card status for transfers. Used as an interrupt signal in I/O and IDE modes. IRQ#0 is for device/slot 0.
PCM_RESET	I	2	PCMCIA/CF reset pin.
PCM_REG#	I	38	PCMCIA/CF pin used to distinguish between common and register memory in memory mode.
PCM_WAIT#	O	39	PCMCIA/CF pin to insert wait states in memory and I/O mode. Used as IORDY in True IDE mode. If there are two sockets in an expansion pack, the expansion pack must logically OR the WAIT# signals from each socket.
PCM_WE#	I	61	PCMCIA/CF pin used for write strobing into the CF card in memory and I/O modes.
PCM_WP	O	89	PCMCIA/CF pin used as a write protect in memory mode. Used as IOIS16# in I/O and IDE modes for 16-bit operation. If there are two sockets in an expansion pack, the expansion pack must logically OR the WP/IOIS16# signals from each socket.
RDY	O	6	Ready signal for slow expansion pack devices to insert wait states on the variable latency I/O port.
RD/WR#	I	4	Read/Write pin for the variable latency I/O port.
MCS[4,2]	I	94, 42	Memory bank chip select from the processor to use address and data pins for memory or I/O cycles.
DQM[3,1:0]	I	53, 56, 54	Byte enables for the 32-bit data bus of the static memory and variable latency I/O port.
MOE#	I	44	Memory bank output enable from the processor to use address and data pins for high bandwidth across the expansion pack.
MWE#	I	43	Memory bank write enable from the processor to use address and data pins for high bandwidth across the expansion pack.

Table 4: Serial Bus Interface Pin Description

Signal Name	DIR	Pin #	Description
SPI_SCK	I	96	Clock pin for the SPI interface.
SPI_DI	I	40	Data input for the SPI interface. The pin is driven by the main unit for data written to the expansion pack.
SPI_DO	O	100	Data output pin for the SPI interface. the pin is driven by the expansion pack for data written to the main unit.
SPI_CS#	I	41	Chip select pin for the SPI interface.

Table 5: Miscellaneous Signal Pin Descriptions

Signal Name	DIR	Pin #	Description
ODET1#, ODET2#	O	51, 50	Expansion pack detect signals. These signals generate an interrupt when the expansion pack is inserted or removed.
BATT_FLT	O	57	Active-high signal that notifies the main unit that the expansion pack battery is below its critical low level.
INT_OP	O	9	Expansion pack general-purpose interrupt used for various functions such as FIFO maintenance, polling, etc.
V_ADP	P/G	48, 98	Positive DC voltage from the AC adapter. Power can come from the main unit or expansion pack.
V_EBAT	P/G	49, 99	Positive battery voltage from the expansion pack to the main unit.
VS_EBAT	O	3	Positive terminal sense line for the extended battery.
OPT_ON	I	47	Notifies the expansion pack that it can run at full power.
MCHG_EN	I	97	Notifies the expansion pack battery charger to limit its current.
EBAT_ON	O	46	Notifies the main unit that the extended battery has sufficient energy to run the main unit.
CC_ETM	P/G	1	Charge current source from the expansion pack extended battery to trickle charge the main battery.
CEN_ETM	OC	7	Signal from the expansion pack that enables the extended battery to trickle charge the main battery.
RESET	I	8	General purpose reset for the expansion pack.
PSKTSEL	I	11	PCMCIA/CF socket select pin for expansion packs with two sockets.
A_OUTR, A_OUTL	I	90, 91	Line out right and left channels from the main unit audio output.
Reserved	TBD	52, 93	Reserved for future use.

PCMCIA/CF Signals

The interface includes PCMCIA support for up to two PCMCIA/CF sockets or devices. This 16-bit interface supports 8- and 16-bit PC cards and handles common memory, I/O and attribute memory accesses. The processor does not support the PCMCIA DMA protocol or CardBus.

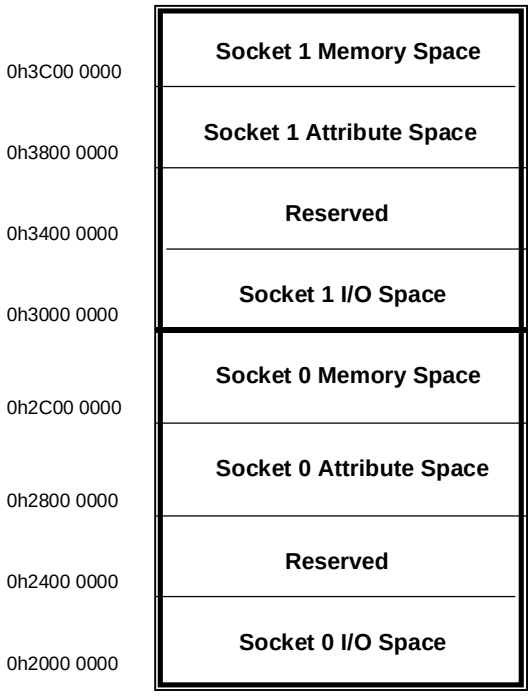
The PCMCIA memory space (Figure 5) is divided into eight partitions, the four for each card slot are common memory, I/O, attribute memory and a reserved space.

The expansion pack interface does not include the VS[1:0]#, V_{PP}[2:1], BVD[2:1] and INPACK# signals. If an expansion pack requires these signals it must implement them on the expansion pack. The VS[1:0]# and V_{PP}[2:1] signals are used by the expansion pack power supply to control the power supplied to the PCMCIA/CF socket(s). There is no provision on implementing BVD[2:1] or INPACK# on the expansion pack due to the lack of support on the processor.

Embedded inside the PCMCIA interface are the CompactFlash (CF) signals. Similar to the PCMCIA support, the CF implementation does not include VS[1:0]# and INPACK#. It also does not support CSEL# which is unique to CF. Again, if an expansion pack requires these signals it must implement them on the expansion pack.

The buffers between the processor on the main unit and the electrical components on the expansion pack are tri-stated during idle mode. If buffers are required to isolate a PCMCIA or CF slot from other component on the expansion pack, it is recommended that the buffers are disabled when the slot is not accessed to minimize power consumption. One possibility is to enable the buffers to the slot with the PCM_CE[2:1]# from the processor and the CD[2:1]# signals from the PCMCIA or CF slot.

FIGURE 5: PCMCIA Memory Space



If an expansion pack includes more than one PCMCIA or CF socket, additional logic is required on the expansion pack for certain signals (please refer to the *Intel StrongARM 1110 Microprocessor Advanced Developer's Manual*). The signals PCM_WAIT# and PCM_WP are outputs from each PCMCIA/CF socket and are logically connected to form one signal for the expansion pack interface. In similar fashion, the CD[2:1]# signals from each socket are logically connected to form one CD signal, CD_SCKT0# and CD_SCKT1#, for each socket on the expansion pack interface. The interface includes the PSKTSEL signal from the processor to determine which PCMCIA/CF socket is accessed.

The processor and the expansion pack interface also support a 32-bit version of the PCMCIA interface (not CardBus) that is not in the PC card specification. Since the 32-bit version of PCMCIA is outside the scope of the PC card specification, it is only intended for use with custom-designed logic. During the 32-bit operation, if any read or write is performed, the entire 32-bit bus is read or written. The 32-bit accesses must align with "16-bit" address space as opposed to "8-bit" address space. Due to a limited number of pins on the expansion pack, the 32-bit operation only has an 11-bit address bus.

All programming registers and other information about the PCMCIA/CF interface are found in the *Intel StrongARM 1110 Microprocessor Advanced Developer's Manual*.

Memory and I/O Signals

The expansion pack interface includes a static memory and I/O interface that uses the same address and data buses as PCMCIA/CF. The static memory and I/O control signals differentiate the accesses from PCMCIA/CF with chip select signals. The chip select signals, MCS[4,2]#, correspond directly to the signals from the processor. MCS[4,2]# support ROM or flash memory, with MCS4# also supporting variable latency I/O. The data bus is 16-bit maximum for memory cycles and 32-bit maximum for variable latency I/O. In 16-bit designs, address bit 0 (A[0]) is not used and in 32-bit designs, address bits 1 and 0 (A[1:0]) are not used.

The variable latency I/O interface differs from static memory in that it allows the use of the data ready input signal, RDY, to insert a variable number of wait states. The variable latency I/O interface uses DQM[3,1:0] as byte enables, where DQM[3] corresponds to the MSB. The variable latency portion of the interface allows the main unit to access slower devices such as micro-controllers and DSPs. A micro-controller on the expansion pack can provide functions such as a UART, battery monitoring, button control, etc.

Caution is required when using the variable latency I/O feature due to the fact it can hold the system bus for excessive amounts of time. If this occurs, it can adversely impact the performance of the main unit.

Other memory signals, MWE# and MOE#, are implemented to complete the static memory and I/O interface.

The SA-1110 includes registers that control the timing of the I/O accesses. Please refer to the *Intel StrongARM 1110 Microprocessor Advanced Developer's Manual* for more details and timing diagrams.

Serial Bus

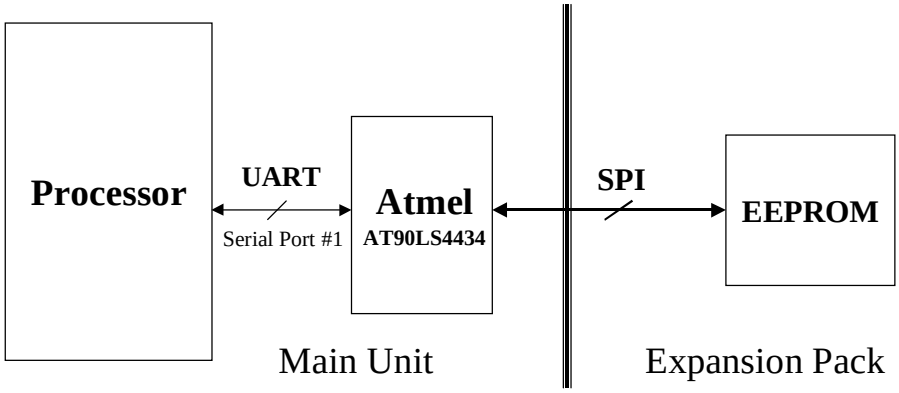
The expansion pack interface includes pins for the Motorola serial peripheral interface (SPI) for system management, identification and other low throughput functions. The master SPI device is a micro controller, an Atmel AT90LS4434, on the main unit that interfaces to a single slave SPI device on the expansion pack. The expansion pack interface includes the four standard SPI signals; SPI_DI, SPI_DO, SPI_CS# and SPI_SCK.

The SPI bus is primarily used to identify expansion packs upon insertion via an EEPROM on the expansion pack. The EEPROM contains configuration, ID, control information and optionally contains bootstrap programs and OEM information.

It is also possible to use SPI on the expansion pack for low bandwidth data transmission for micro controllers, battery management, etc. A maximum of two devices is allowed on the SPI bus of an expansion pack. The SPI_CS# signal goes directly to the EEPROM and an inverted version of SPI_CS# goes to the other device. Figure 6 (SPI Directly to EEPROM) and Figure 7 (Multiple Devices Communicating on SPI Interface) show the two possible implementations of the SPI interface on the expansion pack.

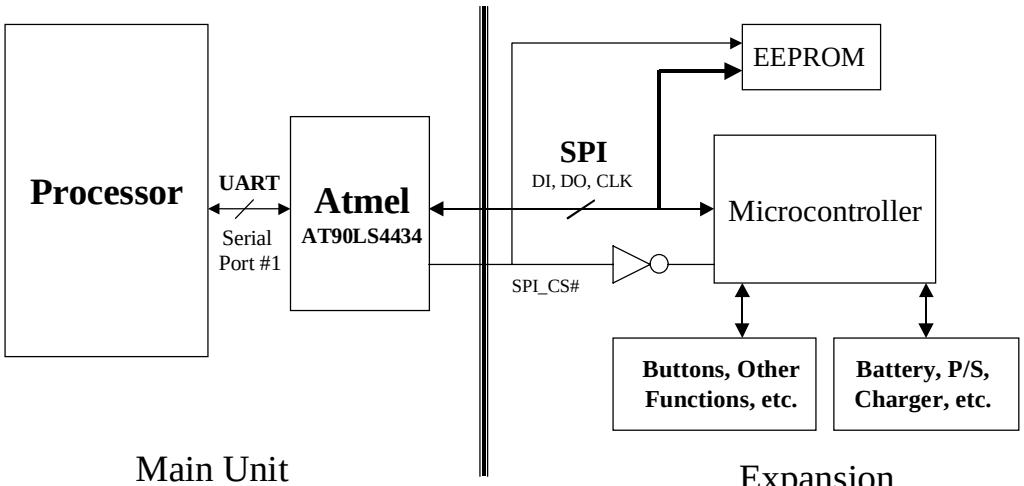
The Software Interface (Chapter 4) portion of this specification provides more details on the EEPROM contents and communication over the SPI bus.

FIGURE 6: SPI Directly to EEPROM



Expansion Pack Interface

FIGURE 7: Multiple Devices Communicating on SPI Interface



Expansion Pack Interface

Battery Signals

The battery signals are primarily designed to support a lithium-ion or lithium polymer rechargeable battery in the expansion pack. If an expansion pack does not include a battery, it should not connect any of the battery signals (V_EBAT, V_ADP, MCHG_EN, BATT_FLT, EBAT_ON, VS_EBAT, CEN_ETM and CC_ETM). If an expansion pack uses a different battery technology or does not want to share AC adapter charging with the main unit, it should not use any of the charging signals on the interface (V_ADP and MCHG_EN). Please read the following paragraphs, Chapter 5 (Battery, Power Supply and Charging) and the DC Characteristics and AC Characteristics carefully for guidelines.

When using a lithium-ion or lithium polymer battery in the expansion pack, the battery signals provide the ability to charge the expansion pack battery simultaneously with the main unit battery and optionally, extend the battery life of the main unit. The batteries in the main unit and the expansion pack are charged from multiple sources. The user can charge the batteries from the DC jack on the main unit, the DC jack on the expansion pack and through the synchronizing serial connector on the main unit. This allows the main unit and the expansion pack to charge their respective batteries separately or at the same time.

The V_ADP signals are the positive DC voltage from the AC adapter to charge the batteries. The V_ADP signals can be sourced from the main unit or the expansion pack, since the AC adapter can be plugged into either one. When charging is sourced from the cradle through the serial connector, the main unit passes the charge to the expansion pack. The charging circuits are designed for lithium-ion or lithium polymer batteries, so if an expansion pack uses another battery technology it should not connect the V_ADP signals. Also, if an expansion pack does not want to share AC adapter charging with the main unit it should not connect the V_ADP signals.

MCHG_EN is an active-high signal from the main unit to notify the expansion pack that the main battery is charging and it must limit its charging current to prevent blowing the fuse in the AC adapter. Typically, the expansion pack should limit its charging current by one-third. If MCHG_EN is low, then the expansion pack can charge its battery at the full charge current. Again, MCHG_EN is used only with lithium-ion or lithium polymer batteries. If an expansion pack uses another battery technology or does not use the V_ADP signals it should not connect MCHG_EN.

The V_EBAT signals are the positive DC voltages from the expansion pack battery to the main unit power supply that provide extended battery life. Generally, the only case the V_EBAT pins are connected is for an expansion pack that is specifically designed as an extended battery. It is recommended that an extended battery have a minimum capacity of 1000 maH.

The CC_ETM and CEN_ETM signals provide a mechanism for the expansion pack battery to provide a trickle charge to the main battery. It is optional for an expansion pack to implement the trickle charge feature. If the feature is not implemented, an expansion pack should not connect CC_ETM and CEN_ETM. The CC_ETM signal provides trickle charge from the expansion pack battery to the main battery. The CEN_ETM is an active-high, open-collector signal that enables the trickle charge from the expansion pack battery to the main battery. The expansion pack must pull this signal up to the extended battery voltage through a resistor (220kΩ to 470kΩ). The expansion pack should pull CEN_ETM low when the AC adapter is plugged in or when the expansion pack battery charge is too low. A current limiter, such as MAX890L or MAX893L, must exist on the expansion pack between its battery and the CC_ETM pin to limit the trickle charge.

VS_EBAT is the positive terminal sense line for the battery in the expansion pack. The main unit uses it to determine if it should trickle charge the main battery with the extended battery. If VS_EBAT has a higher voltage than the main battery, CEN_ETM is driven by the expansion pack to determine if the trickle charge is provided. If VS_EBAT has a lower voltage than the main battery, the main unit pulls CEN_ETM (open collector) low and disables the trickle charge.

EBAT_ON is an active high signal driven by the expansion pack to notify the main unit that the expansion pack battery has sufficient charge to power the main unit (>3.72V). It is only connected when the expansion pack battery is designed to provide extended battery life to the main unit.

BATT_FLT is an active high signal that notifies the main unit that the expansion pack battery has reached its critical low voltage level, typically 3.4V. The main unit then proceeds to shutdown the expansion pack by forcing OPT_ON inactive (low).

More details are given in Chapter 5 (Battery, Power Supply and Charging), the DC Characteristics and the AC Characteristics on the battery and charging signals.

Power and Ground Signals

The interface includes seven ground signals and two 3.3V signals. The maximum current an expansion pack can draw from the V_{DD} pins is 300 mA. *If an expansion pack requires more than 300 mA peak or requires a voltage other than 3.3V, it must include its own power supply and/or battery and charging circuit.* The power and ground pins protrude 0.5 mm farther than the other signals on the main unit connector. This provides power and ground to the expansion pack before the other signals make a connection.

When an expansion pack is first connected to the main unit, the expansion pack can only draw approximately 10 mA from the V_{DD} pins for identification. Once the main unit asserts OPT_ON, an expansion pack can draw the full 300 mA from the main unit. Table 6 (Expansion Pack Current consumption) shows the maximum peak current consumption for an expansion pack given each state of OPT_ON.

Table 6: Expansion Pack Current Consumption

	OPT_ON = Low	OPT_ON = High
Expansion Pack Current Consumption from V_{DD}	Approx. 10 mA	300 mA (max)

The expansion pack should use the power, ground and OPT_ON signals to detect whether it is connected to the main unit, so it can enable the power supply and other functions on the expansion pack.

A_GND is the ground associated with the analog, audio portion of the main unit. It is connected only to expansion packs that use the A-OUTR and A_OUTL signals and should route directly to the analog, audio section of the expansion pack. It is very important not to couple digital noise into A_GND (i.e., connect A_GND to digital ground). If the audio signals are not used by an expansion pack, A_GND is not connected.

Miscellaneous Signals

The expansion pack interface also includes other signals to provide insertion/removal detection, reset and interrupt functions. INT_OP is an active high signal that allows the expansion pack to interrupt the processor for various functions such as event notification, data transfer, etc. This signal is pulled down on the main unit. Please refer to Section 4, Software Interface, for more details on the interrupt service routine and support.

The RESET signal is a general-purpose reset signal from the main unit and is an active high signal. RESET is only active for 100ms (default setting) after OPT_ON is asserted when the expansion pack is inserted. Please refer to Chapter 4 (Software Interface) for details on programming the length of RESET. RESET is not active any other time.

A_OUTR and A_OUTL are line out signals from the right and left channels of main unit's audio codec.

The OPT_ON signal notifies the expansion pack that it can turn on and run at full power. When an expansion pack is first inserted, OPT_ON is low and the expansion pack can only draw a minimal amount of current for identification. When the OPT_ON signal is asserted, the expansion pack can draw the maximum allowed current from the V_{DD} pins.

The ODET[2:1]# signals notify the main unit when an expansion pack is inserted or removed. These signals are pulled high (3.3V) on the main unit and the expansion pack should tie them low. Upon insertion, the signals interrupt the processor and the routine goes through the process of identifying the expansion pack through the SPI signals. Upon removal, the signals go high and again interrupt the processor to notify the system.

The ODET[2:1]# pins on the mating connector are 0.5 mm shorter than normal I/O pins and 1.0 mm shorter than the power pins. This implementation ensures that the expansion pack is fully inserted before the main unit communicates with the expansion pack.

Summary of Subtle Electrical Points

This section summarizes subtle but critical points to the electrical interface into one section. Table 11 (Signal Conditioning Requirements) also shows signal conditioning requirements for the interface.

Bus State in Idle Mode

The buffers between the processor on the main unit and the electrical components on the expansion pack are tri-stated during idle mode. All digital logic that connects to the interface should have proper signal conditioning to prevent erroneous logic levels and/or excessive power consumption. Light pull-down or pull-up resistors (e.g. 100kΩ) are a possible solution to keep the bus in a known state during idle mode.

Variable Latency I/O Mode

If an expansion pack utilizes the variable latency I/O mode, special caution is required due to the fact it can hold the system bus for excessive amounts of time. If this occurs, it can adversely impact the performance of the main unit.

A_GND Usage

A_GND is the ground associated with the analog, audio portion of the main unit. It is only connected to expansion packs that use the A_OUTR and A_OUTL signals and should route directly to the analog, audio section of the expansion pack. It is very important not to couple digital noise into A_GND (i.e. connect A_GND to digital ground). If the audio signals are not used by an expansion pack, A_GND is not connected.

Battery Signals

The battery signals are primarily designed to support a lithium-ion or lithium polymer rechargeable battery in the expansion pack. If an expansion pack does not include a battery, none of the battery signals (V_EBAT, V_ADP, MCHG_EN, BATT_FLT, EBAT_ON, VS_EBAT, CEN_ETM and CC_ETM) should not be connected. If an expansion pack uses a different battery technology or does not want to share AC adapter charging with the main unit, it should not use any of the charging signals on the interface (V_ADP and MCHG_EN). If an expansion pack includes a battery, special attention to the details provided in other sections to ensure safety. Please refer to the reference schematics as a guideline discussed in Chapter 7 (Reference Schematics).

DC Characteristics

These tables show various DC characteristics between the main unit and expansion pack.

Table 7: DC Supply to Expansion Pack

Parameter	Comments	Symbol	Min.	Max.	Units
Vdd Supply Voltage	Operating	V_{DD}	3.13	3.46	V
Peak Current Draw by Expansion Pack from V_{DD} pins	OPT_ON = Low	I_{DD}		10	mA
	OPT_ON = High			300	

Table 8: Battery and Charging Specifications

Parameter	Comments	Symbol	Min.	Max.	Units
V_ADP Voltage		V_ADP	4.75	5.25	V
Total Discharge Current		I_{VADP_D}		2.0	A
Total Charge Current	MCHG_EN = H OR OPT_ON = H	I_{VADP_C}		0.2	A
	MCHG_EN = L AND OPT_ON = L			0.6	
Extended Battery Capacity	Only when expansion pack battery used for extended battery of main unit	B_{CAP}	1000		maH
Extended Battery Voltage	Only when expansion pack battery used for extended battery of main unit	V_{EBAT}	3.72	4.25	V
EBAT_ON Trip Point	Extended Battery Voltage too low and EBAT_ON driven low	$V_{EBAT\ ON}$		3.72	V
Trickle Charge from Option Battery to Main Battery	CEN_ETM = Low	I_{TR}		150	mA

Table 9: Main Unit Output Drive Characteristics

Parameter	Comments	Symbol	Min.	Max.	Units
Output Voltage Signals: A[25:0], D[31:0]	I_{OH} = -2 mA	V_{OH}	2.75		V
	I_{OL} = 2 mA	V_{OL}		0.4	
Output Voltage Signals: See Note 1.	I_{OH} = -18 mA	V_{OH}	2.4		V
	I_{OL} = 16 mA	V_{OL}		0.4	
Output Voltage Signals: See Note 3.	I_{OH} = -1.5 mA	V_{OH}	2.3		V
	I_{OL} = 10 mA	V_{OL}		0.5	
Output Voltage Signals: See Note 4.	I_{OH} = -24 mA	V_{OH}	3.0		V
	I_{OL} = 24 mA	V_{OL}		0.2	

Table 10: Main Unit Input Characteristics

Parameter	Comments	Symbol	Min.	Max.	Units
Input Voltage	Signals: D[31:0]	V_{IH}	2.0		V
		V_{IL}		0.8	
Input Voltage	Signals: RDY	V_{IH}	2.0		V
		V_{IL}		0.8	
Input Voltage	Signals: See Note 2.	V_{IH}	2.5		V
		V_{IL}		0.7	
Input Voltage Signals:	Signals: SPI_DO	V_{IH}	2.1		V
		V_{IL}		0.8	
Tri-state Leakage Current	V_{OH} = V_{DD}/V_{OL} = GND	I_{OZ}	-5.0	5.0	µA
Input Leakage Current	V_{IH} = V_{DD}/V_{IL} = GND	I_L	-5.0	5.0	µA

Table 11: Signal Conditioning Requirements
(See Note 5)

Signal	Main Unit	Expansion Pack
ODET[2:1]#	Pull-up to V_{DD} with 100kΩ	Connected to GND
PCM_IRQ[2:1]#	Pull-up to V_{DD} with 100kΩ	Buffered from card socket to main unit
CD_SCKT[2:1]#	Pull-up to V_{DD} with 100kΩ	CD[2:1]# from socket OR'd to form CD_SCKT# signal
INT_OP	Pull-down to GND with 100kΩ	Pull-down to GND with 100kΩ
SPI_SCK, SPI_DI	None	Pull-down to GND with 100kΩ
RDY	Pull-up to V_{DD} with 100kΩ	None
OPT_ON	Pull-down to GND with 100kΩ	Pull-down to GND with 100kΩ
RESET	Pull-down to GND with 100kΩ	Pull-down to GND with 100kΩ (optional)
PCM_WAIT#, PCM_WP	Pull-up to V_{DD} with 100kΩ	OR gate each signal separately with CD_SCKT#
PCM_RESET	Pull-down to GND with 100kΩ	Buffered to card socket
VS_EBAT	None	Pull-up to extended battery with 1.2kΩ
CEN_ETM	Open Collector	Pull-up to extended battery with 470kΩ
BATT_FLT	Pull-up to V_{DD} with 100kΩ	Pull-up to VDD with 100kΩ (min.)
EBAT_ON	Pull-down to GND with 100kΩ	None
MCHG_EN	Pull-down to GND with 50kΩ	Pull-down to GND with 100kΩ

NOTE:

1. Signals include MCS[4,2]#, MWE#, MOE#, RD/WR#, DQM[3,1:0]#, PSKTSEL, PCM_CE[2:1]#, PCM_REG#, PCM_OE#, PCM_WE#, PCM_IOR#, PCM_IOW#.
2. Signals include INT_OP, PCM_IRQ[2:1]#, CD_SCKT[2:1]#, PCM_WAIT#, PCM_WP, ODET[2:1]#, BATT_FLT.
3. Signals include SPI_CS#, SPI_SCK, SPI_SI and SPI_SO.
4. Signals include OPT_ON, RESET, PCM_RESET.
5. Signal conditioning is required only if the expansion pack connects the respective signals.

AC Characteristics

Table 12: Interface AC Characteristics
(See Notes 2 & 3)

Parameter	Comments	Symbol	Min.	Max.	Units
Signal Delay from Processor to Interface	Signals: A[25:0]	T_{DPIA}		8	ns
	Signals: D[31:0]	T_{DPID}		10	
Signal Delay from Processor to Interface	Signals: See Note 1 & 2	T_{DPIC}		6.0	ns
Signal Delay from Interface to Processor	Signals: D[31:0]	T_{DPID}		10	ns
Signal Delay from Interface to Processor	Signal: RDY	T_{DPIB}		7.0	ns
	Signals: PCM_WAIT#, PCM_WP	T_{DPIC}		10.0	
RESET	Active time after OPT_ON asserted	T_{RST}	100		ms

NOTE:

1. Signals include MCS[4,2]#, MWE#, MOE#, RD/WR#, DQM[3,1:0]#, PSKTSEL, PCM_CE[2:1]#, PCM_REG#, PCM_OE#, PCM_WE#, PCM_IOR#, PCM_IOW#.
2. Signal waveforms and timing requirements are found in the Intel StrongARM 1110 Microprocessor Advanced Developer's Manual, PC Card Standard Release 7.0 and CF+ and CompactFlash Specification Revision 1.4. This specification provides the delay of the buffers between the processor and interface.
3. Times are specified with a 30 pF equivalent load.

FIGURE 8: RESET Timing Waveform

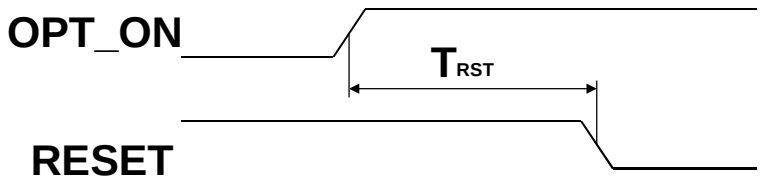


Table 13: Audio Specifications

(See Notes 1 & 2)

Parameter	Comments	Symbol	Min.	Typ	Max.	Units
Output Voltage	Rl = 20 kΩ	V_O		1.0		V
Signal to Noise Ratio	f = 1kHz, RL = 10 kΩ	SN		94		dBr
Total Harmonic Distortion Plus Noise	-3dB FS, f = 1 kHz, RL = 10kΩ	THD + N		-78		dBr
Output Load	Expansion pack load	R_L			10k	Ω
Frequency Response	-3 dB points	FR	20		20k	Hz

NOTE:

1. Audio specifications refer to A_OUTR and A_OUTL.
2. Specifications assume A_GND is properly isolated from digital noise on the expansion pack.

Insertion/Removal

Overview

One of the key features of the expansion packs is the ability to exchange them "on the fly", with power on or off. The user can remove one expansion pack and insert another without significant interaction with the system. Upon insertion, the hardware interface invokes a device manager on the main unit that interrogates the expansion pack on its features without significantly impacting battery life. The interrogation includes data on drivers, applications, configuration and miscellaneous requirements of the expansion pack. This identification process allows the expansion pack to store information, drivers and applications on the expansion pack, so the main unit does not have to use its memory to store information on a large number of expansion packs. It also allows the main unit to remove the drivers and applications from memory when the expansion pack is removed.

Ideally, the software application and drivers to run the expansion pack are on the expansion pack.

Sequence of Events for Insertion

The flow chart in Figure 9 (Insertion Flow Chart) outlines the insertion sequence of events. Starting from a power-on detection, the system boots and detects whether an expansion pack is installed. If an expansion pack is inserted, the expansion pack detect signals, ODET[2:1]#, interrupt the processor to notify the system. The interrupt routine starts a timer to allow the detect signals to debounce. Once the timer times out, it checks to verify the detect signals are still active. If the signals are inactive the sequence starts over. If the detect signals are active, the interrupt routine starts a "device manager" that enables the SPI interface and the V_{DD} pins on the expansion pack. In this state, the expansion pack can draw only 10 mA for identification purposes. The device manager starts downloading information from the SPI EEPROM on the expansion pack. The device manager uses the information from the EEPROM to locate drivers and applications, enable interrupts, determine memory specifications and type, power consumption, slot configuration, etc. The device manager loads the expansion pack drivers and applications based on the information in the EEPROM.

Once the device manger identifies the expansion pack, it determines if it has enough battery life to fully power on the expansion pack. Also, data in the memory device gives the option to display a message to allow the user to enable power to the expansion pack or decline and enable it at later time. Providing the user interface to enable the expansion pack is optional to each individual design. Some expansion packs such as an extended battery or a low power devices may not want to burden the user with the question after an insertion.

When the device manger enables the expansion pack, either automatically or through user interaction, the main unit powers the remaining buffers for the entire interface into a high impedance state. The OPT_ON signal is asserted and notifies the expansion pack to turn on fully. At this point, the expansion pack can draw up to 300 mA peak and/or enable its own battery and power supply circuitry. Afterward, the device manager installs the application software and drivers, typically stored on the expansion pack, to main memory.

If the user does not want to enable the expansion pack or the device manger determines there is not sufficient power upon insertion, the main unit removes power to the V_{DD} pins and disables the SPI interface.

Sequence of Events for Removal

If the expansion pack is removed while the system is on or in hibernation, the expansion pack detect signals, ODET[2:1]#, interrupt the processor to notify the system. The device manger starts a timer to allow the detect signals to debounce. Once the timer times out, it checks to verify the detect signals are still inactive. If the signals are active (expansion pack still installed) the sequence starts over. If the detect signals are inactive, the device manager subsequently deasserts OPT_ON, disables the buffers and removes power to the V_{DD} pins.

If the drivers and application were loaded from the EEPROM driver table, the device manager then unloads the drivers and application. After inserting the expansion pack, the device manager starts IHVInstall and copies IHVUninstall into RAM. Upon removal of the expansion pack, this application is run and subsequently is removed from memory.

FIGURE 9: Insertion Flow Chart

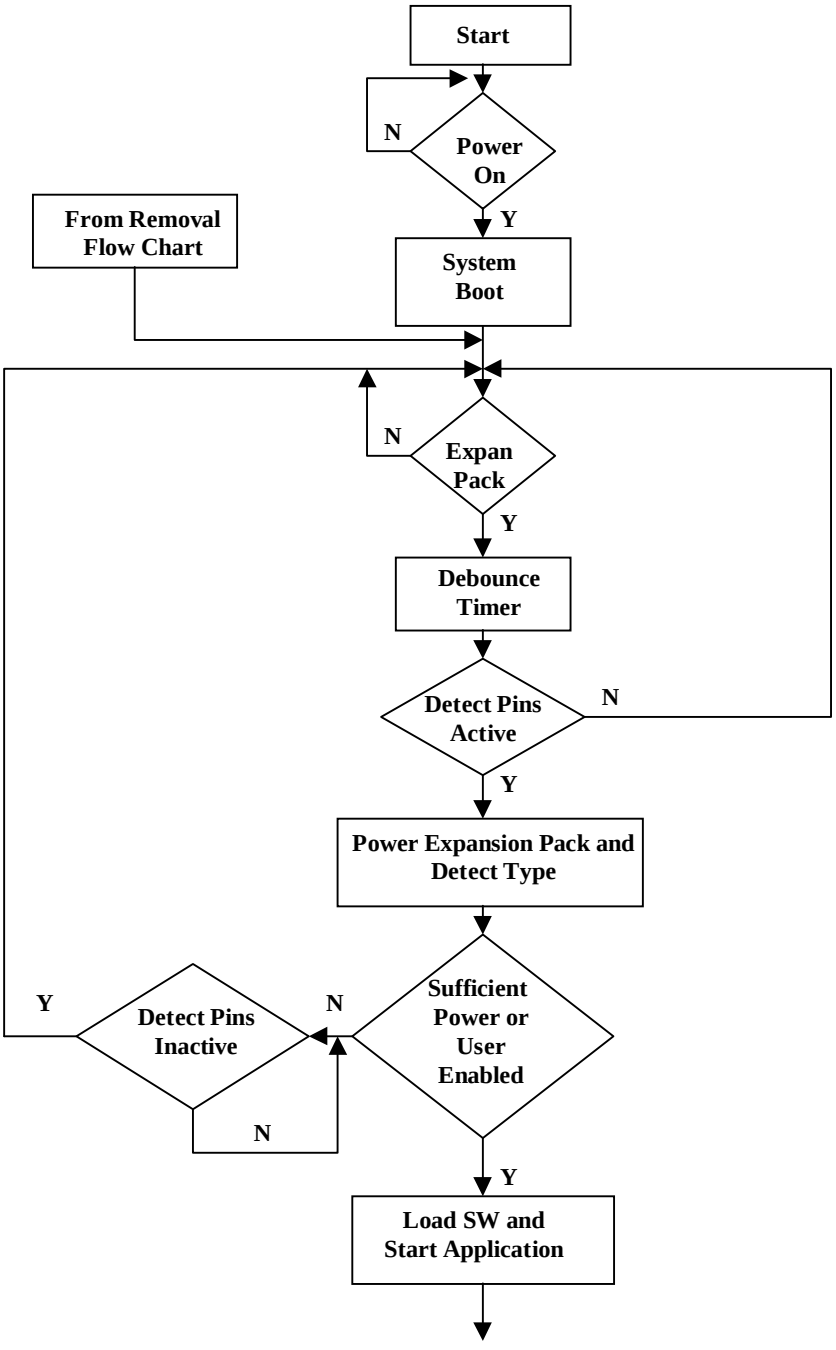
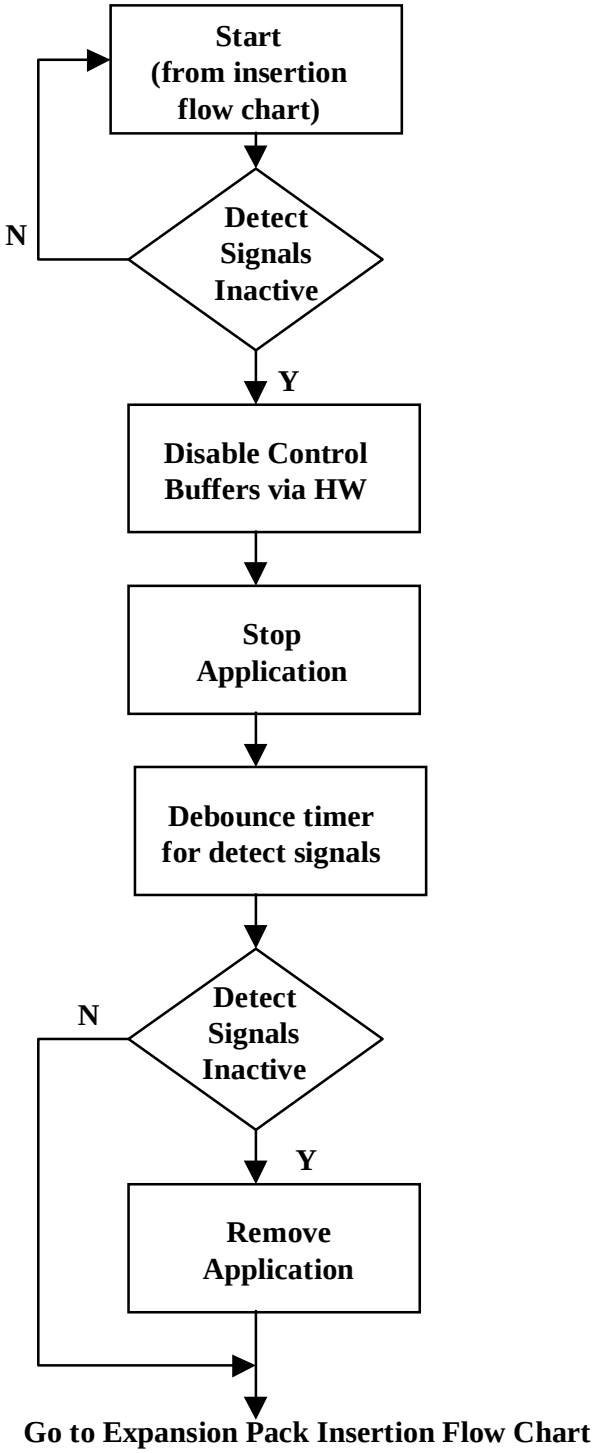


FIGURE 10: Removal Flow Chart



chapter 4

SOFTWARE INTERFACE

Overview

Upon insertion of an expansion pack, a “device manager” type driver on the main unit interrogates the expansion pack and starts the appropriate drivers. The drivers and application software are ideally stored on the expansion pack in ROM or flash memory. The drivers are responsible for communicating with the various pieces of hardware available on the expansion pack. The “device manager” is NOT involved in any of the interactions between the device drivers and the devices on the expansion packs.

The mechanism to load the device drivers is dynamic and dependent on the expansion pack. This requires that the device manager is more data driven. The device manager loads the appropriate drivers based on the available information on the expansion pack identification EEPROM. The next sections describe some of the key data elements that are needed to facilitate this kind of dynamic operation.

EEPROM Data Structure

After an expansion pack is inserted, the "device manager" interrogates the expansion pack to identify its features. This occurs over the SPI bus to an EEPROM on the expansion pack that contains data on drivers, applications, configuration and requirements of the expansion pack. Every expansion pack is required to have EEPROM on the SPI bus for identification. The first version of software only supports 256 bytes or less of EEPROM.

The following table shows the data structure in the EEPROM.

Table 14: EEPROM Data Structure

Expansion Pack Information	Description
ID Information	Mandatory information that identifies the expansion pack.
Control Information	Mandatory information that identifies where the flash memory is located.
Driver Table	Used to identify the drivers that might not have been present in the original unit.
Configuration	Specific configuration information on the option such as power consumption, battery capacity, etc.
Bootstrap Program	If needed, an OEM may store a bootstrap program in this region.
Optional OEM Information	This is a free-form area. It is the OEM's responsibility to lay out this area. It could be used to store software keys, expansion pack parameters, etc.

ID Information

The ID information is mandatory for all expansion packs. This information is used to identify the expansion pack and indicates if further information is needed to start drivers, etc.

Table 15: ID Information

Field #	Name	Type	Length	Description
1	Start of ID		1 b	0xaa
2	Length of data	integer	4 b	Used by the ID API to allow for a block read of identification information. The number in this field should include ALL information in the EEPROM including the information stored in the OEM area.
3	Version Indicator	integer	1 b	Used to determine the information's format. Currently, defaulting to 0x01.
4	Vendor ID	integer	2 b	Unique vendor ID (Compaq assigned).
5	ID Number	integer	2 b	Unique per vendor Product ID.

Table 15: ID Information

Field #	Name	Type	Length	Description
6	Text Description	string	variable	Text description for display to user. Zero delimited.
7	Type	integer	1 b	Identifies type of expansion pack: 2 - minimal hardware 3 - data bus 4 - Bootstrap present
8	Interrupt Enable	BYTE	1 b	'Y'/'N'
9	Extended Battery	BYTE	1 b	'Y'/'N'
10	Initial Power State	BYTE	1 b	'Y'/'N'
11	Suspend Power State	BYTE	1 b	'Y'/'N'
12	Time Reset Width	BYTE	1 b	
13	Reserved	BYTE	1 b	0x00
14	Bootstrap Address	integer	4 b	Address of the Bootstrap program in this EEPROM.
15	OEM Information Address	integer	4 b	Address of OEM information in this EEPROM.
16	Application Name	char	variable	Null Terminated field. Contains the name of the application to start on the expansion pack flash. i.e. "myprog.exe parm1 parm2"
17	Terminator	integer	4 b	Marks end of ID information. *Value:* 0x0f0f0f0f

Control Information

The control information is mandatory. The control information identifies the flash area for the driver that provides "disk" support for it.

Table 16: Control Information

Field #	Name	Type	Length	Description
1	Start of Control	integer	1 b	0xbb. Occurs once per Control Information block.
2	Vendor ID	integer	4 b	Identifies the vendor that supplied the expansion pack. Part of the unique key when combined with the Driver ID.
3	Driver ID	integer	4 b	
4	Memory Location	integer	4 b	Memory location for start of flash part in expansion pack. Used by flash driver.

Table 16: Control Information

Field #	Name	Type	Length	Description
5	Stop Memory Location	integer	4 b	Ending memory location of flash part.
6	Control Information Terminator		4 b	Occurs once per Control Information block. *Value:* 0x0f0f0f0f

Driver Table

The driver table information is optional. It represents the information needed to start the drivers dynamically. It could be stored on the expansion pack as a way to extend the driver table being maintained in the main unit. This information is similar to the information stored in the registry.

This is a list of the drivers that can be found in the expansion pack flash. Multiple drivers are allowed in this section. Only the drivers that are included in the Control information, that are loaded from the expansion pack flash, are included. The Vendor ID and Driver ID can be combined to create a unique key for the Device manager to use when looking up the driver.

Table 17: Driver Information

Field #	Name	Type	Length	Description
1	Vendor ID	integer	4 b	Vendor identifier. 0xffffffff means the end of driver table
2	Driver ID	integer	4 b	Driver identifier.
3	Driver	string	variable	File name of driver, i.e. Driver.dll.
4	Display Name	string	variable	Display name of driver.
5	Stream Prefix	string	3 b	Identifies the prefix for the Stream interface, i.e. “COM”.
6	Record Terminator	char	1 b	0x03
7	Section Terminator		4 b	Occurs once per Driver Table block. *Value: 0x0f0f0f0f*

Configuration Information

This section is not supported in the first version of the software, but is reserved for future revisions. The intent of configuration information is to store data about the expansion pack such as battery capacity, power consumption, socket configuration, etc.

Table 18: Configuration Information

Field #	Name	Type	Length	Description
1	Size of Configuration info	DWORD	4 b	Size of configuration info in bytes
2	Configuration info	binary	variable	Configuration info
3	Section Terminator	DWORD	4 b	0x0f0f0f0f

Bootstrap Program

This is a binary program in an "exe" format to bootstrap expansion packs that do not have a dedicated ROM memory bank. It is copied into the main unit's file system for execution. While resident drivers may be started, it is assumed that the bootstrap program is responsible for loading and starting the necessary drivers and applications.

Table 19: Bootstrap Program Information

Field #	Name	Type	Length	Description
1	Size of Bootstrap	DWORD	4 b	Size of bootstrap in bytes
2	Bootstrap program	binary	variable	Binary data in “exe” format
3	Section Terminator	DWORD	4 b	0x0f0f0f0f

OEM Area

The OEM area is an optional field. Some examples include part numbers, serial numbers, revision history, manufacturing date, etc. The field contains all remaining memory following the bootstrap area.

Table 20: OEM Area Information

Field #	Name	Type	Length	Description
1	Size of OEM Area	DWORD	4 b	Size of OEM area in bytes
2	OEM Data	binary	variable	OEM data
3	Section Terminator	DWORD	4 b	0x0f0f0f0f

Other Software considerations

The IHV will need to implement certain routines for power handling. These are:

- Power On
- Power Off
- Global Variable Maintenance

In addition this section addresses the Expansion Pack SDK. These functions are provided by Compaq to enable the hardware developer to better control the expansion pack and the Device Manager as it relates to the EEPROM, expansion pack insertion and insertion pack removal.

Power On Routine

This is a code snippet that could be used in the power on routine. It demonstrates processing needed to handle the OPT_Pwr_On and Opt_Reset signals.

```
VOID HWPowerOn(
     PVOID pHead // @parm PVOID returned by HWInit.
     )
{
   Pxxx_HW_INFO pHWHead = (Pxxx_HW_INFO)pHead;
   Pxxx_PDD_INFO pPDDHead = (Pxxx_PDD_INFO)pHead;
     // Restore any registers that we need
*(pHWHead->pRegister0) = pHWHead-> pRegister0;
*(pHWHead->pRegister1) = pHWHead-> pRegister1;
*(pHWHead->pRegister2) = pHWHead-> pRegister2;
// Other needed handles here…
PowerHandler(ON); // refer to Turn on Power
   return;
} // HWPowerOn()
```

Power Off Routine

This is a sample routine for the power off processing. It demonstrates how to handle the Opt_Pwr_Off and Opt_Reset signals. It also includes an example of how to save registers for later use.

```
VOID
   HWPowerOff(
      PVOID pHead // @parm PVOID returned by HWInit.
      )
{
   Pxxx_HW_INFO pHWHead = (Pxxx_HW_INFO)pHead;
   Pxxx_PDD_INFO pPDDHead = (Pxxx_PDD_INFO)pHead;
// Other indeed handles here…
   // Save any registers that we need
pHWHead-> pRegister0 = *(pHWHead->pRegister0);
pHWHead-> pRegister1 = *(pHWHead->pRegister1);
pHWHead-> pRegister2 = *(pHWHead->pRegister2);
PowerHandler(OFF); // refer to Turn on Power
   return;
} // HWPowerOff())_©"©()/
```

Maintaining a Global Variable

This sample code demonstrates one method for maintaining a global variable for lower level driver routines.

```
PDRIVER_GLOBALS pDrvGlob = (PDRIVER_GLOBALS)
DRIVER_GLOBALS_PHYSICAL_MEMORY_START;
void BitSetExtendGPIO(ULONG bits)
{
   pDrvGlob->misc.extendIO |= bits;
   (ULONG*) EXTERNAL_IO_BASE = pDrvGlob->misc.extendIO;
}
void BitClearExtendGPIO(ULONG bits)
{
   pDrvGlob->misc.extendIO &= ~bits;
   (ULONG*) EXTERNAL_IO_BASE = pDrvGlob->misc.extendIO;
}
Void PowerHandler(BYTE bState)
{
   if (ON == bState)
{
   // turn on Opt_Pwr_On
   BitSetExtendGPIO(EXTEND_GPIO_OPT_POWER);
```

```
   // turn on Opt_On
   BitSetExtendGPIO(EXTEND_GPIO_OPT_ON);
   // Reset Expansion Pack
   BitSetExtendGPIO(EXTEND_GPIO_OPT_RESET);
BitClearExtendGPIO (EXTEND_GPIO_OPT_RESET);
}
else if (OFF == bState)
{
   // turn off Opt_Pwr_On
   BitClearExtendGPIO (EXTEND_GPIO_OPT_POWER);
   // turn off Opt_On
   BitClearExtendGPIO (EXTEND_GPIO_OPT_ON);
   // mark global, keep the Opt_On & Opt_Pwr_On State while
   device
being suspended
pDrvGlob->misc.wPwrState |= ( DRV_OPT_ON_SUSPEND_ON |
   DRV_OPT_PWR_ON_SUSPEND_ON);
}
}
```

Expansion Pack SDK

Compaq is planning an SDK with some functions that will be useful in creating the software for an expansion pack. The following functions are provided as a part of the Expansion Pack SDK:

```
BOOL PPC_GET_BATT_LEVEL(HWND hwnd, UINT32 *bufout);
BOOL PPC_GET_TIME_RESETWIDTH_WAITSTABLE(HWND hwnd, UINT32 *pbuf);
BOOL PPC_SET_INTERRUPT_ENABLED(HWND hwnd, BOOL bflag);
BOOL PPC_SET_POWER(HWND hwnd, BOOL bflag);
BOOL PPC_GET_POWER(HWND hwnd, UINT32 *pbuf);
BOOL PPC_REBOOT(HWND hwnd);
int PPC_InstallCompleted(int iResult);
int PPC_UninstallCompleted(int iResult);
void PPC_EnableFlashWrite(void);
void PPC_DisableFlashWrite(void);
void PPC_DestroyPartitionWhenRegistered(void);
PBYTE PPC_NVM_AddStr(HWND hWnd, PBYTE pbuf, const char *strSource);
PBYTE PPC_NVM_AddBin(HWND hWnd, PBYTE pbuf, const char *strSource, UINT32 size);
BOOL PPC_NVM_Write(HWND hWnd, PVOID pnvm_in, HWND hwndProgress);
BOOL PPC_NVM_Read(HWND hWnd, PVOID pnvm_out, HWND hwndProgress);
BOOL PPC_NVM_FreeRead(HWND hWnd, PVOID pnvm_out);
```

PPC_GET_BATT_LEVEL

This function reports remaining charge for the main and extended battery as a percentage range from 0 to 100 in increments of 10. It reports “BATTERY_PERCENTAGE_ UNKNOWN” if the percentage of battery life is unknown.

Syntax

BOOL PPC_GET_BATT_LEVEL(HWND hwnd, UINT32 *bufout)

Parameters

hWnd[in]: Handle of current window. Reserved, set it to be NULL.

bufout [out]:

HIWORD: Reserved.

LOWORD:

HIBYTE: Percentage remaining of the main battery charge.

LOBYTE: Percentage remaining of the extended battery charge.

Return Value

Nonzero indicates success.

Example

```
DWORD dwResult;
.// Read percentage of full battery charge remaining
if (PPC_GET_BATT_LEVEL(NULL, &dwResult) )
{
ShowDbgString(L"PPC_GET_BATT_LEVEL success\r\n");
.
.
   ShowDbgString(L"Main=%d%%, Extended=%d%%\r\n”,
      (dwResult >> 8 )& 0xff,
         dwResult & 0xff);
}
```

PPC_GET_TIME_RESETWIDTH_WAITSTABLE

This function provides the width of the RESET signal and delay time cycles are executed to the expansion pack. This data is provided in the EEPROM. The Device Manager only resets the expansion pack the first time it is inserted.

Syntax

BOOL PPC_GET_TIME_RESETWIDTH_WAITSTABLE(HWND hwnd, UINT32 *pbuf)

Parameters

hWnd[in]: Handle of current window. Reserved, set it to be NULL.

pbuf [out]:

HIWORD: Width to reset expansion pack; measured in ms.

LOWORD: Time to wait for the hardware to become stable after reset; measured in ms.

NOTE: Set to 0xFFFF if you don't need to reset expansion pack or wait until the hardware is stable.

Return Value

Nonzero indicates success.

Example

```
DWORD dwWidth;
// Read percentage of full battery charge remaining
if (PPC_GET_TIME_RESETWIDTH_WAITSTABLE(NULL, &dwWidth) )
{
   WORD wRwidth, wWwidth;
   ShowDbgString(L"PPC_GET_TIME_RESETWIDTH_WAITSTABLE
   OK\r\n");
   wRwidth = (dwWidth >> 16 )& 0xffff;
   wWwidth = dwWidth & 0xffff;
   ShowDbgString(L"reset width=%d, waitstable=%d\r\n”,
      wRwidth, wWwidth);
.
.
}
```

PPC_SET_INTERRUPT_ENABLED

This function sets the interrupt-enabled bit for expansion pack in the HAL layer. When the expansion pack is designed to interrupt the main unit for event handling, this function is used to enable the interrupt. By default, the interrupt is disabled.

Syntax

BOOL PPC_SET_INTERRUPT_ENABLED(HWND hwnd, BOOL bflag);

Parameters

hWnd[in]: Handle of current window. Reserved, set it to be NULL.

bflag [in]: TRUE enables the interrupt and FALSE disables the interrupt.

Return Value

Nonzero indicates success.

Example

```
HANDLE XXX_Init( ULONG Identifier )
{
PHW_INDEP_INFO pXXXHead = NULL;
   // Allocate our control structure.
   pXXXHead = (PHW_INDEP_INFO)LocalAlloc(LPTR,
                                  sizeof(HW_INDEP_INFO));
   // Check that LocalAlloc did stuff ok too.
   if ( ! pXXXHead)
   {
        ShowDbgString(L"Error allocating memory for pXXX-
        Head, XXX_Init
     failed\n\r"));
        return (NULL);
   }
if ( !InterruptInitialize(
        pXXXHead ->pHWObj->dwIntID,
        pXXXHead->hEvent,
        pXXXHead->pHWObj->pFuncTbl->HWGetRxStart((PVOID)pSe-
        rialHead),
                          0) )
   {
   ShowDbgString(L”drv XXX Init failed\r\n”);
     XXX_Deinit(pXXXHead);
     return (NULL);
   }
// enable the interrupt
   PPC_SET_INTERRUPT_ENABLED(NULL, TRUE);
.
   return (pXXXHead);
}
```

PPC_SET_POWER

This function sets or resets the state of hardware pin OPT_ON.

Syntax

BOOL PPC_SET_POWER(HWND hwnd, BOOL bflag);

Parameters

hWnd[in]: Handle of current window. Reserved, set it to be NULL.

bflag [in]: Set FALSE to power up the expansion pack through OPT_ON. Set others to power down.

Return Value

Nonzero indicates success.

Example

```
// reset OPT_ON to power up the expansion pack
PPC_SET_POWER(NULL, FALSE);
```

PPC_GET_POWER

This function returns current state of hardware pin OPT_ON.

Syntax

BOOL PPC_GET_POWER(HWND hwnd, UINT32 *pbuf);

Parameters

hWnd[in]: Handle of current window. Reserved, set it to be NULL.

pbuf [out]: Current state of OPT_ON. 0 means expansion pack is powering up, other mean it's powering down.

Return Value

Nonzero indicates success.

Example

```
DWORD dwState;
. . .
// read OPT_ON state
PPC_GET_POWER(NULL, &dwState);
if (0 == dwState)
{
// if powering up do something here …
}
else
{
// if powering down do something here …
}
```

PPC_REBOOT

This function provides an interface to reboot the main device by software.

Syntax

BOOL PPC_REBOOT(HWND hwnd);

Parameters

hWnd[in]: Handle of current window. Reserved, set it to be NULL.

Return Value

Nonzero indicates success.

Example

```
switch (LOWORD(wParam))
{
   case IDC_BTN_RESET:
      // if button clicked
      if (BN_CLICKED == HIWORD(wParam))
         PPC_REBOOT(NULL); //reboot main device
         return TRUE;
}
```

PPC_InstallCompleted

This function lets the device manager receive the notification and information from install.exe.

Syntax

int PPC_InstallCompleted(int iResult);

Parameters

iResult[in]: See details below.

Table 21: PPC_InstallCompleted Parameters for iResult [in]

Value	Name	Description
0X0001	PR_RESET_REQUIRED	Reset main device requested, device manager automatically reboots main device after one (1) second.
0X0002	PR_OPT_ON_REQUIRED	Device manager needs to activate OPT_ON pin after install.exe completed. Please note that OPT_ON is activated if the extended battery is defined in EEPROM.
0X0004	PR_OPT_RESET_REQUIRED	Device manager needs to activate OPT_RESET pin within a defined interval after install.exe is completed.
0x0000	PR_SUCCESS	Running install.exe or uninstall.exe successful.
0xFFFF	PR_FAILED	Running install.exe or uninstall.exe failed.

Return Value

Returns iResult as above.

Example

```
case WM_DESTROY:
.
.
// notify DM install has been completed and no special
requirement
   int i = PPC_InstallCompleted(PR_SUCCESS);
   PostQuitMessage(0);
   return 0;
```

PPC_UninstallCompleted

This function lets the device manager receive the notification and information from uninstall.exe.

Syntax

int PPC_UninstallCompleted(int iResult);

Parameters

iResult[in]: See details below.

Table 22: PPC_UninstallCompleted Parameters for iResult [in]

Value	Name	Description
0X0001	PR_RESET_REQUIRED	Reset main device requested, device manager automatically reboots main device after one (1) second.
0X0002	PR_OPT_ON_REQUIRED	Device manager needs to activate OPT_ON pin after install.exe completed. Please note that OPT_ON is activated if the extended battery is defined in EEPROM.
0X0004	PR_OPT_RESET_REQUIRED	Device manager needs to activate OPT_RESET pin within a defined interval after install.exe is completed.
0x0000	PR_SUCCESS	Running install.exe or uninstall.exe successful.
0xFFFF	PR_FAILED	Running install.exe or uninstall.exe failed.

Return Value

Returns iResult as above.

Example

```
case WM_DESTROY:
.
.
  // notify DM install has been completed and no special
  requirement
  int i = PPC_UninstallCompleted(PR_SUCCESS);
  PostQuitMessage(0);
  return 0;
```

PPC_EnableFlashWrite

This function enables flash memory for write operations.

Syntax

void PPC_EnableFlashWrite(void);

Parameters

None.

Return Value

None.

Example

```
// Here we Enable the write function
PPC_EnableFlashWrite();
.
.
// Do something here, e.g. write files into flash memory…
.
.
// Here we disable the write function
PPC_DisableFlashWrite();
.
.
```

PPC_DisableFlashWrite

This function enables flash memory for write operations.

Syntax
void PPC_DisableFlashWrite(void);

Parameters

None.

Return Value

None.

Example

```
// Here we Enable the write function
PPC_EnableFlashWrite();
.
.
// Do something here, e.g. write files into flash memory…
.
.
// Here we disable the write function
PPC_DisableFlashWrite();
.
.
```

PPC_DestroyPartitionWhenRegistered

This function allows you to format the flash memory in the expansion pack as a disk.

Syntax

void PPC_DestroyPartitionWhenRegistered(void);

Parameters

None.

Return Value

None.

Example

```
// Here we enable the flag to perform a destroy partition
table of flash disk to
// get an opportunity to re-format the flash disk when it has
been registered.
PPC_DestroyPartitionWhenRegistered();
```

PPC_NVM_AddStr

This function provides an entry to add a string type of variable into EEPROM (sometimes referred to as NVRAM) structure. It allocates a memory block to store the source string and returns the address.

Syntax

PBYTE PPC_NVM_AddStr(HWND hWnd, PBYTE pbuf, const char *strSource);

Parameters

hWnd[in]: Handle of current window. Reserved, set it to be NULL.

pbuf[out]: Destination stored in the string. It is always in the field of the EEPROM structure, which has string type.

strSource[in]: Address of a source string which is filled into EEPROM structure with.

Return Value

Return NULL if function failed, e.g. insufficient memory.

It returns the start address of allocated memory block, which is the same as destination address (i.e. pbuf).inat.

Example

```
.
.
// fill “Compaq PC-Card Expansion” as the text description
to user
nvm_in.ssc_nvm_id_info.strTextDesc =
   PPC_NVM_AddStr(NULL,
nvm_in.ssc_nvm_id_info.strTextDesc,
   "Compaq PC-Card Expansion");
.
.
// write contents into NVRAM
if (PPC_NVM_Write(NULL, &nvm_in, hwndProgress) == FALSE)
{
   ShowDbgString(L"WRITE ERROR");
   return 0;
```

PPC_NVM_AddBin

This function provides an entry to add a binary data into a BLOB type of variable into EEPROM (sometimes referred to as NVRAM) structure. It allocates a memory block to store the source binary data and returns the address.

Syntax

PBYTE PPC_NVM_AddBin(HWND hWnd, PBYTE pbuf, const char *strSource, UINT32 size);

Parameters

hWnd[in]: Handle of current window. Reserved, set it to be NULL.

pbuf[out]: Destination to be stored the binary data. It should always be the field of the EEPROM structure, which has the CEBLOB type.

strSource[in]: Address of a source binary data which will be filled into EEPROM structure with.

Size[in]: Specifies the size, in bytes, of the BLOB. It also means the memory size that will be allocated for pbuf.

Return Value

Return NULL if function failed, e.g. insufficient memory.

It returns the start address of allocated memory block, which is the same as destination address (i.e. pbuf).

Example

```
//fake binary data
char bs[]={0x0, 0x1, 0x2, 0x3, 0x4, 0x5};
nvm_in.blobIntrEnableInfo.dwCount = sizeof(Bin1)/
sizeof(char);
nvm_in.blobIntrEnableInfo.lpb = PPC_NVM_AddBin(NULL,
        nvm_in.blobIntrEnableInfo.lpb,
        bs,
        nvm_in.blobIntrEnableInfo.dwCount);
.
.
// write contents into NVRAM
if (PPC_NVM_Write(NULL, &nvm_in, hwndProgress) == FALSE)
{
   ShowDbgString(L"WRITE ERROR");
   return 0;
```

PPC_NVM_Write

This function writes structure pnvm_in into physical EEPROM (sometimes referred to as NVRAM). It fills the relevant settings in pnvm_in to EEPROM and frees the memory that may be allocated by both functions of PPC_NVM_AddStr and PPC_NVM_AddBin.

Syntax

BOOL PPC_NVM_Write(HWND hWnd, PVOID pnvm_in, HWND hwndProgress);

Parameters

hWnd[in]: Handle of current window. Reserved, set it to be NULL.

pnvm_in[in]: Address of structure SSC_NVM to be written.

hwndProgress[in]: The handle of the progress bar indicates the progress of a lengthy operation by displaying a colored bar inside a horizontal rectangle. Set to NULL if it is not needed. Driver may update its parent window with standard API UpdateWindow.

Return Value

It returns a nonzero value if the referred structure data has been successfully written into physical EEPROM. If the operation fails, it returns a FALSE.

Example

```
// write contents into NVRAM
if (PPC_NVM_Write(NULL, (PVOID)&nvm_in, hwndProgress) ==
FALSE)
{
   ShowDbgString(L"WRITE ERROR\r\n");
   return 0;
}
```

PPC_NVM_Read

This function reads from physical EEPROM (sometimes referred to as NVRAM) and fills the data into the structure pnvm_out. To avoid a memory leak, user must manually free the allocated memory with function PPC_NVM_FreeRead.

Syntax

BOOL PPC_NVM_Read(HWND hWnd, PVOID pnvm_out, HWND hwndProgress);

Parameters

hWnd[in]: Handle of current window. Reserved, set it to be NULL.

pnvm_out[out]: Address of structure SSC_NVM that is filled with the data read from physical EEPROM.

hwndProgress[in]: The handle of the progress bar indicates the progress of a lengthy operation by displaying a colored bar inside a horizontal rectangle. Set to NULL if a lengthy operation is not needed.

Driver may update its parent window with the standard API UpdateWindow.

Return Value

It returns a nonzero value if the referred structure data has been successfully read and filled from physical EEPROM. If failed at physical read or structure filled, it returns a FALSE.

Example

```
// read contents from NVRAM
if ( PPC_NVM_Read(NULL, (PVOID)&nvm_out, hwndProgress) )
{
   PPC_ShowDbgString(L"Read success\r\n");
// do something here
.
.
.
// release extra-allocated memory at last
   PPC_NVM_FreeRead(NULL, (PVOID)pnvm_out);
}
```

PPC_NVM_FreeRead

This function releases the allocated memory by PPC_NVM_Read. The developer must call this function when it no longer needs the data that was read via the PC_NVM_Read function.

Syntax

BOOL PPC_NVM_FreeRead(HWND hWnd, PVOID pnvm_out);

Parameters

hWnd[in]: Handle of current window. Reserved, set it to be NULL.

pnvm_out[in]: The address of SSC_NVM that had been stored the read data. Driver will release the extra-allocated memory for it.

Return Value

It returns a nonzero value if allocated memory successfully released. If it failed at releasing the extra-allocated memory, it returns a FALSE.

Example

Refer to section PPC_NVM_Read.

Interrupts

The following interrupts are generated as a part of the expansion pack implementation.

Interrupts

Table 23: Interrupts

Interrupt	Description
SYSINT_OP	This is the interrupt signal generated by the expansion pack. It is available for application or driver use.

Table 24: Signal

Signal	Description
OPT_IND	The ODET[2:1]# signals are combined to generate an insertion signal, OPT_IND, when an expansion pack is inserted. When this signal is present, the lower level drivers will send an OPT_PLUG message to the device manager.
Opt_Int	This corresponds to the INT_OP signal on the interface.
Opt_Reset	This is the reset signal that is sent to the expansion pack. The Device Manager will issue a RESET to the expansion pack device. The length of RESET is taken from the Reset Time field of the EEPROM. For more details, please refer to the ID information section description earlier in this chapter.
Opt_Pwr_On	This signal controls the expansion pack power (VDD). This signal must be turned on before the expansion pack can be enabled. For more details, please refer to the power handling routine description earlier in this chapter. NOTE: Before reading or writing to the EEPROM, this signal will be turned ON with a 5 ms delay before reading the EEPROM. The developer needs to maintain the pin state, while device is been powered on or down. The Device Manager maintains the setting of Opt_Pwr_On.

Table 24: Signal

Signal	Description
Opt_On	Opt_On is used to notify the expansion pack that it can turn on all the electronics. NOTE: This signal is not required to read the EEPROM. The card detection of CF/PCMCIA signals are controlled by this signal. Before this signal is turned on, the main unit cannot receive card detect notification. The device driver must maintain the pin state while device has been powered on. The Device Manager maintains the setting. The device driver should use the appropriate functions to affect the state in power handling routines.

Significant Messages

Table 25: Significant Messages

Message	Description
Opt_Plug	This message is sent to the device manager. After receiving this message, the device manager will perform the expansion pack setup procedures.

- Expansion Pack Detect – reserved for Expansion Pack Device Manager.

Expansion Pack Removed Notification

An application can register with the device manager for notification of expansion pack removal. When the expansion pack is removed, the device manager will inform the registered applications and drivers of the removal.

Specific Applications Used By Device Manager

To facilitate insertion, removal and control panel information. The device manager and associated programs look for and use specific applications from the expansion pack flash. The following table briefly identifies these applications:

Table 26: Specific Applications Used by Device Manager

Application	Description
IHVInstall.exe	Facilitates Expansion Insertion
IHVUninstall.exe	Facilitates Expansion Removal
Diagnostic.exe	Helps end-user gather information about expansion pack.

IHVInstall.exe

The Device Manager identifies this installation executable as a setup program. It is executed when the expansion pack is inserted. This application is used for installation, but could be used to load specific device drivers, registry settings or application files. It should also start the appropriate application for the expansion pack.

It must contain the SDK call **PPC_InstallCompleted.** This enables the Device manager to proceed with processing.

IHVUninstall.exe

The Device Manager identifies this executable as the opposite of the installation executable. It is copied to the main unit. It is called automatically upon expansion pack removal. It performs the appropriate notifications to device drivers and applications that are using the expansion pack. The application is deleted after execution completes. Another good use for this application is to remove any unneeded files or registry settings.

It must contain the SDK call **PPC_UninstallCompleted**. This enables the device manager to perform some necessary housekeeping.

Diagnostic.exe

The Device Manager identifies this executable as the diagnostic or “self test” application. When this application is present, the Device Manager enables the “Diagnostic” button on the expansion pack control panel applet. The end user could then start this application by tapping on that button. This application is also used to display information that is specific to the expansion pack. There are no specific requirements for this application. Compaq recommends that the application be compliant with the guidelines for Windows CE logo certification.

chapter 5

BATTERY, POWER SUPPLY AND CHARGING

Overview

An expansion pack can obtain power for its electronics from two sources. The first one is the main unit through the V_{DD} pins on the interface. The other source is to provide its own power from a built-in battery. Figure 11 (Expansion Pack Power Circuit Block Diagram) shows a block diagram of a sample power circuitry and distribution scheme.

The main unit can provide up to 300 mA peak at a regulated 3.3V to the expansion pack. When an expansion pack is first connected to the main unit, the expansion pack can only draw approximately 10 mA from the V_{DD} pins to allow the main unit to identify it. Once the main unit asserts OPT_ON, an expansion pack can draw the full 300 mA from the main unit.

If an expansion pack requires more than 300 mA peak or requires a voltage other than 3.3V, it must include its own power supply and/or battery and charging circuit. Upon insertion, the expansion pack must use power from the main unit while OPT_ON is low to allow the main unit to identify it. Typically, an expansion pack uses V_{DD} to supply power for the critical logic, EEPROM and the flash memory. Once OPT_ON is high, the expansion pack can enable its own power supply circuits for the remaining circuitry.

The batteries in the main unit and the expansion pack are charged from multiple sources. The user can charge the batteries from the DC jack on the main unit, the DC jack on the expansion pack or through the serial connector on the main unit. Thus, expansion packs with a battery must include a DC jack for charging with an AC adapter. This allows the main unit and the expansion pack to charge their respective batteries separately or at the same time.

It is optional for the expansion pack to provide extended battery life to the main unit. The implementation depends on the total peak current consumption of the expansion pack and the main unit. It is recommended that an extended battery have a minimum capacity of 1000 maH.

If the expansion pack includes a battery, specific requirements must be met to ensure proper operation and safety. The following sections and Chapter 7 (Reference Schematics) give more details on a possible implementation.

Battery and Power Supply

Figure 11 (Expansion Pack Power Circuit Block Diagram) shows a block diagram of the battery, charger, safety circuit and power supply. The expansion pack battery supplies power to the expansion pack power supply through the power switch on top of Figure 11. The power switch also can supply power to the power supply from the AC adapter signal, V_ADP. If the AC adapter is plugged in, the power switch disconnects the expansion pack battery from the power supply and the AC adapter supplies the power to the power supply. If the AC adapter is not plugged in and the battery has sufficient charge, the power switch enables the battery to supply the power.

The critical-low detect circuit monitors the voltage level of the battery to verify it does not go below the critical voltage level specified by the battery (typically 3.4V). This circuit also generates the BATT_FLT signal to notify the main unit if the battery has reached this point.

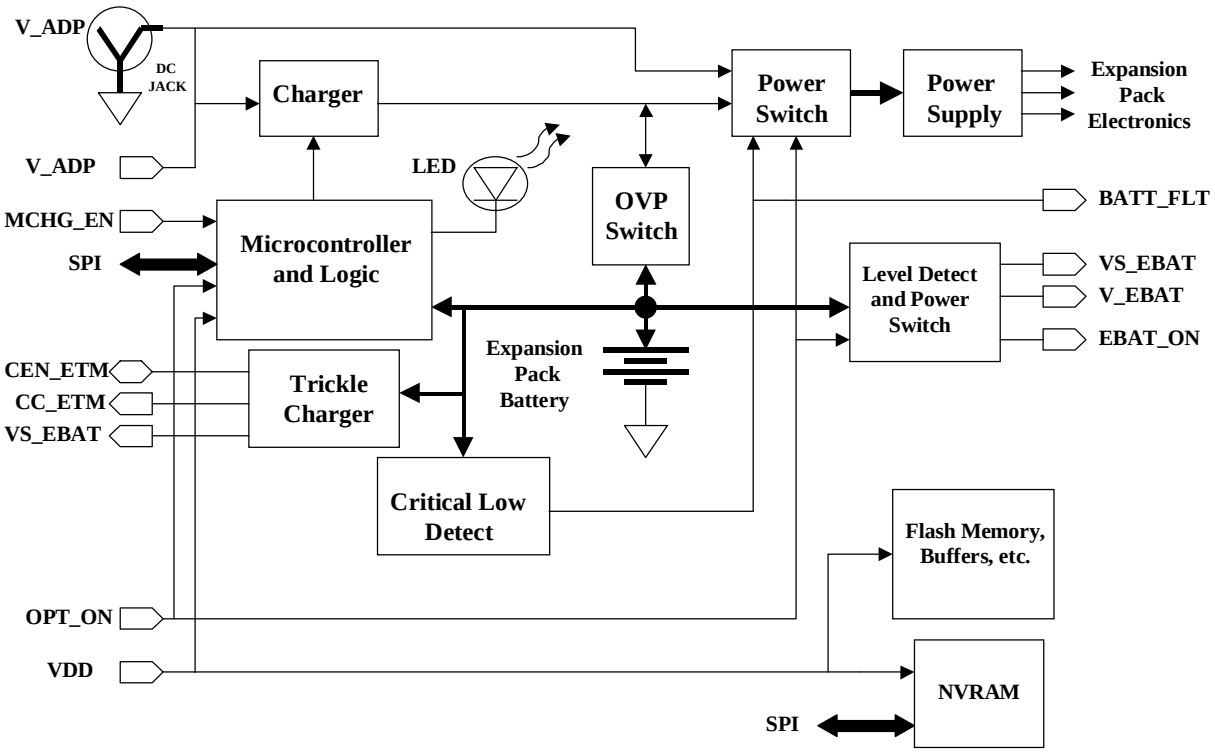
The power switch is controlled by OPT_ON, which enables the expansion pack to run at full power. If OPT_ON is inactive, the power switch is disabled and no power is supplied to the expansion pack power supply.

The micro controller monitors the battery voltage, temperature and charging. It typically includes A/D converters to monitor the battery parameters and communicates to the main unit through the SPI bus. Battery status can be displayed on the main unit via the SPI bus and APIs provided in the Software Interface section (Chapter 4).

Battery Charger Implementation

Figure 11 also includes a block diagram of the charging circuit. The signals V_ADP and MCHG_EN signals provide the ability to charge the expansion pack battery simultaneously with the main unit battery.

FIGURE 11: Expansion Pack Power Circuit Block Diagram



The V_ADP signals are the positive DC voltage from the AC adapter to charge the batteries. The V_ADP signals can be sourced from the main unit or the DC jack on the expansion pack, since the AC adapter can be plugged into the main unit or the expansion pack. When charging is sourced from the synchronizing cradle through the serial connector, the main unit passes the charge to the expansion pack through the V_ADP signals.

The V_ADP signals feed the charger circuit that includes a power transistor and charge regulator such as the MAX846 to control the current to the expansion pack battery. The battery charger is designed to charge the lithium polymer battery with constant current and constant voltage charge modes. MCHG_EN is a signal from the main unit to notify the expansion pack that the main battery is charging and the expansion pack must limit its charging current to prevent blowing the fuse in the AC adapter. OPT_ON is also typically used by the charging circuit to limit the charge current when OPT_ON is active.

The charging units are designed for lithium-ion or lithium polymer batteries, so if an option pack uses another battery technology it should not connect the V_ADP or MCHG_EN signals. Also, if an expansion pack does not want to share AC adapter charging with the main unit it should not connect the V_ADP and MCHG_EN signals.

The micro controller is used to monitor the battery and charge conditions. It is typically used to monitor charge time, battery temperature, battery voltage and system power requirements to control the charger. The micro controller also controls an LED that notifies the user that the battery is being charged by blinking at 1 Hz. If the battery is fully charged and the AC adapter is plugged in, the LED is turned on.

The OVP (over-voltage protection) switch monitors the battery and disconnects the expansion pack battery if the battery voltage exceeds the specification.

If an expansion pack includes a DC jack, the developer may choose to use the same one as the main unit.

The charging circuits are designed for lithium-ion or lithium polymer batteries, so if an option pack uses another battery technology, it should not connect the V_ADP signals. Also, if an expansion pack does not want to share AC adapter charging with the main unit, it should not connect the V_ADP signals.

Extended Battery Implementation

An expansion pack can provide extended battery life to the main unit in two ways. First, it can connect the V_EBAT and EBAT_ON signals when the expansion pack battery is used to run the main unit. Second, it can connect the CC_ETM, CEN_ETM and VS_EBAT signals with a current limiter to provide a trickle charge to the main unit battery. The trickle charge keeps the main battery at a sufficient level to power the main unit in the event the expansion pack is removed while the unit is on. The V_EBAT signals are the positive DC voltages from the expansion pack battery to the main unit power supply. The V_EBAT signals are connected to the expansion pack battery through a power switch. A voltage level detect circuit is used to enable the power switch and EBAT_ON signal when the battery has sufficient charge to supply power to the main unit. EBAT_ON is driven low level when extended battery voltage is lower than 3.72V.

If an expansion pack does not function as an extended battery to the main unit, the V_EBAT and EBAT_ON signals should not be connected.

The CC_ETM, CEN_ETM and VS_EBAT signals provide a mechanism for the expansion pack battery to provide a trickle charge to the main battery. The CC_ETM signal provides the trickle charge from the expansion pack battery to the main battery. The CEN_ETM is an active high, open-collector signal that enables the trickle charge from the expansion pack battery to the main battery. The expansion pack must pull this signal up to the extended battery voltage. The expansion pack should pull CEN_ETM low when the AC adapter is plugged in or when the expansion pack battery charge is too low. A current limiter, such as MAX890L or MAX893L, must exist on the expansion pack between its battery and the CC_ETM pin to limit the trickle charge.

VS_EBAT is the positive terminal sense line for the battery in the expansion pack. The main unit uses it to determine if it should trickle charge the main battery with the extended battery. If VS_EBAT has a lower voltage than the main battery, the main unit pulls CEN_ETM (open collector) low and disables the trickle charge. If VS_EBAT has a higher voltage than the main battery, CEN_ETM is pulled high by the expansion pack. If the AC adapter is plugged in or the expansion pack battery is too low (typically 3.65V), then the expansion pack must pull CEN_ETM low and disable the trickle charge.

If an expansion pack does not provide a trickle charge to the main unit, the CC_ETM, CEN_ETM and VS_EBAT signals should not be connected.

chapter 6

MECHANICAL INTERFACE

Overview

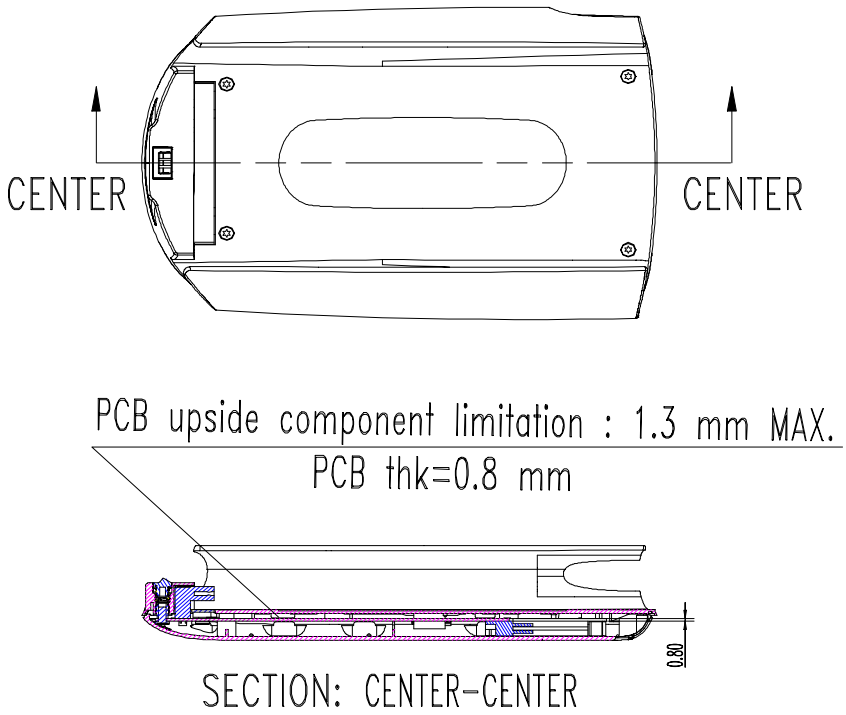
All functional expansion packs consist of four basic structures, including:

1. a uniquely-curved, injection-molded plastic base part which enables any expansion pack to physically slide up and onto the back of any main unit;
2. a common universal connector soldered to a PCB with absolute dimensions as to the position of the connector and of the thickness of the board but with less criteria as to the board area dimensions (see Figure 13: PCB Topside Component Limitation);
3. an unknown volume of "new" electronics that will, at minimum, communicate through the PCB and the universal connector;
4. an injection-molded plastic top cover part of specified shape at its bottom mating edge but of unspecified volume and shape (and possibly with unspecified openings) throughout its remainder.

Figure 12 (Main Unit Sliding into an Expansion Pack) illustrates the principle of a main unit sliding onto an expansion pack (in this case, a CompactFlash expansion pack). The expansion pack and main unit eventually make electrical connection through their respective universal connector plug and receptacle located near the bottoms of the expansion pack and the main unit, respectively.

FIGURE 12: Main Unit Sliding into an Expansion Pack

FIGURE 13: PCB Topside Component Limitation



Certain constraints of form factor in any future development of expansion packs must also be comprehended and these constraints would include that:

1. the plastic base part or sleeve of the expansion pack which immediately surrounds the main unit has specified dimensions and close tolerance gap with main unit (see the following Note),
2. the lower rear and bottom portions of the expansion pack base part or sleeve have specified dimensions and Industrial Design so as to preserve a reliable fit when inserted into the iPaq Pocket PC docking cradle and
3. NO future design of an expansion pack's form factor should allow blockage of (i.e., deny access to) those user-accessible hardware features around the top of the main unit (including, the headphone jack, FIR port, microphone openings, record button and stylus). However, please understand that the total stack-up thickness of the expansion pack as measured from the rear surface of the main unit is determined by the requirements of each individual expansion pack.

NOTE: It is recognized that developers may discover certain complications when interfacing their designs with the unusual shape and the close mating tolerances of the expansion pack's plastic base part or sleeve. Therefore, it is possible to procure sample and production volumes of certain common parts from the original vendors. Nevertheless, the injection-molded cover part or turtle-shell is the responsibility of the developer of the new expansion pack.

Figure 14 (Exploded View Example from a CompactFlash Expansion Pack, Part 1) and Figure 15 (Exploded View Example from a CompactFlash Expansion Pack, Part 2) show exploded views of an expansion pack using the example of a CompactFlash expansion pack. These figures are intended to only provide a general understanding of how the mechanical structures fit together. **They are not intended for actual mechanical design.**

FIGURE 14: Exploded View Example of a CompactFlash Expansion Pack, Part 1.

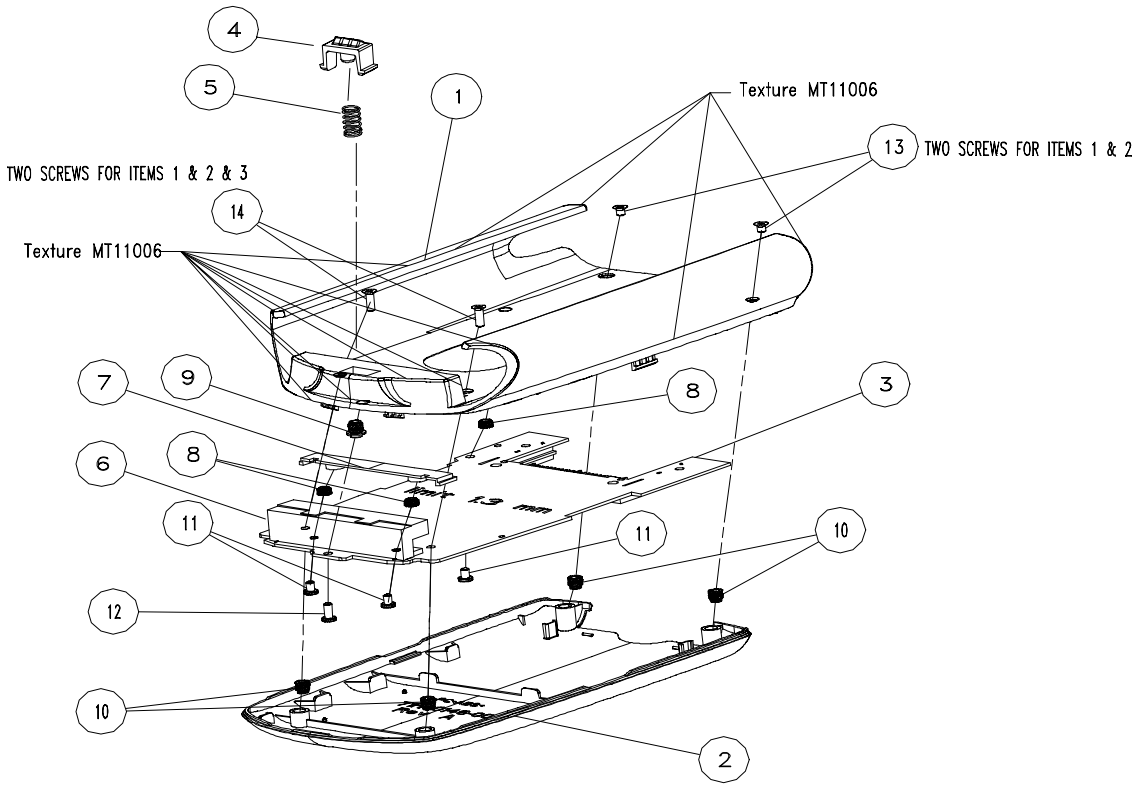


Table 27: Part List for a CompactFlash Expansion Pack (Part 1)

Item	Description	Qty	Material
1	OPTION PACK BASE, iPAQ	1	PC/ABS (Kobelco ku2-1517)
2	OPTION PACK COVER, iPAQ	1	PC+ABS (Kobelco ku2-1517)
3	PCB ASSY, CF CARD, iPAQ (Example only)	1	PCB THICKNESS=0.8 mm
4	LOCK BUTTON, iPAQ	1	PC/ABS (Kobelco ku2-1517)
5	LOCK BUTTON SPRING, iPAQ	1	PC/ABS (Kobelco ku2-1517)
6	UNIVERSAL CONNECTOR, OPTION PACK, iPAQ	1	

Table 27: Part List for a CompactFlash Expansion Pack (Part 1)

Item	Description	Qty	Material
7	UNIVERSAL CONN, SUPPORT, iPAQ	1	PC/ABS (Kobelco ku2-1517)
8	INSERT F-20-36-17, iPAQ	3	Brass
9	INSERT F-20-36-42, iPAQ	1	Brass
10	INSERT F-20-35-30, iPAQ	4	Brass
11	PHILLIPS SCREW, FLAT PAN HEAD M2.0X2.5	3	Nickel
12	PHILLIPS SCREW, FLAT PAN HEAD M2.0X4	1	Nickel
13	TORX SCREW FLAT HEAD M2.0X2.3 BLACK	2	
14	TORX SCREW FLAT HEAD M2.0X5.5 BLACK	2	

FIGURE 15: Exploded View Example from a CompactFlash Expansion Pack, Part 2

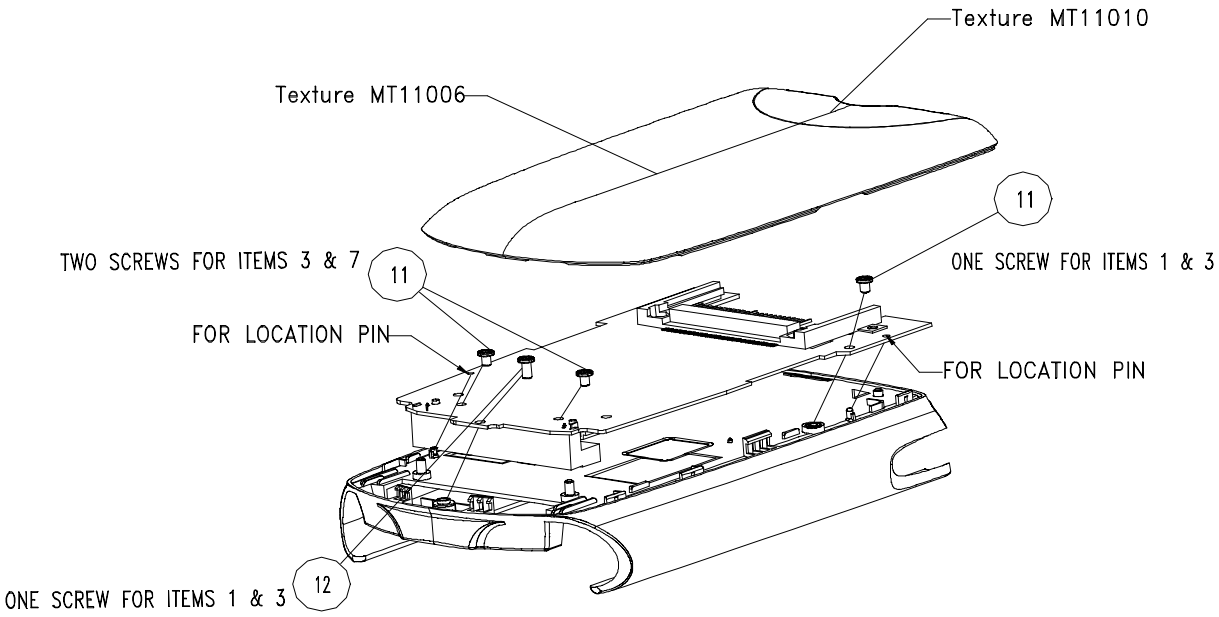


Table 28: Part List for a CompactFlash Expansion Pack (Part 2)

Item	Description	Qty	Material
11	PHILLIPS SCREW, FLAT PAN HEAD M2.0x2.5	3	Nickel
12	PHILLIPS SCREW, FLAT PAN HEAD M2.0x4	1	Nickel

Additional mechanical design highlights that are noted for development of an expansion pack include:

1. The cosmetic texture surface of the expansion pack plastic turtle shell or “cover part” **(**the developer’s responsibility) are specified in the figures above to ensure seamless appearance with the expansion pack’s sleeve or base plastic textured part.
2. The PC/ABS resin manufacturer and type and color of the expansion pack plastic turtle shell or “cover part” (the developer’s responsibility) is specified in the figures above to ensure seamless cosmetic and material appearance with the expansion pack’s sleeve or base plastic part.
3. The format for all mechanical drawings is Pro-Engineer Version 20. The drawings are available at http://www.compaq.com/handhelds/developer.
4. It is possible to procure the following components from the original vendors.
    - Expansion Pack Sleeve
    - Plastic resin, PC/ABS, Ku2-1517
    - Expansion Pack Connector (or Universal Connector)
    - Lock Button
    - Lock Button Spring
    - Expansion Pack Connector plastic support part

Interface (Universal) Connector

The interface between the expansion pack and the main unit is a 100-pin plug/receptacle connection with the plug connector on the main unit and the receptacle connector on the expansion packs. The connectors mate 180° from each. Each connector solders to the respective PCB with a mixture of through-hole and surface mount pins on a 0.8mm pitch. See the following figure for a view of the two connectors fully mated.

Some of the pins on each connector protrude out at different lengths to ensure certain events happen sequentially. Table 29 (Interface 'Universal' Connector) shows the various lengths for each of the plugs and receptacles on the connectors.

Table 29: Interface (Universal) Connector

	Pin #	Plug Distance from Front	Receptacle Distance from Front
Shorten Receptacle Pins	10, 47, 50, 51, 92	0.90 mm	1.82 mm
Extended Plug Pins	5, 21, 31, 45, 49, 55, 66, 76, 86, 95, 99	0.40 mm	1.32 mm
Normal Pins	All others	0.90 mm	1.32 mm

FIGURE 16: Expansion Pack Connectors Mated

chapter 7

REFERENCE SCHEMATICS

As available, reference schematics for expansion packs are planned to coincide with this specification. Future schematics are listed below. Please refer to http://www.compaq.com/handhelds/developer for updates.

- Lithium Polymer Battery support circuitry
- UART connection
- Dual PCMCIA/CF slot
- Single CF slot

chapter 8

REGULATORY REQUIREMENTS AND APPROVALS

Suggested Agency Approvals

It is the responsibility of the manufacturer to obtain the necessary regulatory certifications for their product. Certifications that should be considered include, but are not limited to the following:

- FAA - US
- FCC Part 15 - US
- UL 1950 - US
- FCC Part 68 - US
- ICES-003 - Canada
- CSA 950 - Canada
- CS-03 - Canada
- RSP100 - Canada
- RSS210 - Canada
- CE - Europe
- ETS300328 - Europe
- ETS300826 - Europe
- CTR21 - Europe
- CISPR 22 - International
- IEC 60950 - International

Agency Acceptance Testing

The manufacturer of expansion packs for the Compaq iPAQ H3000 Series is responsible for all agency testing.

chapter 9

ENVIRONMENTAL REQUIREMENTS

The developer is responsible to assure the expansion pack meets all environmental requirements of the customer. Some suggested specifications are listed below:

Operational Environment

Temperature Ranges

Operating Temperature (Independent of altitude) 0°C to 40°C.

Non-Operating Temperature (Independent of altitude) -30°C to 60°C.

Humidity

Operating (non-condensing) 20% to 80% at 25°C.

Non-Operating (38.7°C maximum wet bulb temperature) 5% to 85%.

Altitude

Operating 0 to 15,000 feet [4,572 m]. Equivalent to 14.7 to 8.29 psia.

Non-Operating 0 to 40,000 feet [12,192 m]. Equivalent to 14.7 to 4.4 psia.

Environmentally Safe Materials

Any plastic casework and the packaging material shall not contain any ozone depleting chemicals such as CFCs, PBDE, PBDPE or Halon compounds.

Toxic Materials

Materials which produce toxic effects during service usage or due to component failure shall not be used in the expansion pack construction. Cadmium and polychlorinated biphenyls may not be used in any form. The use of beryllium is only allowed in semi-conductors and shall not be exposed upon failure.