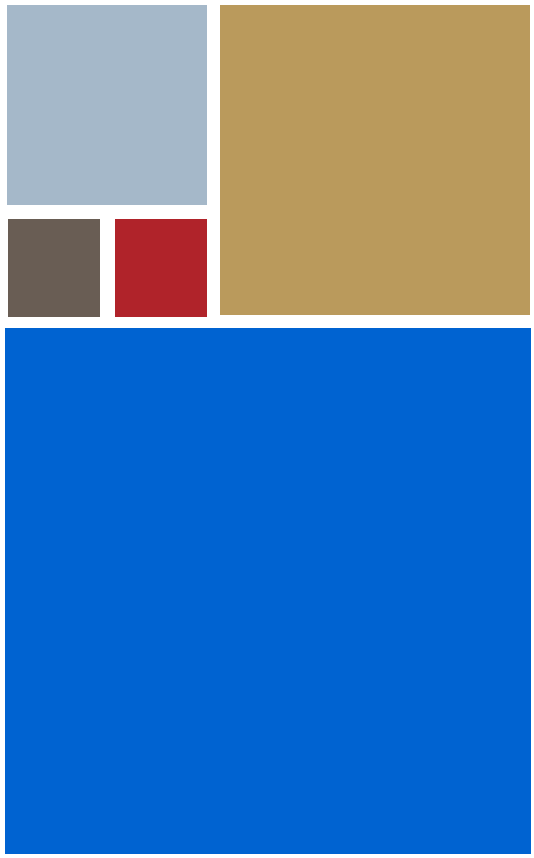

Home

Power Management Subsystem Specification

Version 4.7

RadiSys
THE POWER OF WE

www.radisys.com

Revision A • July 2006

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Contents

1 Overview

Power management is crucial to enabling long life from small and inexpensive batteries in personal communications devices. As an addition to the core OS-9® operating system, the Power Management Subsystem aids an embedded system, especially a portable battery-powered system, in conserving energy (and thus, extending battery life) via customizable power management policy.

As opposed to communications and human-interface (and most other interfaces an application deals with), the Power Management Subsystem provides a system-level interface to the kernel and a set of conventions used to write device drivers and applications.

Definitions

Power Management Subsystem terminology used in this manual is defined in this section.

Power Unaware

Power unaware device drivers and applications are those not managed by the Power Management Subsystem.

Power Aware

Power aware device drivers and applications are those managed by the Power Management Subsystem.

A power aware application may provide useful hints to a power management support mechanism (such as giving an initialized device a hint to power down due to anticipated non-use for a long interval).

Support Mechanisms

Low-level support mechanisms are used by the Power Management Subsystem to implement power management strategies. Support mechanisms include:

- Power aware device drivers
- Power aware file managers
- Power aware system modules

Different levels of power management may be implemented. For example, a liquid crystal display (LCD) screen driver may implement an internal timer to blank the screen upon a predefined period of non-use, or a hard disk driver may implement a similar internal timer to turn off the hard disk motor upon a predefined period of non-access to the disk. In both of these cases, power management is implemented totally in local device drivers. But in cases where power management crosses subsystem boundaries, such as turning off the system clock, the Power Management Subsystem, based upon entries in the Power Policy Table, implement this power management.

A Power Managed System

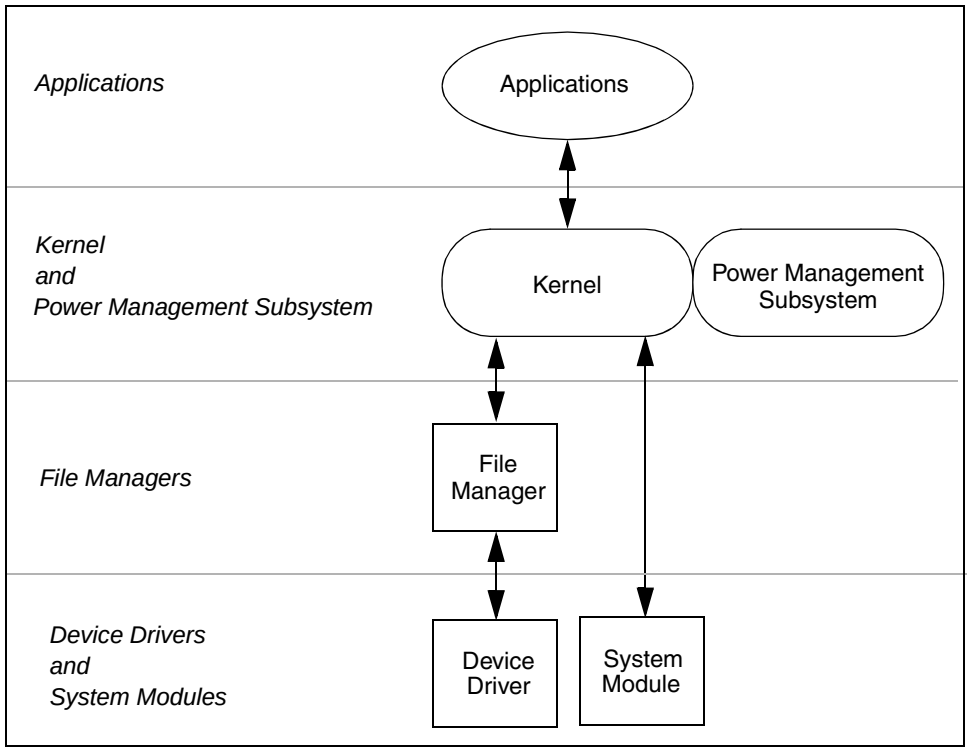
A Power Managed system commonly includes:

- Kernel and Power Management Subsystem
- Applications
- Device Drivers
- File Managers
- System Modules

The Power Management Subsystem is customizable. Documentation and example sources enabling development of power aware device drivers and applications and power management policy are provided in this manual.

Applications, device drivers, file managers, and system modules in a power managed system may be either power-aware or -unaware.

Figure 1-1. A Power Managed System



By implementing various levels of the distributed power management support mechanisms depicted in Figure 1-1, a system designer can be as aggressive as necessary in conserving power in a portable communications device.

Power Aware Applications

The highest power management level—power aware applications—implements power-down of devices consuming high power (or even medium- to low-power consumption devices if aggressively conserving power) when the device is not in use. For example, a serial port is powered-up when initialized since the serial driver must be ready to receive or transmit data. The application, however, knows the characteristics of data transmitted and should power down the serial driver when it determines that transmission is not expected for a long period of time.

Power Management Subsystem

The Power Management Subsystem supports power management at the operating system. Upon recognizing the absence of active processes (all processes are either sleeping or waiting for an external event) the Power Management Subsystem can place the system into a very low powered state by turning off the system clock and powering down unnecessary chips and devices.

Power Aware Device Drivers

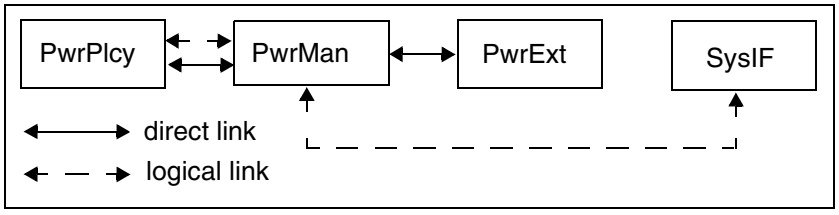
The lowest power management level—power aware device drivers—enables software that interfaces with hardware (e.g., device driver) to be aware of the power consumption characteristics of its local subsystem. For example, an audio module subsystem can be initialized yet powered down until it is actually in use. In this example, the audio module subsystem would be powered up before playing the first note of a song and then powered back down after playing the last note.

Power Management Subsystem Components

The Power Management Subsystem components identified following are described in this section:

- Power Management Module (`PwrMan`™)
- Power Policy Module (`PwrPlcy`™)
- Power Extension Module (`PwrExt`™)
- System Interface Module (`SysIF`™)

Figure 1-2. Power Management Subsystem Components



PwrMan

`PwrMan`, a generic object code module available across all supported OS-9 processor platforms, provides a consistent system level interface including library functions, device and power information tables, and a status utility. `PwrMan` is designed to support a wide variety of power management policies by providing a generic, system-level interface for:

- Establishing, implementing, and maintaining policy

- Maintaining and transitioning between power states

For more information, see Chapter 2 PwrMan.

PwrPlcy

`PwrPlcy` is provided as generic source code that is customizable by original equipment manufacturers (OEMs). It is highly dependent on target system hardware configurations and the specific power management strategy chosen for that system. `PwrPlcy` is the high level mechanism responsible for:

- Decision making for power state changes
- Initializing `PwrMan` power states
- Instigating power state transitions, based upon past and current system states, via library functions

For more information, see Chapter 3 PwrPlcy.

PwrExt

`PwrExt` is a system-state subroutine module used to override the `PwrMan` system call. At initialization, `PwrMan` looks for both `PwrExt` and `PwrPlcy` and if either or both are in memory, `PwrMan` links first to `PwrExt` and then `PwrPlcy`.

For more information, see Chapter 4 PwrExt.

SysIF

`SysIF` is a special system module providing a system-specific interface for the microprocessor and other hardware components without device driver interfaces.

`SysIF` enables `PwrPlcy` to reference the power levels of the CPU (such as normal operation, throttled, and deep-sleep) just as it references other device-driver components (such as a serial or ethernet drivers).

For larger power managed systems, several `SysIF` type modules may be needed. For example, the system could have a CPU system module that controls all CPU-specific operations and a separate battery system module that controls a smart battery.

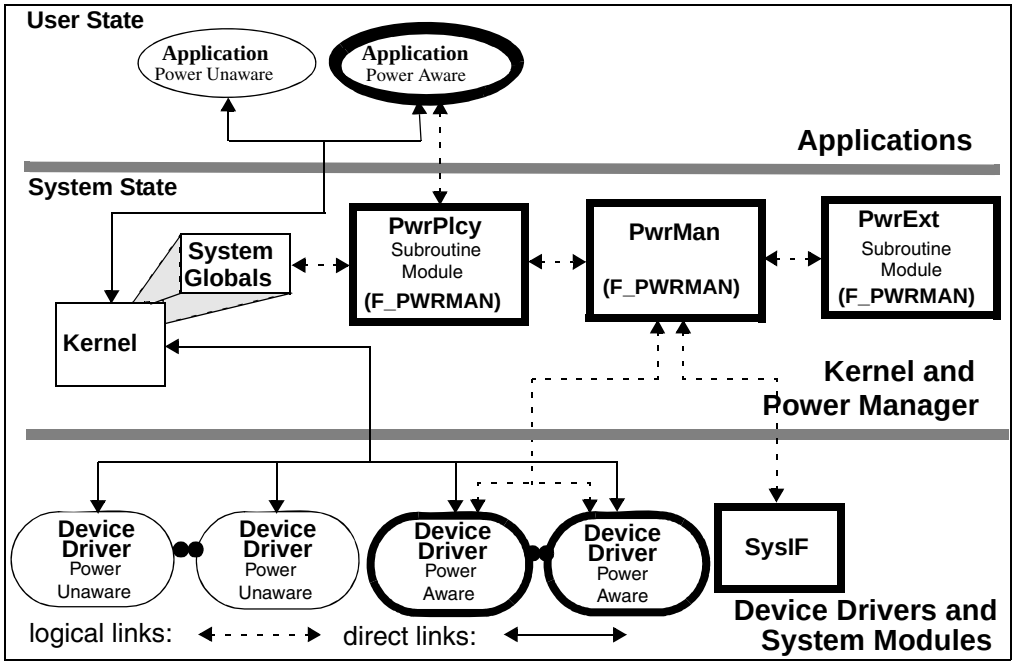
For more information, see Chapter 5 SysIF.

Interaction in the Power Managed System

Figure 1-3 depicts logical and direct links between components in a power managed system.

All power-aware and -unaware device drivers and applications communicate with the kernel. Power aware device drivers and applications may communicate directly with the Power Management Subsystem for power management requests. Power unaware device drivers may request power management via the kernel to the Power Management Subsystem if a `SysIF` exists in the system to power manage that device.

Figure 1-3. Interaction in the Power Managed System



2 PwrMan

PwrMan, a system module kernel extension, provides a consistent system level interface for power management. PwrMan includes library functions, device and power information tables, and a status utility, available across all supported processor platforms. PwrMan is designed to support a wide variety of power management policies by providing a generic, system-level interface for:

- Establishing, implementing, and maintaining policy
- Transitioning between power states

This chapter covers the following system level interface information:

- Device Registry Table
- Power State Table
- Power Structures
- PwrMan Globals Structure
- PwrMan Library
- pwrstat Utility

See Appendix C Assembly Interface for OS-9 for 68K.

PwrMan Tables

PwrMan comprises two table types:

- Device Registry
- Power State

The Device Registry Table identifies power aware devices to be power managed and device driver or SysIF callback functions and parameters.

See the Device Registry Table and Power State Table subsections in this chapter.

Callback functions provide hardware specific power management interfaces..

The Power State Table identifies device power control.

To power manage a device identified in the Device Registry Table, a corresponding entry must exist in the Power State Table. The common field between the two tables is the device name (or id). To create a unique entry (based upon ID) in a table and a corresponding entry in the other table, the _os_pwr_reg() and _os_pwr_add() library functions must be used.

Updates to entries (state additions, device or state deletions, or device or state changes), not creation of unique entries, to either of the tables causes PwrMan to dynamically update the other table.

The PwrPlcy module initializes and manages entries in the Power State Table. By using two tables, the order of PwrMan table initialization is irrelevant; devices may register with PwrMan (via the Device Registry Table) before the Power State Table is initialized, or vise-versa..

To view table entries, use the pwrstat utility described in this chapter..

Device Registry Table

An example Device Registry Table is shown in Table 2-1.. An initial allocation of 16 Device Registry Table entries is made by PwrMan. If an attempt is made to register more than sixteen entries, PwrMan allocates additional entries in 16 block increments.

Table 2-1. Example Device Registry Table

id	func	funcparam	devpwrdef
"t2"	<t2 function>	<t2 parameter>	<pointer>
"cpu"	<cpu function>	<cpu parameter>	<pointer>

Table 2-1. Example Device Registry Table (Continued)

id	func	funcparam	devpwrdef
"t1"	<t1 function>	<t1 parameter>	<pointer>
null	null	null	null

Device Registry Table data is formulated from device drivers and `SysIF` calls to `_os_pwr_reg()` and `_os_pwr_unreg()` library functions.

`_os_pwr_reg()` adds an entry to the Device Registry Table and checks the Power State Table to determine if the same `id` exists in both tables. If so, the function and parameter fields for the entry in the Power State Table are set to the callback function and parameters identified in the Device Registry Table. If not, the Power State Table is not updated.

`_os_pwr_unreg()` removes an entry from the Device Registry Table.

`id` is the name of the table entry. This is the common link between the Device Registry Table and the Power State Table. This field is a case-sensitive ASCII string.

`func` is a pointer to the callback power management registered by the driver or system module.

`funcparam` is a device-specific parameter, usually consisting of a device static pointer or device entry pointer.

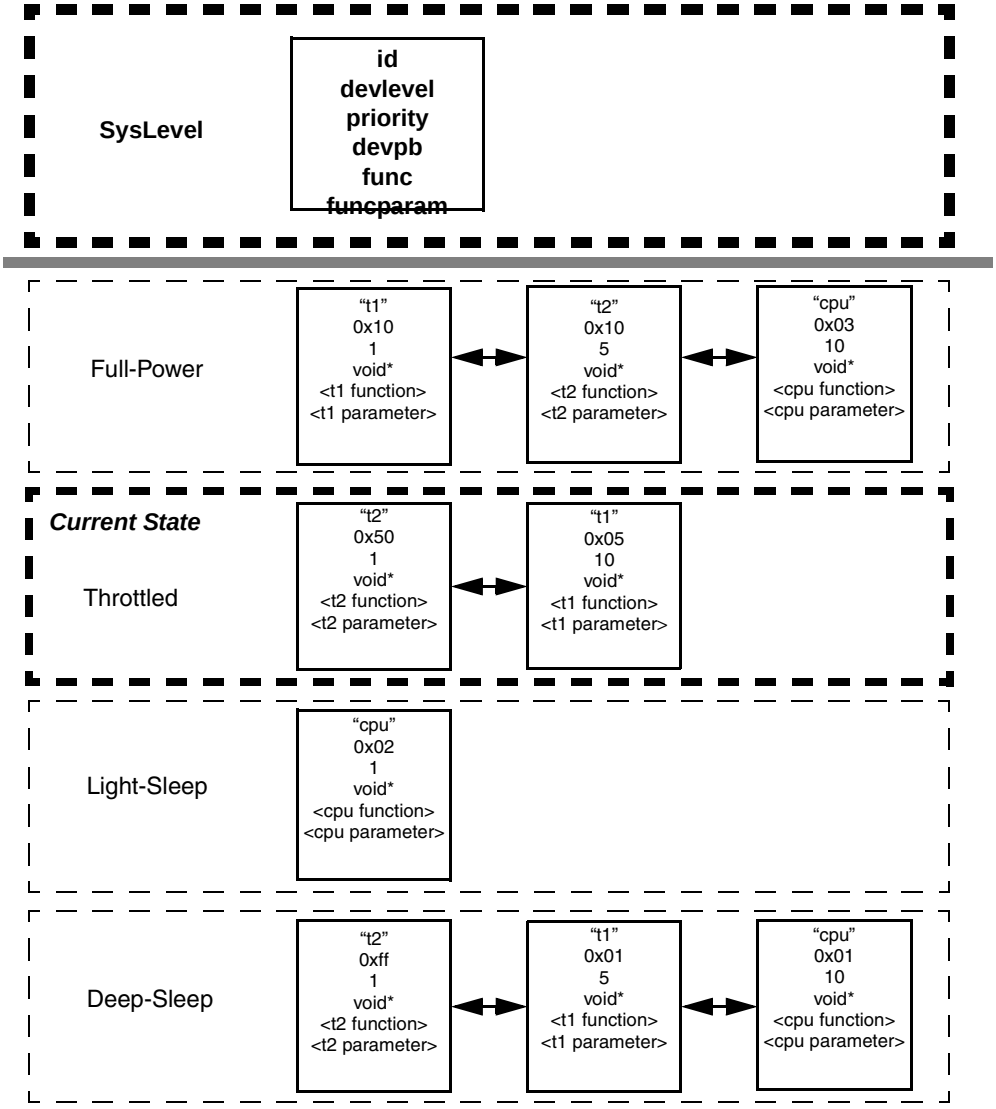
`devpwrdef` is a pointer back to the local device energy condition structure.

Power State Table

The main goal of `PwrMan` is to maintain the Power State Table. The initialization of this table is left to `PwrPlcy`.

An example Power State Table is shown in Figure 2-1.. An initial allocation of 32 Power State Table entries is made by `PwrMan`. If more than 32 entries are added, `PwrMan` allocates additional entries in 32-block increments.

Figure 2-1. Example Power State Table



`_os_pwr_add()` adds an entry to the Power State Table and determines if the same ID is in the Device Registry Table. If not, the function and parameter fields for the entry in the Power State Table are set to NULL.

`_os_pwr_remove()` removes an entry from the Power State Table.

`id` is the name of the entry. This is the common link between the Device Registry Table and the Power State Table. This field is a case-sensitive ASCII string.

`syslevel` is the power state name.

`devlevel` is a parameter for the callback function that specifies which part of the callback function is executed. For example, the same callback function may be used for several power states of a device. `devlevel` can indicate which power state (`syslevel`) is used.

priority designates the order in which the callback function devlevels specified in the syslevel execute upon a state change. The lower the value, the higher the priority (e.g., 1 is highest priority).

devpb is an optional parameter block for the callback function. devpb may specify additional details concerning which part of the callback function is executed. For example, when using a PCMCIA card, this parameter may be used for whatever device is plugged into the card at that time. If devpb is not in use, devpb must be filled with NULL.

func is a pointer to the callback function registered by the driver or system module.

funcparam is a device-specific parameter, usually consisting of a device static pointer or device entry pointer..

The devlevel and the devpb Power State Table entries are device specific. Power state entries for the same power state can (and probably will) have different power parameter values between them. This implies that PwrMan should be aware of all the devices that are in the system as well as their power characteristics (via the Power State Table and Device Registry Table)..

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devpb can be used for anything needed by the driver. For example, it could be used for a parameter block to change a system clock rate independent of the current system state..

Power Management Power State Table Flow

In addition to the Power State Table, PwrMan maintains a pointer to the current power state, currlevel, in the pwrman_globals structure.

Requests to change power states are made by PwrPlcy to PwrMan. When changing states, PwrMan:

1. Changes the current state pointer to the new syslevel
2. Calls each power state entry callback function in the syslevel with devpb and funcparam

If errors are returned from these callback functions and the ret_on_err global flag is not set, PwrMan continues to process the remaining entries in that power state but returns the first error encountered to PwrPlcy. Upon notification of an error during state change, PwrPlcy determines whether to return to the previous power state or remain in the current one. If an error occurs while trying to change states and ret_on_err is set, PwrMan restores the previous state and immediately returns an error.

Power Structures and Definitions

Power Management Subsystem power structures are defined in this section. Structures are:

- Device Energy Condition

- Local Power Mode
- Power Event

Device Energy Condition

The `pwr_devcond` structure resides in the <`MWOS/SRC/DEFS/PWRMAN/pwrman.h`> header file. This structure may be used to describe the current energy/power condition of a device. The data represents the device's current power condition. `PwrExt` may use the information in calculating the entire system's energy condition or in determining if there is a need to generate a power event (`pwr_event`). A device driver or `SysIF` may update the `pwr_devcond` structure without generating a `pwr_event`..

Power events are unrelated to OS-9 or OS-9 for 68K events used in interprocess communication.

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For a definition of `pwr_event`, reference the Power Event subsection in this chapter.

The `pwr_devcond` structure may be part of a Device Registry Table entry if used as the last parameter of the `_os_pwr_reg()` and `_os_pwr_unreg()` calls. The writer of `PwrExt` determines whether to use or ignore the information.

```
typedef struct pwr_devcond {
    Pwr_localmode lpm;/* ptr to array of local power modes */
    u_int32 num_lpm;/* # of local power modes */
    pwr_devtype dev_type;/* device type */
    pwr_level pres_level;/* present power level */
    int32 pres_energy;/* present energy level (mW) */
    int32 pres_drain;/* present energy drain (mW/hr) */
    u_int8 rsv1[24];/* reserved */
} pwr_devcond, *Pwr_devcond;
```

`lpm` is a pointer to the local power mode of the device.

`num_lpm` is the number of local power modes for the device.

`dev_type` describes the type of device in terms of energy or power.

`pres_level` is the present local power mode level of the device.

`pres_energy` is the present energy level of the device.

`pres_drain` represents the device's present energy drain or load on the system.

For information about local power mode, reference the Local Power Mode subsection in this chapter.

Local Power Mode

The loc_pwr_mode structure resides in the <MWOS/SRC/DEFS/PWRMAN/pwrman.h> header file. loc_pwr_mode is a structure used to represent local power modes of devices. This is a suggested way of abstracting how power or energy may be defined in a system, making the power management system more portable.

```
typedef struct pwr_localmode {
   pwr_level level;/* Local power mode level */
   int32 maxload;/* max energy load or drain (mW) */
   int32 minload;/* min energy load or drain (mW) */
   u_int32 entrytime;/* worst-case device entry time (ms) */
   u_int32 exittime;/* worst-case device exit time (ms) */
   char lpm_name[PWR_IDLEN];/* local power-mode name */
   u_int8 context_pres;/* device context preserved flag */
   u_int8 rsv1[11];/* reserved */
} pwr_localmode, *Pwr_localmode;
```

level is the local power mode level.

max_load and min_load are the maximum and minimum energy loads the device may put on the system.

entrytime and exittime are the worst-case times the device takes to power-up and down respectively.

lpm_name is the local power mode name.

context_pres indicates whether the context of the device is preserved. An example where this may be used is to indicate whether a device is plugged into a PCMCIA card.

Power Event

The pwr_event structure resides in the <MWOS/SRC/DEFS/PWRMAN/pwrman.h> header file. _os_pwr_ev_notify() and _os_pwr_ev_request() are calls that use the pwr_event structure.

Power events are used to pass information from the device driver/SysIF level to PwrPlcy. For example, a new device is added to the system that may need a substantial amount of power or a device suddenly becomes active, such as a fax machine, and is going to consume more power as a result. Power events may be used to pass such vital information to PwrPlcy enabling PwrPlcy to make the appropriate changes in the system, if necessary.

Power events are also meant for situations that cause the system's power condition to change. Thus, power events should be used when something that causes a substantial change in power within the system occurs. As the system's power level hits lower and lower thresholds, the criteria for a substantial change of power in the system may change. In other words, as the energy left in a battery gets lower, more circumstances

may cause a substantial change of power in the system to occur, thus requiring a power event to occur.

Since there is overhead involved with using power events, a system is not required to use them. A simpler system may use interprocess communication mechanisms already built into the operating system, such as signals and events, to indicate that something has changed in the system.

Power events are unrelated to OS-9 or OS-9 for 68K events used in interprocess communication..

```
typedef struct pwr_event {
    char* devid;/* ptr to device identifier */
    Pwr_devcond devcond;/* ptr to device condition struct */
    pwr_level old_lpm;/* ptr to old local power mode */
    pwr_level new_lpm;/* ptr to new local power mode */
    int32 old_energy;/* old energy level (mW) */
    int32 new_energy;/* new energy level (mW) */
    int32 old_drain;/* old drain/[supply] (mW/hr) */
    int32 new_drain;/* new drain/[supply] (mW/hr) */
    u_int8 rsv1[16];/* reserved */
} pwr_event, *Pwr_event;
```

`dev_id` is a pointer to the device identifier.

`dev_cond` is a pointer to the overall device power condition structure.

`old_lpm` is the local power mode before the power event takes place.

`new_lpm` is the local power mode that the device just entered (via `_os_pwr_ev_notify()` or is requesting to enter (via `_os_pwr_ev_request()`).

`old_energy` and `new_energy` (used by suppliers only) represent the change in the amount of energy stored. The associated unit is energy-based (e.g., milliwatt-hours (mw-hour)).

`old_drain` and `new_drain` represent the change, in mw-hour, in the rate of use/supply of energy. Based on the nature of the device being either a consumer or supplier of energy, the `old_drain` and `new_drain` fields may represent positive or negative values, respectively.

pwrman_globals Structure

`pwrman_globals` resides in <`MWOS/SRC/DEFS/PWRMAN/pwrman.h`>. The structure comprises addresses of callback functions of fields in the Power State Table and is known by all Power Management Subsystem modules: `PwrPlcy`, `PwrMan`, `PwrExt`, and `SysIF`.

```
/* Global Variables to PwrMan, pwrplcy, and pwrext */
struct pwrman_globals {
```

```
  Sysglobs sglobptr;/* system globals pointer */

  Pwr_state phead;/* head of the Power State table */
  Pwr_state pfree;/* power state table free pool */

  Pwr_devreg dthead;/* head of the device registry table */
  Pwr_devreg dtfree;/* device registry table free pool */

  pwr_level currlevel;/* current system power level */

  void* pwrplcy_mem;/* PwrPlcy-specific memory pointer */
  error_code (*pwrplcy_func)(F_pwrman_pb pb, Pwrman_globals ldptr);
      /* PwrPlcy entry point function */
  void* pwrext_mem;/* PwrExt-specific memory pointer */
  error_code (*pwrext_func)(F_pwrman_pb pb, Pwrman_globals ldptr);
      /* PwrExt entry point function */
  u_int8 from_usrstate;/* usr state flag */
    #define FROM_SYSSTATE 0x00
    #define FROM_USRSTATE 0x01

  u_int8 from_super;/*super user flag */
    #define FROM_NONSUPER 0x00
    #define FROM_SUPER 0x01

  u_int8 ret_on_err;/* return on state-change err flag */
  u_int8 rsv1[1];/* reserved */

  error_code (*pwrman_func)(F_pwrman_pb pb, Pwrman_globals ldptr);
      /* PwrMan entry point function */

  Mh_com pwrplcy_modhead;/* pointer to PwrPlcy module head */
  Mh_com pwrext_modhead;/* pointer to PwrExt module head */

  u_int8 rsv2[12];/* reserved */
};
```

`sysglob` is a pointer to the system globals.

`phead` and `dthead` are pointers to the heads of the Power State and Device Registry tables respectively.

`pfree` and `dtfree` are pointers to the Power State and Device Registry tables free entry pools, respectively.

`currlevel` is the current power state.

`pwrplcy_mem` is a pointer to `PwrPlcy` allocated local memory.

`pwrplcy_func` is a pointer to the `PwrPlcy` entry point.

pwrext_mem is a pointer to PwrExt allocated local memory.

pwrext_func is a pointer to the PwrExt entry point.

from_usrstate is a flag indicating run a process from user state.

from_super is a flag indicating that super user is required to run the process.

ret_on_err is a flag error handling when one of the callback functions error during an _os_pwr_change(). If ret_on_err is set and a callback function errors, the previous state is restored and the error is returned immediately. If ret_on_err is not set and a callback function errors, _os_pwr_change() continues to call the remaining callback functions for that state and then returns the first error.

pwrman_func is the pointer to the default entry point of the F$PwrMan system call.

pwrplcy_modhead holds a pointer to a module head for unlinking.

pwrext_modhead holds a pointer to a module head for unlinking.

PwrMan Library

Power Management C library function bindings reside in MWOS/<OS>/<CPU>/LIB/pwrman.l.

<OS>=OS9
OS9000
<CPU>=68000
PPC
80386

This library provides an interface for all PwrMan operations. All power management macro, structure, and type definitions reside in MWOS/SRC/DEFS/pwrman.h.

PwrMan library information for assembly language users is provided in Appendix C Assembly Interface for OS-9 for 68K.

Table 2-2. PwrMan System Level Function Functions

Syntax	Description
error_code _os_pwr_add(char id[PWR_IDLEN], pwr_level syslevel, u_int32 priority, pwr_level devlevel, void *devpb)	Adds an entry in the Power State Table.
error_code _os_pwr_callback(char id[PWR_IDLEN], pwr_level devlevel, void *devpb)	Calls either the SysIF or driver callback function without changing states.
error_code _os_pwr_change(pwr_level syslevel)	Changes the current power state to the one indicated as syslevel.

Table 2-2. PwrMan System Level Function Functions (Continued)

Syntax	Description
error_code _os_pwr_check(char version[PWR_VERS_LEN])	Checks to see if `PwrMan` is active in the system.
error_code _os_pwr_copyglob(pwrman_globals *pwrglob)	Retrieves a copy of the internal `PwrMan` globals (for debugging use only).
error_code _os_pwr_debug(const pwrman_globals **pwrglob)	Retrieves a pointer to the internal `PwrMan` globals (for debugging use only).
error_code _os_pwr_ev_request(Pwr_event pwrevent)	Sends `PwrPlcy` a power event requesting a change in state.
error_code _os_pwr_link_ext(char id[PWR_IDLEN])	Link to a `PwrExt` module.
error_code _os_pwr_link_plcy(char id[PWR_IDLEN])	Link to a `PwrPlcy` module.
error_code _os_pwr_ev_notify(Pwr_event pwrevent)	Sends `PwrPlcy` a power event indicating that a change of state must occur.
error_code _os_pwr_reg(char id[PWR_IDLEN], error_code (*func)(void *funcparam, pwr_level devlevel, void *devpb),void *funcparam, Pwr_devcond devpwrdef)	Adds an entry in the Device Registry Table.
error_code _os_pwr_remove(char id[PWR_IDLEN], pwr_level syslevel, u_int32 priority, pwr_level devlevel, void *devpb)	Removes an entry from the Power State Table.
error_code _os_pwr_unlink_ext(void)	Unlink from the attached `PwrExt` module.
error_code _os_pwr_unlink_plcy(void)	Unlink from the attached `PwrPlcy` module.
error_code _os_pwr_unreg(char id[PWR_IDLEN], error_code (*func)(void *funcparam, pwr_levl devlevel, void *devpb), void *funcparam, Pwr_devcond devpwrdef)	Removes an entry from the Device Registry Table.

Table 2-3. PwrMan Function Overview

Function	Processor State		Group Permissions *		Typical Calling Entity/Use			
	System	User	Super	User	PwrPlcy	Device Driver/ SysIF	Power Aware Applica-tion	Debug/ Test
_os_pwr_add()	X	X	X		X		X	
_os_pwr_callback()	X	X	X		X		X	
_os_pwr_change()	X	X	X		X		X	
_os_pwr_check()	X	X	X	X			X	
_os_pwr_copyglob()	X	X	X	X				X
_os_pwr_debug()	X		X					X
_os_pwr_ev_notify()	X	X	X			X		
_os_pwr_link_ext()	X		X					X
_os_pwr_link_plcy()	X		X					X
_os_pwr_reg()	X		X			X		
_os_pwr_remove()	X	X	X		X		X	
_os_pwr_ev_request()	X	X	X			X		
_os_pwr_unlink_ext()	X		X					X
_os_pwr_unlink_plcy()	X		X					X
_os_pwr_unreg()	X		X			X		

* Permissions are not relevant to system state.

Table 2-4. PwrMan System Level Function Errors

Number	Error	Functions	Resolution
208	EOS_UNKSVC	All	`P2init PwrMan` prior to using `PwrMan` library functions.
221	EOS_MNF	_os_pwr_link_ext() _os_pwr_link_plcy()	The module specified by id in the function syntax does not exist.
231	EOS_KWNMOD	_os_pwr_unlink_ext() _os_pwr_unlink_plcy()	Unlink from attached `PwrExt` module using `_os_pwr_unlink_<module>()` before linking to the named module.

_os_pwr_add()

Add an Entry in the Power State Table

Syntax

```
#include <PWRMAN/pwrman.h>


error_code _os_pwr_add(char id[PWR_IDLEN], pwr_level syslevel,
u_int32 priority, pwr_level devlevel, void *devpb);
```

Description

`_os_pwr_add()` creates an entry to the Power State Table for `PwrMan` and determines if the same ID is in the Device Registry Table. If so, the function and parameter fields for the entry in the Power State Table are set to the callback function and parameters identified in the Device Registry Table. If not, the function and parameter fields for the entry in the Power State Table are set to NULL.

`id` is the name of the entry. This is the common link between the Device Registry Table and the Power State Table. This field is a case-sensitive ASCII string.

`syslevel` is the power state level used for defining the state in which the entry is to be placed.

`priority` designates the order in which the callback function `devlevels` within the `syslevel` execute upon a state change. The lower the value, the higher the priority (e.g., 1 is highest priority).

`devlevel` is a parameter for the callback function that specifies which part of the callback function is executed. For example, the same callback function may be used for several power states of a device. `devlevel` can indicate which power state (`syslevel`) is used.

`devpb` is an optional parameter block for the callback function. `devpb` may specify additional details concerning which part of the callback function is executed. For example, when using a PCMCIA card, this parameter may be used for whatever device is plugged into the card at that time. If `devpb` is not in use, `devpb` must be filled with NULL.

Library

`pwrman.l`

See Also

`_os_pwr_remove()`

_os_pwr_callback()

Call the callback Function Directly

Syntax

```
#include <PWRMAN/pwrman.h>


error_code _os_pwr_callback(char id[PWR_IDLEN], pwr_level devlevel,
void *devpb);
```

Description

`_os_pwr_callback()` calls a callback function without doing a power state change.

`id` is the name of the entry. This is the common link between the Device Registry Table and the Power State Table. This field is a case-sensitive ASCII string.

`devlevel` is a parameter for the callback function that specifies which part of the callback function is executed. For example, the same callback function may be used for several power states of a device. `devlevel` can indicate which power state (`syslevel`) is used.

`devpb` is an optional parameter block for the callback function. `devpb` may specify additional details concerning which part of the callback function is executed. For example, when using a PCMCIA card, this parameter may be used for whatever device is plugged into the card at that time. If `devpb` is not in use, `devpb` must be filled with NULL.

Library

`pwrman.l`

_os_pwr_change()
Change Power State

Syntax

```
#include <PWRMAN/pwrman.h>


error_code _os_pwr_change(pwr_level syslevel);
```

Description

`_os_pwr_change()` changes the current power state pointer, `currlevel`, to the specified `syslevel` and calls the callback functions of each of the Power State Table entries in that `syslevel`.

If the global flag, `ret_on_err` within the `pwrman_globals` structure is set, then `os_pwr_change()` returns upon the first error and restores the previous power state. If `ret_on_err` is not set, `os_pwr_change()` returns the first error and continues with the power state change.

`syslevel` is the name of power state to which to transition.

Library

`pwrman.l`

_os_pwr_check()
Determine if PwrMan is Enabled

Syntax

```
#include <PWRMAN/pwrman.h>


error_code _os_pwr_check(char version[PWR_VERS_LEN]);
```

Description

`_os_pwr_check()` determines if `PwrMan` is installed in the system and, if so, returns the version number.

`version` is the version number of `PwrMan` upon returning `SUCCESS`. *version* is a character array buffer allocated by the caller and filled by `PwrMan`. If the `version` is NULL, then the buffer is not filled but the function returns successfully.

Library

`pwrman.l`

_os_pwr_copyglob()
Retrieves a Copy of the Internal PwrMan Globals

Syntax

```
#include <PWRMAN/pwrman.h>

error_code _os_pwr_copyglob(pwrman_globals *pwrglob);
```

Description

`_os_pwr_copyglob()` retrieves a copy of the internal `PwrMan` globals.

Library

`pwrman.l`

See Also

`_os_pwr_debug()`

_os_pwr_debug()
Retrieves a Pointer to the Internal PwrMan Globals

Syntax

```
#include <PWRMAN/pwrman.h>


error_code _os_pwr_debug(const pwrman_globals **pwrglob);
```

Description

`_os_pwr_debug()` passes a pointer to the `PwrMan` globals. This call is useful for debugging.

- `pwrglob` is a read-only pointer to `PwrMan` globals. .

`pwrglob` is constant structure. The fields in this structure should not be changed.

Library

`pwrman.l`

See Also

`_os_pwr_copyglob()`

_os_pwr_ev_notify()
Send a Notification Power Event

Syntax

```
#include <PWRMAN/pwrman.h>


error_code _os_pwr_ev_notify(Pwr_event pwrevent);
```

Description

`_os_pwr_ev_notify()` enables a driver or `SysIF` to pass information to `PwrPlcy` about a power state change that occurred or that needs to occur. For example, if a new device is plugged into the system, the driver could use `_os_pwr_ev_notify()` to notify `PwrPlcy` of the change in the system.

`pwrevent` is a parameter block of type `pwr_event` that holds vital information (such as how much power a device needs) for passing to `PwrPlcy`. `PwrPlcy` uses `pwrevent` to determine if additional changes must occur in the system. For example, if a new device drains a lot of power from the system, `PwrPlcy` may need to turn off another device or put some devices in lower power states.

Library

`pwrman.l`

See Also

`_os_pwr_ev_request()`

_os_pwr_ev_request()
Send Request Power Event

Syntax

```
#include <PWRMAN/pwrman.h>


error_code _os_pwr_ev_request(Pwr_event pwrevent);
```

Description

`_os_pwr_ev_request()` enables a driver or `SysIF` to pass information to `PwrPlcy` to request a change of power state. A state change occurs if `PwrPlcy` approves the request.

`pwrevent` is a parameter block of type `pwr_event` that holds vital information (such as how much power a device needs) for passing to `PwrPlcy`. `PwrPlcy` uses `pwrevent` to determine if additional changes must occur in the system. For example, if a new device drains a lot of power from the system, `PwrPlcy` may need to turn off another device or put some devices in lower power states.

Library

`pwrman.l`

See Also

`_os_pwr_ev_notify()`

_os_pwr_link_ext()
Link to a PwrExt Module

Syntax

```
#include <PWRMAN/pwrman.h>

error_code _os_pwr_link_ext(char id[PWR_IDLEN]);
```

Description

`_os_pwr_link_ext()` links to the `PwrExt` module specified by `id`. `id` is the name of the module to which to link.

Library

`pwrman.l`

See Also

`_os_pwr_unlink_ext()`

_os_pwr_link_plcy()
Link to a PwrPlcy Module

Syntax

```
#include <PWRMAN/pwrman.h>

error_code _os_pwr_link_plcy(char id[PWR_IDLEN]);
```

Description

`_os_pwr_link_plcy()` links to the `PwrPlcy` module specified by `id`. `id` is the name of the module to which to link.

Library

`pwrman.l`

See Also

`_os_pwr_unlink_plcy()`

_os_pwr_reg()
Add an Entry in the Device Registry Table

Syntax

```
#include <PWRMAN/pwrman.h>


error_code _os_pwr_reg( char id[PWR_IDLEN], error_code (*func)(void
*funcparam, pwr_level devlevel, void *devpb), void *funcparam,
Pwr_devcond devpwrdef);
```

Description

`_os_pwr_reg()` creates an entry in the Power State Table for `PwrMan` and determines if the same ID is in the Device Registry Table. If so, function and parameter fields for the entry in the Power State Table are set to the callback function and parameters identified in the Device Registry Table. If not, the function and parameter fields for the entry in the Power State Table are set to NULL.

`id` is the name of the entry. This is the common link between the Device Registry Table and the Power State Table. This field is a case-sensitive ASCII string.

```
error_code (*func)(void *funcparam, pwr_level devlevel, void* devpb)
```

`func` is the callback function that `PwrMan` calls when changing states.

`funcparam` is the parameter (or parameter block) for `func`.

`devlevel` is a parameter for the callback function that specifies which part of the callback function is executed. For example, the same callback function may be used for several power states of a device. `devlevel` can indicate which power state (`syslevel`) is used.

`devpb` is an optional parameter block for the callback function. `devpb` may specify additional details concerning which part of the callback function is executed. For example, when using a PCMCIA card, this parameter may be used for whatever device is plugged into the card at that time. If `devpb` is not in use, `devpb` must be filled with NULL.

`funcparam` is used for any device specific parameters that may be needed in the callback function, such as a device table entry pointer or a device static storage pointer.

`devpwrdef` is the pointer to a structure which defines the present energy condition of a device.

Library

`pwrman.l`

See Also

`_os_pwr_ev_unreg()`, `pwr_devcond structure`

_os_pwr_remove()

Delete an Entry in the Power State Table

Syntax

```
#include<PWRMAN/pwrman.h>


error_code _os_pwr_remove(char id[PWR_IDLEN], pwr_level syslevel,
u_int32 priority, pwr_level devlevel, void *devpb);
```

Description

`_os_pwr_remove()` removes an entry from the Power State Table for PwrMan and determines if the same ID is in the Device Registry Table. If so the function and parameter fields for the entry in the Device Registry Table are set to NULL.

`id` is the name of the entry. This is the common link between the Device Registry Table and the Power State Table. This field is a case-sensitive ASCII string.

`syslevel` is the name of power state from which to remove the entry.

`priority` of the entry as specified in `_os_pwr_add()`.

`devlevel` of the entry as specified in `_os_pwr_add()`.

`devpb` of the entry as specified in `_os_pwr_add()`.

Library

`pwrman.l`

See Also

`_os_pwr_add()`

_os_pwr_unlink_ext()
Unlink from the Attached PwrExt Module

Syntax

```
#include <PWRMAN/pwrman.h>

error_code _os_pwr_unlink_ext(void);
```

Description

`_os_pwr_unlink_ext()` unlinks from the attached `PwrExt` module.

Library

`pwrman.l`

See Also

`_os_pwr_link_ext()`

Errors

`EOS_MNF`	There is not a `PwrExt` module attached to unlink.

_os_pwr_unlink_plcy()
Unlink from the Attached PwrPlcy Module

Syntax

```
#include <PWRMAN/pwrman.h>

error_code _os_pwr_unlink_plcy(void);
```

Description

`_os_pwr_unlink_plcy()` unlinks from the attached `PwrPlcy` module.

Library

`pwrman.l`

See Also

`_os_pwr_ev_reg()`

Errors

`EOS_MNF`	There is not a `PwrPlcy` module attached to unlink.

_os_pwr_unreg()

Delete an Entry in the Device Registry Table

Syntax

```
#include <PWRMAN/pwrman.h>


error_code _os_pwr_unreg(char id[PWR_IDLEN], error_code (*func)(void
*funcparam, pwr_level devlevel, void *devpb), void *funcparam,
Pwr_devcond devpwrdef);
```

Description

`_os_pwr_unreg()` removes an entry from the Device Registry Table for `PwrMan` and checks to determine if the same ID is in the Power State Table. If so, the function and parameter fields for the entry in the Power State Table are set to NULL.

`id` is the name of the entry. This is the common link between the Device Registry Table and the Power State Table. This field is a case-sensitive ASCII string.

```
error_code (*func)(void *funcparam, pwr_level devlevel, void *devpb)
```

`func` of the entry as specified in `_os_pwr_reg()`.

`funcparam` of the entry as specified in `_os_pwr_reg()`.

`devlevel` of the entry as specified in `_os_pwr_reg()`.

`devpb` of the entry as specified in `_os_pwr_reg()`.

`funcparam` is used for any device specific parameters that may be needed in the callback function, such as a Device Registry Table entry pointer or a device static storage pointer.

`devpwrdef` is a pointer to a structure which defines the present energy condition of a device.

Library

`pwrman.l`

See Also

`_os_pwr_ev_reg()`, `pwr_devcond structure`

pwrstat Utility

The `pwrstat` utility enables viewing of some internal `PwrMan` structures, such as version label, Device Registry Table entries, and Power State Table entries. A description of the `pwrstat` utility and example dumps from the utility are provided in this section.

pwrstat

Enables Command Line, Pseudo Power Policy Control

Syntax

```
pwrstat [<opts>]
```

Description

`pwrstat` displays the Device Registry Table and Power State Table. `pwrstat` can also add or remove states from the Power State Table.

Options

`-?`	Display the options, function, and command syntax of `pwrstat`.
`-a=<id> <syslevel> <devlevel> <priority>`	Add a power state entry.
`-c=<syslevel>`	Change to system level.
`-d`	Display the Device Registry Table.
`-i`	`P2init` the `PwrMan` module.
`-le[=<module>]`	Link to the `PwrExt` module.
`-lp[=<module>]`	Link to `PwrPlcy` module.
`-p`	Display the Power State Table.
`-r=<id> <syslevel> <devlevel> <priority>`	Remove a power state entry.
`-v`	Print out `PwrMan` version.
`-ue`	Unlink from `PwrExt` module.
`-up`	Unlink from `PwrPlcy` module.

The `-a` and `-r` dynamically add or remove respectively a state from the Power State Table. Parameters to the `-a` and `-r` options are the same.

The `-c` option enables change of power state.

The `-d` option displays the Device Registry Table entries for devices registered with `PwrMan`.

The `-i` initializes the `PwrMan` module.

The `-le [=<module>]` option links to the `PwrExt` module specified by `<module>`. If only one `PwrExt` module exists in the Power Management Subsystem, the module name need not be specified. If a `PwrExt` module is linked in the Power Management Subsystem, it must be unlinked using the `-ue` option prior to linking a different `PwrExt` module.

The `-lp [=<module>]` option links to the `PwrPlcy` module specified by `<module>`. If only one `PwrPlcy` module exists in the Power Management Subsystem, the module name need not be specified. If a `PwrPlcy` module is linked

in the Power Management Subsystem, it must be unlinked using the `-up` option prior to linking a different `PwrPlcy` module.

The `-p` option displays the Power State Table entries for power states of the power aware system.

`pwrstat` does not display information for unregistered devices..

The `-r` option removes, from the Power State Table, the power state entry specified by `<id>, <syslevel>, <devlevel>,` and `<priority>` in the option.

The `-v` option displays the `PwrMan` version number.

Option Variables

`id` is the name of the entry. This is the common link between the Device Registry Table and the Power State Table. This field is a case-sensitive ASCII string.

`syslevel` indicates the current power state level.

`devlevel` is a parameter for the callback function that specifies which part of the callback function is executed. For example, the same callback function may be used for several power states of a device. `devlevel` can indicate which power state (`syslevel`) is used.

`priority` designates the order in which the callback function `devlevels` within the `syslevel` execute upon a state change. The lower the value, the higher the priority (e.g., 1 is highest priority).

The `pwrstat` display header lists the system name and the OS-9 version number.

Examples

This first example displays the Device Registry Table entries.

```
$ pwrstat -d
```

Motorola VME147 OS-9/68K V3.0

Id	C/B Ptr	Data Addr	Device Param
dev1	$004f048e	$004ed9c0	$00000000
dev2	$004f04d8	$004ed9c0	$00000000
dev3	$004f0520	$004ed9c0	$00000000
dev4	$004f056a	$004ed9c0	$00000000

The following example displays Power State Table entries.

```
$ pwrstat -p
```

Motorola VME147 OS-9/68K V3.0

Id	Call Back Ptr	Call Back Param
cpu	$00f203b0	0x00000010

The following example adds an entry to the Power State Table.

```
$ pwrstat -a=cpu 0x10 0x10 1 or pwrstat -acpu 0x10 0x10 1
```

The following example removes an entry from the Power State Table.

```
$ pwrstat -r=cpu 0x10 0x10 1 or pwrstat -rcpu 0x10 0x10 1
```

3 PwrPlcy

PwrPlcy is provided as generic source code that is customizable by OEMs as it is highly dependent on the target system hardware configuration as well as the specific type of power management strategy chosen for that system or project. As such, PwrPlcy, after establishing specific rules for state changing, is relatively static. Power aware applications communicate with PwrPlcy to interactively modify power management policy.

PwrPlcy is the high level mechanism responsible for:

- Power state change decision making
- Initialization of PwrMan power states
- Information in this chapter includes:
- Default Idle Loop
- Customizing the Idle Loop (OS-9)
- Customizing the Idle Loop (OS-9 for 68K)
- PwrPlcy Example

All PwrPlcy definitions, types, and function prototypes reside in the MWOS/SRC/SYSMODS/PWRMAN/PWRPLCY/<port> directory.

Default Idle Loop

To support low-overhead power management, OS-9 for 68K and OS-9 kernels have two system globals data areas: a context switch count area and an idle callout function area.

The context switch count is initialized to zero during kernel boot-up and incremented (to its maximum allowable value) during every context switch (in the kernel `currproc()` routine). A power policy provider may reset this field to zero, wait for an interval, then check it again to determine if context switches occurred (and thus the system wasn't entirely idle) during that interval.

The idle callout function area consists of a function pointer and function parameter. Both the idle callout function pointer and parameter are required. The idle callout function may consist of just a return and enter into a busy-wait loop. A power policy provider may use this idle callout function to prompt power state changes.

Customizing the Idle Function for OS-9

`PwrMan` may replace the kernel default idle function. Requirements of the idle loop are:

- Idle function called with interrupts masked
- Idle function called as a subroutine
- The following registers passed to the idle function:

  (`a6`) = system global data pointer

  (`sr`) = interrupts are masked

  (`a7`) = active system stack
- Upon returning to the kernel, the following register settings are required:

  (`a7`) = intact

  (`sr`) = interrupts are unmasked

  All other registers must be intact. The active system stack must not be switched if the system has an MSP/ISP stack set.
- Idle function must
- Honor the `B_NoStop` flag
- If a `STOP/LPSTOP` is performed, ensure that an accidental stack switch does not occur if the system is using the MSP/ISP stack set

Customizing the Idle Function for OS-9 for 68K

The following are requirements for an OS-9 for 68K idle loop.

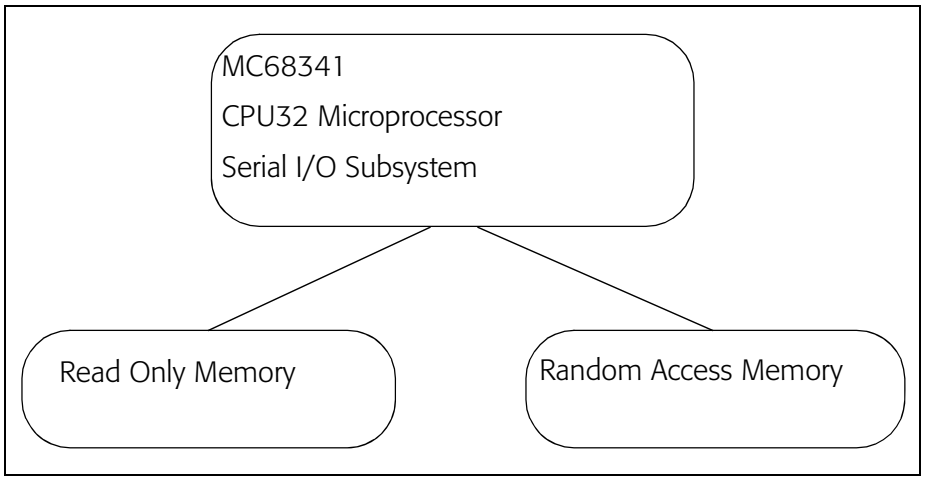
- Idle function called with interrupts masked
- Idle function must return with interrupts enabled

PwrPlcy Example

Our example system, shown in Figure 3-1 consists of an MC68341, ROM, and RAM. This system comprises the following:

- `SysIF` module to interface with the MC68341 microprocessor core and real-time clock
- `SCFDRVR` SCF device driver to interface with the MC68341 serial I/O subsystem
- `SPFDRVR` SPF device driver to interface with the MC68341 SPI communications subsystem
- `RAMDISK` NRF device driver to provide a RAM disk

Figure 3-1. Example System



After determining the hardware configuration and device interface configuration for the target system, the power policy writer must gather all device power management characteristics information, Figure 3-2. These device power management characteristics help determine the possible types of power management policies and are used to determine `PwrMan` Power State Table initialization.

Figure 3-2. Example System Characteristics

CPU (microprocessor interface) 0x10: on 0x20: sleep (LPSTOP w/ clocks on)
SCFDRVR (serial controller interface) 0x10: powered up
SPFDRVR (SPI-bus interface) 0xff: powered up
RAMDISK (RAM-disk interface) (no power management interface because this is a software driver)

The overall power management strategy chosen for this example is a simple, three-state policy, Figure 3-3. This policy consists of three power states: on, idle, and suspend as identified in *Table 3-1.*.

Table 3-1. State/Strategy Example

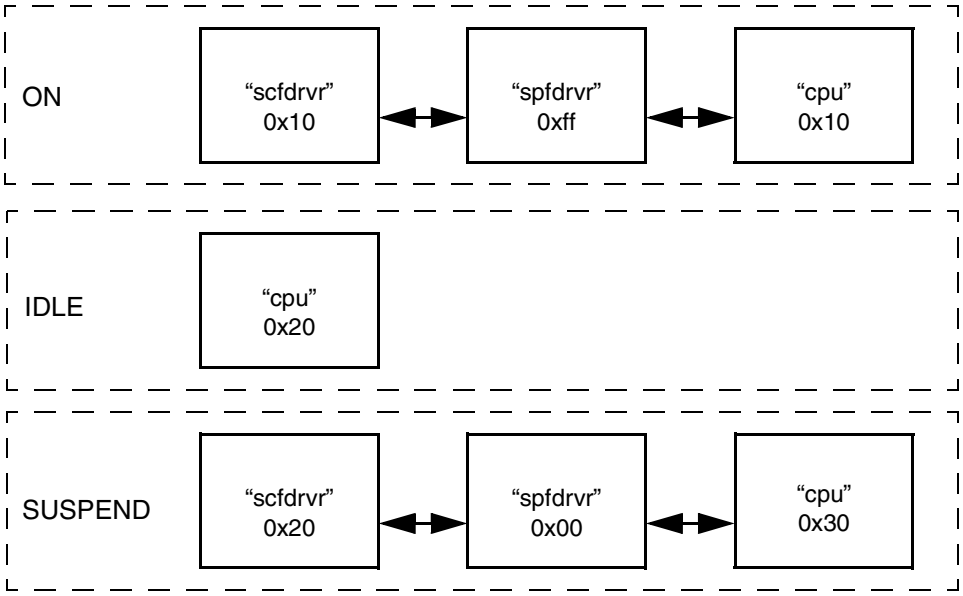
State	Strategy
on	All devices are powered up and the CPU (and all associated clock signals) is running.
idle	All devices are powered up but the CPU is in a low-powered stop (LPSTOP) state with clock signals activated.
suspend	All devices are powered down and the CPU is in LPSTOP with clock signals deactivated.

The RAM-disk driver is not specified anywhere in the power management state diagram; Since the RAM-disk is a software-only device, it does not need a power management interface in this system..

From the derived power state diagram and device power management characteristics, a designer can begin to implement the PwrPlcy module. First, PwrPlcy initializes PwrMan with a Power State Table which implements the desired power management policy, Figure 3-3.. This table specifies the order and the power option to pass to registered devices whenever the corresponding power state is entered.

PwrPlcy then places an idle intercept routine into the system globals to determine (by the kernel calling this idle routine) when the system is idle (when no active processes are running). Finally, PwrPlcy calls PwrMan to change to the current (initial) power state, ON.

Figure 3-3. Example Power State Table



From this point on, the power management policy is being applied to this system. The kernel calls the idle intercept routine when it detects that no applications are running in the system. PwrPlcy registers a timed alarm, say one minute, with the OS. If the alarm goes off and applications were not activated in the interim, a transition to the SUSPEND state occurs and PwrPlcy calls PwrMan to change the current power state to IDLE. PwrMan then calls the CPU registered callback routine with "0x20" which indicates that the CPU should be placed into a SLEEP state. The CPU module must also set a real-time clock interrupt prior to the next OS timed event (as found in the d_elapse field in the OS-9 system globals) and disable the ticker interrupt.

Finally, the CPU performs an LPSTOP with system clocks still running. At this point, the CPU blocks until the next interrupt. When the CPU comes out of the LPSTOP, it checks the system active process queue to determine if any active processes are pending. If there are no active processes pending, the CPU simply reenters LPSTOP, updating the real-time clock interrupt if needed. Otherwise, the CPU returns control back to PwrMan and then back to PwrPlcy. PwrPlcy calls PwrMan to change the current power state to ON and then returns control back to the kernel.

If the SUSPEND timed alarm goes off while still in the IDLE state, PwrPlcy changes the current power state to SUSPEND. This causes PwrMan to call SCFDRVR with 0x20 indicating that the SCF driver should power down, then SPFDRVR with 0x00 indicating that the SPF driver should power down, then CPU with 0x30 indicating that the CPU should be turned off. The CPU module acts similarly to the IDLE state except that it performs an LPSTOP with the system clocks turned off. Also similar to the IDLE state, any activated process causes PwrPlcy to change the current power state back to ON and returns control to the kernel.

In contrast to the previous simple example, a more complicated power management policy may require additional states, transitional states, or even dynamically changing states depending upon the power management strategy for the target system and the implementation of the PwrPlcy module. In a very complicated system, the PwrPlcy implementor must choose between a straightforward, but large, Power State Table encompassing every possible power state of the target system and a smaller, more complex, Power State Table dynamically updated by PwrPlcy.

pwrplcy.c

Source code for pwrplcy.c follows.

```
/*****************************************************************
**********
** Power Manager Policy subroutine module guts
**
*****************************************************************
**********
** Copyright 1995 by Microware Systems Corporation
**
** Copyright 2001 by RadiSys Corporation
**
** Reproduced Under License
**
**
**
** This source code is the proprietary confidential property of
**
** Microware Systems Corporation, and is provided to licensee
**
** solely for documentation and educational purposes. Reproduction,
**
** publication, or distribution in any form to any party other than
**
** the licensee is strictly prohibited.
**
*****************************************************************
**********
** Edition History:
**
```

```
** #   Date     Comments                                          By
**
** --- -------- ------------------------------------------------ --
------- **
**   1 06/14/95 creation                                         bat
**
**   5 12/21/95 ported to PwrMan (for 68328 board)               rmm
**
**   6 01/05/96 added in the subroutine module stuff             rmm
**
**   7 01/10/96 changed subroutine module interface to P2        rmm
**
**   8 01/15/96 split into 3 files & modules                     rmm
**
**   9 05/30/96 modified for PwrMan v1.0.Beta structures         bat
**
**  10 09/11/96 updated cast's for new sysglob structure         bat
**
**  11 01/12/97 modified INIT and added DEINIT to pwrplcy        ecm
**
**    01/17/97 <---------------- PwrMan v2.1 ---------------->
**
*************************************************************************
*********/


/*
** Header Files
*/

#define _SYSEDIT
#include <defs.h>


/*
** Constants
*/

/* power state table initialization array */
const devreg_init pwrstates[] = {
   /* SystemPowerStateIDLocalPowerStatePrioirty

   /* ON state */
   {   PWRPLCY_STATE_ON,"gfx",MPC821_PWR_LCD_ON,1},
   {   PWRPLCY_STATE_ON,"cpu",MPC821_PWR_CPU_NRMLHIGH,0xffffffff},

   /* IDLE state */
```

```
   {   PWRPLCY_STATE_IDLE,"cpu",MPC821_PWR_CPU_NRMLLOW,0xffffffff},

   /* SUSPEND state */
   {   PWRPLCY_STATE_SUSPEND,"gfx",MPC821_PWR_LCD_OFF,1},
   {   PWRPLCY_STATE_SUSPEND,"cpu",MPC821_PWR_CPU_DOZELOW,0xffffffff
},

   /* end-of-list */
   {0,0,0,0},
};

/*
** System-Call Entry Point
**
** Trying to do the following setup:
**      fpb   = parameter block containing subcode and version number
**      ldptr = Pwrman's global structure
*/
error_code PwrPlcy_entry(F_pwrman_pb pb, Pwrman_globals ldptr)
{
   error_code err;
   Localdata plcyptr = ldptr->pwrplcy_mem;

   switch(pb->subcode) {

      /* Initialize the power state table, set up system globals,
and
      ** go through power states
       */
      case PWRPLCY_INIT:
      {
         status_reg oldirq;
         Devreg_init pwrstates_ptr;

         /* get & initialize power policy globals */
         {
               u_int32 size = sizeof(localdata);
               u_int32 color = 0;

            /* allocate some memory for power policy use */
            if ((err=_os_srqmem(&size,(void**)&plcyptr,color)) !=
SUCCESS) {
               return(err);
            }

            /* initialize the newly acquired memory */
```

```
            ldptr->pwrplcy_mem = plcyptr;
        }

    /* load up the power state table */
    {
        int i;
        for (i=0; (pwrstates[i].id[0] != 0); i++) {
            if ((err = pwr_add(ldptr,
            (char*)pwrstates[i].id,
            pwrstates[i].syslevel,
            pwrstates[i].priority,
            pwrstates[i].devlevel,
            NULL)) != SUCCESS) {
            return(err);
            }
        }
    }

    /* change to our initial power state */
    if ((err = pwr_change(ldptr,START_STATE)) != SUCCESS) {
        return(err);
    }

    /* setup ourselves to be the kernel's idle function */
    oldirq = irq_save(); irq_disable();
    {
        /* save old, and set d_switches to 0 so we can see if
        ** it increments indicating there`s active processes
        ** in the system
        */
        plcyptr->old_d_switches = ldptr->sglobptr->d_switches;
        ldptr->sglobptr->d_switches = 0;

        /* get the current tick count to see if we can go idle */
        plcyptr->d_ticks = ldptr->sglobptr->d_ticks;

        /* save old, replace kernel's idle function parameters
with our own */
        plcyptr->old_d_idledata = ldptr->sglobptr->d_idledata;
        ldptr->sglobptr->d_idledata = ldptr;

        /* save old, and replace kernel's idle function with our
own */
        plcyptr->old_d_idle = ldptr->sglobptr->d_idle;
        ldptr->sglobptr->d_idle = idle;
    }
```

```
   irq_restore(oldirq);

   return(SUCCESS);

} /* PWRPLCY_INIT */

case PWRPLCY_DEINIT:
{
   status_reg oldirq;
   Devreg_init pwrstates_ptr;

   u_int32 size;

   /* do our best to remove the pwrplcy-loaded state table */
   {
      int i;
      for (i=0; (pwrstates[i].id[0] != 0); i++) {
         if ((err = pwr_remove(ldptr,
         (char*)pwrstates[i].id,
         pwrstates[i].syslevel,
         pwrstates[i].priority,
         pwrstates[i].devlevel,
         NULL)) != SUCCESS) {
         /* throw away errors */
         return(SUCCESS);
         }
      }
   }

   /* change to the startup power state */
   if ((err = pwr_change(ldptr, 0x00)) != SUCCESS) {
      return(err);
   }

   /* put the kernel's idle function back */
   oldirq = irq_save(); irq_disable();
   {
      /* put d_switches back */
      ldptr->sglobptr->d_switches = plcyptr->old_d_switches;

      /* put kernels idle function parameters back */
      ldptr->sglobptr->d_idledata = plcyptr->old_d_idledata;

      /* put kernel's idle function back */
      ldptr->sglobptr->d_idle = plcyptr->old_d_idle;
```

```
            }
            irq_restore(oldirq);

            {
               /* get size of memory */
               size = sizeof(localdata);

               /* deinitialize the pwrplcy memory */
                 ldptr->pwrplcy_mem = NULL;

               /* deallocate memory from power policy use */
               if ((err=_os_srtmem(size,(void*)plcyptr)) != SUCCESS) {
                  return(err);
               }

            }
            return(SUCCESS);

         } /* PWRPLCY_DEINIT */

         /* go to the ON state */
         case PWRPLCY_STATE_ON:
         {
            /* change to ON state */
            return(pwr_change(ldptr,PWRPLCY_STATE_ON));

         } /* PWRPLCY_STATE_ON */

         /* go to the IDLE state */
         case PWRPLCY_STATE_IDLE:
         {
            /* change to IDLE state */
            return(pwr_change(ldptr,PWRPLCY_STATE_IDLE));

         } /* PWRPLCY_STATE_IDLE */

         /* go to the SUSPEND state */
         case PWRPLCY_STATE_SUSPEND:
         {
            /* change to SUSPEND state */
            return(pwr_change(ldptr,PWRPLCY_STATE_SUSPEND));

         } /* PWRPLCY_STATE_SUSPEND */

      } /* switch */
```

```
   /* if the call is not "switched" out, return unknown service code
*/
   return(EOS_UNKSVC);

} /* PwrPlcy_entry */


/* Own idle routine that will replace the kernel's idle routine.
Assume that
** the kernel has masked interrupts.
*/
void idle(void)
{
   Sysglobs sglobptr;
   Pwrman_globals ldptr;
   Localdata plcyptr;

   /* get global pointers */
   sglobptr = get_static();
   ldptr = (void*)(sglobptr->d_idledata);
   plcyptr = ldptr->pwrplcy_mem;

   /* check if the correct amount of time has gone by before going
idle */
   if (sglobptr->d_ticks >= (plcyptr->d_ticks+IDLE_DELAY)) {

      /* if d_switches is 0, we're going idle */
      if ((sglobptr->d_switches) == 0) {

         /* change to SUSPEND state
         ** This change will place the CPU in a "freeze" mode; An
         ** interrupt or real-time clock alarm will wake it up
         ** and finally return from this call; Thus, we need to
         ** change back to ON after this call returns.
         */
         (void)pwr_change(ldptr,PWRPLCY_STATE_SUSPEND);
         (void)pwr_change(ldptr,PWRPLCY_STATE_ON);
      }

      /* set d_switches to 0 so we can see if it increments
      ** indicating there`s active processes in the system
      */
      ldptr->sglobptr->d_switches = 0;

      /* get the current tick count to see if we can go idle */
```

```
        plcyptr->d_ticks = ldptr->sglobptr->d_ticks;
    }

    /* re-enable interrupts before leaving back to kernel */
    irq_enable();

    return;
}

/*
** Local "_os_pwr_add()" binding w/ direct access to PwrMan
** (eg, no system call)
*/
error_code pwr_add(Pwrman_globals ldptr, char id[PWR_IDLEN],
pwr_level syslevel, u_int32 priority, pwr_level devlevel, void*
devpb)
{
    f_pwrman_add_pb pb;

    /* set-up parameter block */
    pb.pwrcom.subcode = PWRMAN_STATEADD;
    pb.pwrcom.edition = PWR_PB_EDITION;
    pb.id = id;
    pb.syslevel = syslevel;
    pb.priority = priority;
    pb.devlevel = devlevel;
    pb.devpb = devpb;

    /* call PwrMan directly to perform "system call" */
    return((*ldptr->pwrman_func)((F_pwrman_pb)(&pb),ldptr));
}

/*
** Local "_os_pwr_remove()" binding w/ direct access to PwrMan
** (eg, no system call)
*/
error_code pwr_remove(Pwrman_globals ldptr, char id[PWR_IDLEN],
pwr_level syslevel, u_int32 priority, pwr_level devlevel, void*
devpb)
{
    f_pwrman_remove_pb pb;

    /* set-up parameter block */
    pb.pwrcom.subcode = PWRMAN_STATEREMOVE;
    pb.pwrcom.edition = PWR_PB_EDITION;
    pb.id = id;
```

```
    pb.syslevel = syslevel;
    pb.priority = priority;
    pb.devlevel = devlevel;
    pb.devpb = devpb;

    /* call PwrMan directly to perform "system call" */
    return((*ldptr->pwrman_func)((F_pwrman_pb)(&pb),ldptr));
}

/*
** Local "_os_pwr_change()" binding w/ direct access to PwrMan
** (eg, no system call)
*/
error_code pwr_change(Pwrman_globals ldptr, pwr_level syslev)
{
    f_pwrman_change_pb pb;

    /* set-up parameter block */
    pb.pwrcom.subcode = PWRMAN_CHANGE;
    pb.pwrcom.edition = PWR_PB_EDITION;
    pb.syslevel = syslev;

    /* call PwrMan directly to perform "system call" */
    return((*ldptr->pwrman_func)((F_pwrman_pb)(&pb),ldptr));
}
```

4 PwrExt

PwrExt is a system-state subroutine that may override PwrMan. During initialization, PwrMan looks for both PwrExt and PwrPlcy. If either or both are in memory during initialization, PwrMan links to PwrExt first and PwrPlcy second.

For more information, see Chapter 2 PwrMan.

PWREXT_INIT and PWRPLCY_INIT run at initialization. These should contain an initialization code to run. If an initialization code is not necessary, return (SUCCESS).

Furthermore, if PwrExt is found in the system upon initializing PwrMan, pwrext_func in the pwrman_globals structure is initialized to the address of the PwrExt entry point. If a PwrExt module is not in the system upon initializing PwrMan, pwrext_func is null. When an F$PwrMan call occurs, the function held in pwrman_globals pwrman_func is called. Thus, if PwrExt is in the system and its entry point is in pwrman_func, any PwrMan call can be replaced by a PwrExt call.

Figure 4-1 and Figure 4-2 illustrate flow diagrams with and without PwrExt in the system, respectively.

In the PwrExt initialization routine (PWREXT_INIT), the following occurs:

- The PwrMan entry point (pwrman_entry) is saved in PwrExt static storage (pwrext_mem) and is replaced by pwrext_entry.

To customize the _os_pwr_change() system call, the PWRMAN_CHANGE subcode in PwrExt is used to override the PwrMan PWRMAN_CHANGE subcode. PwrExt should save the PwrMan entry point and call it as a default case for calls that are not replaced within PwrExt.

```
error_code Pwrext_entry(F_pwrman_pb pb) {
   switch(pb->subcode) {
      case PWREXT_INIT:
      SavePwrmanEntry(pb);
      ReplacePwrmanEntry(pb);
      }
      case PWRMAN_CHANGE:
      {
      MyCustomPwrChange(pb);
      }
      default:
      {
      CallPwrmanEntry(pb);
   }
```

Figure 4-1. Flow Diagram with PwrExt

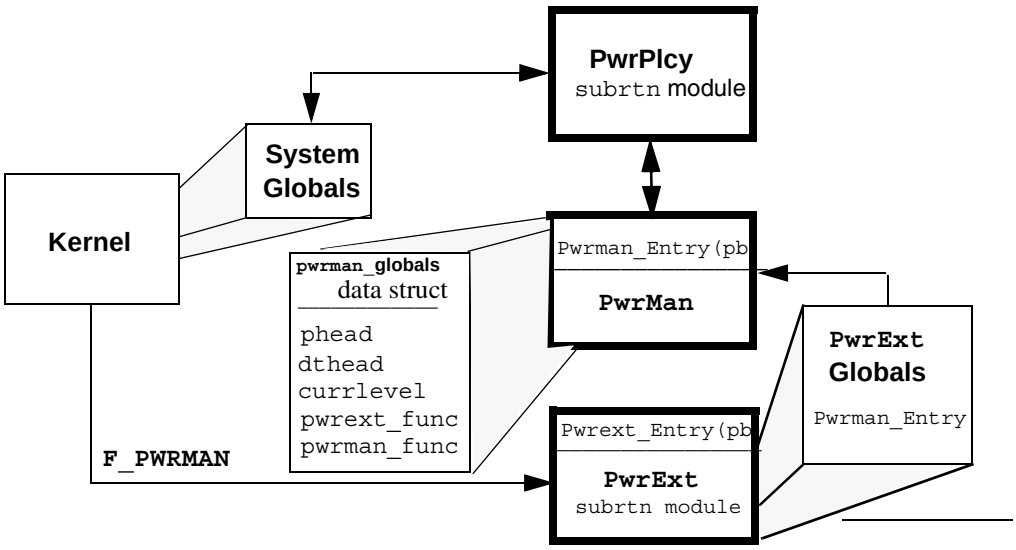
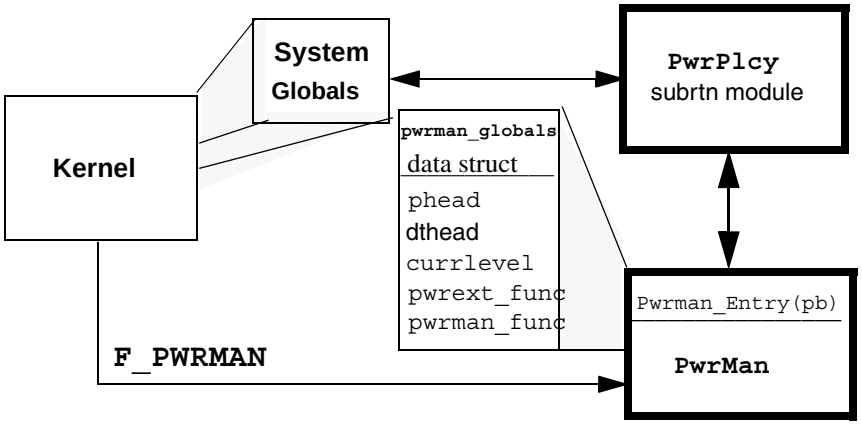


Figure 4-2. Flow Diagram Without PwrExt



pwrext.c

```
/*****************************************************************
**********
** Power Manager Extensions entry points
**
*****************************************************************
**********
** Copyright 1995 by Microware Systems Corporation
**
** Copyright 2001 by RadiSys Corporation
**
** Reproduced Under License
**
```

```
**
**
** This source code is the proprietary confidential property of
**
** Microware Systems Corporation, and is provided to licensee
**
** solely for documentation and educational purposes. Reproduction,
**
** publication, or distribution in any form to any party other than
**
** the licensee is strictly prohibited.
**
*******************************************************************
**********
** Edition History:
**
** #   Date     Comments                                          By
**
** --- -------- ------------------------------------------------- --
------- **
**   1 06/14/95 creation                                         bat
**
**   5 12/21/95 ported to PwrMan (for 68328 board)               rmm
**
**   6 01/05/96 added in the subroutine module stuff             rmm
**
**   7 01/10/96 changed subroutine module interface to P2        rmm
**
**   8 01/15/96 split into 3 files & modules                    rmm
**
**   9 05/31/96 updated for PwrMan v1.0.Beta structures          bat
**
**  10 09/11/96 updated cast's for new sysglob structure        bat
**
**  11 01/12/97 added DEINIT routine for pwrman detach          ecm
**
**    01/17/97 <--------------- PwrMan v2.1 --------------->
**
*******************************************************************
*********/


/*
** Header Files
*/

#define _SYSEDIT
#include <defs.h>
```

```
/* Trying to do the following setup:
**      fpb   = parameter block containing subcode and version number
**      ldptr = Pwrman's global structure
*/

/*
** System-Call Entry Point
*/
error_code PwrExt_entry(F_pwrman_pb pb, Pwrman_globals ldptr)
{
   error_code err;
   Localdata extptr = ldptr->pwrext_mem;

   switch(pb->subcode) {

      /* Initialize pwrext module - srqmem() some memory for globals
      ** to be stored in.  Store Pwrman's entry point in this area to
      ** be called as a default case.
      */
      case PWREXT_INIT:
      {
         u_int32 size = sizeof(localdata);
         u_int32 color = 0;

         /* if we need more than 4 bytes for local "global"
variables,
         ** then we'll need to srqmem some memory for PwrExt use
         */

         /* assume that the current value in entrycb is PwrMan's
         ** entry point.  srqmem() some memory and grab it to use
         ** as a default case for any calls not customized by PwrExt
         */
         if ((err=_os_srqmem(&size,(void**)&extptr,color)) !=
SUCCESS) {
            return(err);
         }

         /* initialize the newly acquired memory & install ourselves
         ** as the default PwrMan entry point, saving the previous
         ** default in our globals
         */
         extptr->pwrman_func = ldptr->pwrman_func;
         ldptr->pwrext_mem = extptr;
         ldptr->pwrman_func = PwrExt_entry;
```

```
            return(SUCCESS);

         } /* PWREXT_INIT */


         case PWREXT_DEINIT:
         {
            u_int32 size = sizeof(localdata);

            /* reinstall the saved pointer as the default PwrMan */
            /* entry point, and null the pwrext_mem pointer out */

            ldptr->pwrman_func = extptr->pwrman_func;
            ldptr->pwrext_mem = NULL;

            /* return memory to system */

            if ((err=_os_srtmem(size,(void*)extptr)) != SUCCESS) {
               return(err);
            }


            return(SUCCESS);

         } /* PWREXT_DEINIT */


#if 0
         /* This is where the customized change function will go.  I'm
just
         ** passing back a bogus error to make sure I hit the function.
         */
         case PWRMAN_CHANGE:
         {
            return(999);

         } /* PWRMAN_CHANGE */
#endif

      } /* switch */


      /* if the call is not "switched" out, call PwrMan's entry point,
*/
```

```
    /* and have him deal with it */

    return((*extptr->pwrman_func)(pb, ldptr));

} /* PwrExt_entry */
```

5 SysIF

SysIF is provided as generic source code by processor family. SysIF can be customized by OEM's as it is a system-specific interface for the microprocessor and other hardware components without device driver interfaces.

SysIF implements power management functions and provides feedback to PwrPlcy about a device's tactical power management issues (e.g., it can't shut down right now) in the absence of a power aware device driver. SysIF enables PwrPlcy to reference the power levels of the CPU (such as normal operation, throttled, and deep-sleep) just as it references other device-driver components (such as a serial driver or ethernet driver).

During SysIF initialization, SysIF registers a power callback routine with PwrMan which PwrPlcy may then reference in its Power State Table initialization. SysIF does not install any system calls by default. However, a user-defined system call may be used if system components other than PwrMan or PwrPlcy require access to data in SysIF.

For larger power managed systems, several SysIF types may be needed. For example, the system could have a CPU P2 module that controls all the CPU-specific operations and another SysIF module that controls a smart battery.

Custom header files may be defined. Examples reside in MWOS/SRC/SYSMODS/SYSIF/<board>.

CPU and real time clock functions of a sample SysIF, based on an MPC821, follows.

cpu.c

```
/*************************************************************************
**********
** ADS821 System Module
**
*************************************************************************
**********
** Copyright 1995-1997 by Microware Systems Corporation
**
** Copyright 2001 by RadiSys Corporation
**
** Reproduced Under License
**
**
**
** This source code is the proprietary confidential property of
**
** Microware Systems Corporation, and is provided to licensee
**
** solely for documentation and educational purposes. Reproduction,
**
** publication, or distribution in any form to any party other than
**
** the licensee is strictly prohibited.
**
*************************************************************************
**********
** Edition History:
**
** #   Date     Comments                                          By
**
** --- -------- ------------------------------------------------- --
------- **
**   1 02/01/96 Creation                                         jgm
**
**   2 04/02/96 Ported to use with the ADS821 PPC board          jgm
**
**   3 06/04/96 Cleaned up to ship out with the Beta release     jgm
**
**   4 01/16/97 Modified to work with MPC821 Rev A chip          ecm
**
**    01/17/97 <--------------- PwrMan v2.1 --------------->
**
*************************************************************************
*********/

/*
```

```
** Header Files
*/

#include <defs.h>

/*
** Definitions
*/

#define CSRCBIT (1<<10) /* it is actually bit 21, but going in
reverse logic */
                /* it is the CSRC bit in the PLPCRC register */

/*
** Initialize the CPU
*/
error_code cpu_init(Localdata ldptr)
{
   char     device[PWR_IDLEN] = "cpu";  /* name of the device to
register */
   error_codeerr; /* error code temp variable */
   Pwr_devconddevpwrdef=NULL; /* Device Energy Condition Definition,
NULL for this Example */

   /* initialize the hardware */
/* ldptr->regs = REGBASE; /* Set the actual port address */

   /* Tell PwrMan to call us on power-down */
   err = _os_pwr_reg(device,dr_pwrman,ldptr,devpwrdef);
   if (err == SUCCESS){
      /* PwrMan in system and successful -- continue */
   }
   else if (err == EOS_UNKSVC) {
      /* no PwrMan in system -- continue */
   } else {
      /* PwrMan in system and unsuccessful -- return */
       return(err);
   }
   return(SUCCESS);
}


/*
** De-Initialize the CPU
*/
error_code cpu_term(Localdata ldptr)
```

```
{
   char     device[PWR_IDLEN] = "cpu"; /* name of the device to
register */
   Pwr_devconddevpwrdef=NULL; /* Device Energy Condition Definition,
NULL for this Example */

   /* Tell PwrMan to forget our previous registration */
   (void)_os_pwr_unreg(device,dr_pwrman,ldptr,devpwrdef);
   return(SUCCESS);
}


/*
** Function to switch the CPU to the ON state(Normal High)
*/
error_code cpu_nrmlhigh(Localdata ldptr)
{
   status_reg oldirq;
   u_int16 state = MPC821_PWR_CPU_NRMLHIGH; /* normal high mode */

   oldirq = irq_maskget(); /* mask irqs */
   {
      ldptr->regs->irq_regs.simask &= ~SIMASK_RTC; /* disable the
RTC interrupt */
      LOW(ldptr->regs->pll_regs.plprcr,CSRCBIT); /* clear the CSRC
bit */
   }
   irq_restore(oldirq);/* unmask irqs */

   return(SUCCESS); /* Return a success */
}


/*
** Function to switch the CPU to the ON(LOW) state(Normal Low)
*/
error_code cpu_nrmllow(Localdata ldptr)
{
   status_reg oldirq;
   u_int16 state = MPC821_PWR_CPU_NRMLLOW; /* normal low mode */

   oldirq = irq_maskget(); /* mask irqs */
   {
      ldptr->regs->irq_regs.simask |= SIMASK_RTC; /* unmask the RTC
bit to enable the RTC interrupt */
      ldptr->regs->pll_regs.sccr |= (DFNLSET | POW_ENABLE); /* Set
```

```
to divide by 4 */
      /* call common function */     /* and set the PRQEN bit to
switch to */
      (void)common(ldptr,state);  /* the high frequency(as defined
by the */
                  /* DFNH bits) after an interrupt */
   }
   irq_restore(oldirq);    /* unmask irqs */

   LOW(ldptr->regs->pll_regs.plprcr,CSRCBIT); /* clear the CSRC bit,
go back to DFNH */
   ldptr->regs->pll_regs.sccr &= ~DFNLSET; /* Return to the default
*/
   ldptr->regs->irq_regs.simask &= ~SIMASK_RTC; /* disable the RTC
interrupt */

   return(SUCCESS); /* Return a success */
}


/*
** Function to switch the CPU to the DOZE HIGH state
*/
error_code cpu_dozehigh(Localdata ldptr)
{
   status_regoldirq;
   u_int16state = MPC821_PWR_CPU_DOZEHIGH; /* doze high mode */

   oldirq = irq_maskget();     /* mask irqs */
   {
      ldptr->regs->irq_regs.simask |= SIMASK_RTC; /* unmask the RTC
bit to enable the RTC interrupt */
      ldptr->regs->pll_regs.sccr |= (DFNHSET | POW_ENABLE); /* Set
to divide by 2 */
      /* call common function */                          /* and
set the PRQEN bit to switch to */
      (void)common(ldptr,state);  /* the high frequency(as defined
by the */
                  /* DFNH bits) after an interrupt */
   }
   irq_restore(oldirq); /* unmask irqs */

   ldptr->regs->pll_regs.sccr &= ~DFNHSET; /* Return to the default
*/
   ldptr->regs->irq_regs.simask &= ~SIMASK_RTC; /* disable the RTC
interrupt */
```

```
   return(SUCCESS); /* Return a success */
}


/*
** Function to switch the CPU to the DOZE LOW state
*/
error_code cpu_dozelow(Localdata ldptr)
{
   status_reg  oldirq;
   u_int16 state = MPC821_PWR_CPU_DOZELOW; /* doze low mode */

   oldirq = irq_maskget();     /* mask irqs */
   {
      ldptr->regs->irq_regs.simask |= SIMASK_RTC; /* unmask the RTC
bit to enable the RTC interrupt */
      ldptr->regs->pll_regs.sccr |= (DFNLSET | POW_ENABLE); /* Set
to divide by 4 */
      /* call common function */  /* and set the PRQEN bit to switch
to */
      (void)common(ldptr,state);  /* the high frequency(as defined
by the */
                  /* DFNH bits) after an interrupt */
   }
   irq_restore(oldirq); /* unmask irqs */

   LOW(ldptr->regs->pll_regs.plprcr,CSRCBIT); /* clear the CSRC bit,
go back to DFNH */
   ldptr->regs->pll_regs.sccr &= ~DFNLSET; /* Return to the default
*/
   ldptr->regs->irq_regs.simask &= ~SIMASK_RTC; /* disable the RTC
interrupt */

   return(SUCCESS); /* Return a success */
}

/* WARNING!!!!!!!!! WARNING!!!!!!!!!! WARNING!!!!!!!!!!

Only use the sleep mode if you have SRAM or you can refresh DRAM when
you
power down because sleep, deep sleep, and power down modes shut off
the memory
controller, which means you will lose what you have in memory if you
don't
refresh it somehow.  These next three functions are optional only if
you have
a way to keep memory alive and go to one of these states.
```

```
*/


/*
** Function to switch the CPU to the SLEEP state
** This is only here if you have some method of preserving memory!
*/
error_code cpu_sleep(Localdata ldptr)
#if 0
{
   status_regoldirq;
   u_int16state = MPC821_PWR_CPU_SLEEP; /* sleep mode */

   oldirq = irq_maskget();/* mask irqs */
   {
      ldptr->regs->irq_regs.simask |= SIMASK_RTC; /* unmask the RTC
bit to enable the RTC interrupt */

      /* Add your code here! */

      /* call common routine */
      (void)common(ldptr,state);
   }
   irq_restore(oldirq); /* unmask irqs */

   ldptr->regs->irq_regs.simask &= ~SIMASK_RTC; /* disable the RTC
interrupt */

   return(SUCCESS);
}
#else
{
   return(EOS_UNKSVC);
}
#endif


/*
** Function to switch the CPU to the DEEP SLEEP state
** This is only here if you have some method of preserving memory!
*/
error_code cpu_deep_sleep(Localdata ldptr)
#if 0
{
   status_reg  oldirq;
   u_int16 state = MPC821_PWR_CPU_DEEP_SLEEP; /* deep sleep mode */
```

```
   oldirq = irq_maskget(); /* mask irqs */
   {
      ldptr->regs->irq_regs.simask |= SIMASK_RTC; /* unmask the RTC
bit to enable the RTC interrupt */

      /* Add your code here! */

      /* call common routine */
      (void)common(ldptr,state);
   }
   irq_restore(oldirq); /* unmask irqs */

   ldptr->regs->irq_regs.simask &= ~SIMASK_RTC; /* disable the RTC
interrupt */

   return(SUCCESS);
}
#else
{
   return(EOS_UNKSVC);
}
#endif


/*
** Function to switch the CPU to the POWER DOWN state
** This is only here if you have some method of preserving memory!
*/
error_code cpu_pwrdwn(Localdata ldptr)
#if 0
{
   status_reg  oldirq;
   u_int16 state = MPC821_PWR_CPU_PWRDWN; /* power down mode */

   oldirq = irq_maskget(); /* mask irqs */
   {
      ldptr->regs->irq_regs.simask |= SIMASK_RTC; /* unmask the RTC
bit to enable the RTC interrupt */

      /* Add your code here! */

      /* call common routine */
      (void)common(ldptr,state);
   }
   irq_restore(oldirq); /* unmask irqs */
```

```
   ldptr->regs->irq_regs.simask &= ~SIMASK_RTC; /* disable the RTC
interrupt */

   return(SUCCESS);
}
#else
{
   return(EOS_UNKSVC);
}
#endif


/*
** Entry point for the call back function
*/
error_code dr_pwrman(void *ldptr, pwr_level pwrlvl, void *devpb)
{
   switch (pwrlvl){ /* switch to the level requested */

      /* cpu to normal high state */
      case MPC821_PWR_CPU_NRMLHIGH:
      {
         return(cpu_nrmlhigh((Localdata)ldptr));
      }

      /* cpu to normal low state */
      case MPC821_PWR_CPU_NRMLLOW:
      {
         return(cpu_nrmllow((Localdata)ldptr));
      }

      /* cpu to doze high state */
      case MPC821_PWR_CPU_DOZEHIGH:
      {
         return(cpu_dozehigh((Localdata)ldptr));
      }

      /* cpu to doze low state */
      case MPC821_PWR_CPU_DOZELOW:
      {
         return(cpu_dozelow((Localdata)ldptr));
      }

      /* cpu to sleep state */
      case MPC821_PWR_CPU_SLEEP:
```

```
            {
               return(cpu_sleep((Localdata)ldptr));
            }

            /* cpu to deep sleep state */
            case MPC821_PWR_CPU_DEEP_SLEEP:
            {
               return(cpu_deep_sleep((Localdata)ldptr));
            }

            /* cpu to power down state */
            case MPC821_PWR_CPU_PWRDWN:
            {
               return(cpu_pwrdwn((Localdata)ldptr));
            }

            /* cpu driver to terminate */
            case MPC821_PWR_CPU_TERM:
            {
               return(cpu_term((Localdata)ldptr));
            }
         }
         return(EOS_UNKSVC);
      }


      /*
      ** CPU-Management common routine
      **
      ** ASSUME: interrupts are masked up to maximum level before calling
      common()!
      */
      void common(Localdata ldptr, u_int16 state)
      {
         u_int32 sec = ldptr->sysglob->d_elapse / ldptr->sysglob-
      >d_tcksec; /* compute the # */
         u_int32 active;/* of seconds to sleep for.  d_elapase */
         u_int32 statereg;/* is the shortest timed sleep in the */
         status_reg svirq;/* sleep queue & is stored as ticks */

         /* check for minimum sleep period */
         if ((ldptr->sysglob->d_elapse == 0) || (sec > MINSLEEP)) {

            /* set real-time clock alarm interrupt for any timed sleeps */
            if (ldptr->sysglob->d_elapse > 0) {
```

```
            /* compute real-time clock wake-up time */
            sec -= (MINSLEEP-1);

            (void)currentime(ldptr); /* get the current time from the
hardware */

            /* Sleep for a maximum of one day */
            if (sec >= MAXSEC) {
               sec = ((MAXSEC-1) + ldptr->sec);

               /* start real-time clock alarm interrupt */
               if (rtc_alarm_set(ldptr,sec) != SUCCESS) {
                  /* can't start alarm interrupt */
                  return;
               }
            } else {
               sec += ldptr->sec;

               /* start real-time clock alarm interrupt */
               if (rtc_alarm_set(ldptr,sec) != SUCCESS) {
                  /* can't start alarm interrupt */
                  return;
               }
            }
         }

         /* turn off ticker(TB and DEC) and PIT module if it is running
*/
         ldptr->regs->tbr_regs.tbscr &= ~TBR_ENABLE; /* this will be
running because this is our ticker module */
         ldptr->regs->pit_regs.piscr &= ~PIT_ENABLE; /* need to only
shut off if it is running, OPTIONAL */

         /* only power down for a maximum of 24 hours */
         if (ldptr->sysglob->d_elapse == 0){

            /* Get the current time and save it in static storage */
            (void)currentime(ldptr);

            /* power down for a Maximum of 24 hours */
            sec = ((MAXSEC-1) + ldptr->sec);
            /* wake up after 24 hours */
            if (rtc_alarm_set(ldptr,sec) != SUCCESS){
               /* can't start alarm interrupt */
               return;
            }
```

```
         /* call the check routine to see if there are any active
processes */
         if ((active = check(ldptr)) == 0){

            /* Check to see if the status bits are set or not and
clear them if they are */
            if (((ldptr->regs->pll_regs.plprcr & PLL_TEXPS) != 0) &&
((ldptr->regs->pll_regs.plprcr & PLL_TMIST) != 0)) {
               ldptr->regs->pll_regs.plprcr |= (PLL_TEXPS |
PLL_TMIST);
            }

            /* save the mask level and then enable interrupts */
            svirq = irq_save(); irq_enable();
            {

/* When using the DFNL, there are several issues which need
addressed.  One is
when you divide by 2 through divide by 32, the cpu acts as normal.
When you go
to one of the LOW modes, the serial port(keyboard) interrupt will
wake you up.  When
you divide by 64, you cannot wakeup from the serial port
interrupt(can only assume some
hardware problem).  When you use the divide by 256, it will not wake
up from a serial
port interrupt and it will also give a 244 error, which means a read
error from the
serial port.  So there seems to be a problem with trying to use the
64 or 256 values.
Example, use only 2,4,8,16&32.
*/

               if (state == MPC821_PWR_CPU_NRMLLOW){
               HIGH(ldptr->regs->pll_regs.plprcr,CSRCBIT); /* set
the CSRC bit */
               }
               if (state == MPC821_PWR_CPU_DOZEHIGH){
               ldptr->regs->pll_regs.plprcr |= PLL_HIDOZE; /* go to
a high doze mode */
               }
               if (state == MPC821_PWR_CPU_DOZELOW){
               ldptr->regs->pll_regs.plprcr |= (PLL_LODOZE |
PLL_CSRC); /* go to a low doze mode */
               }
```

```
/******* OPTIONAL for the sleep, deep sleep, power down modes
********/
                if (state == MPC821_PWR_CPU_SLEEP){
                ldptr->regs->pll_regs.plprcr |= PLL_SLEEP; /* go to a
sleep mode */
                }
                if (state == MPC821_PWR_CPU_DEEP_SLEEP){
                ldptr->regs->pll_regs.plprcr |= PLL_DEEP_SLEEP; /* go
to a deep sleep mode */
                }
                if (state == MPC821_PWR_CPU_PWRDWN){
                ldptr->regs->pll_regs.plprcr |= PLL_PWRDWN; /* Power
down */
                }
/******* OPTIONAL for the sleep, deep sleep, power down modes
********/

            }
            irq_restore(svirq); /* restore mask */
         }
      } else {
         /* call the check routine to see if there are any active
processes */
         if ((active = check(ldptr)) == 0){

            /* Check to see if the status bits are set or not and
clear them if they are */
            if (((ldptr->regs->pll_regs.plprcr & PLL_TEXPS) != 0) &&
((ldptr->regs->pll_regs.plprcr & PLL_TMIST) != 0)) {
               ldptr->regs->pll_regs.plprcr |= (PLL_TEXPS |
PLL_TMIST);
            }

            /* save the mask level and then enable interrupts */
            svirq = irq_save(); irq_enable();
            {

/* When using the DFNL, there are several issues which need
addressed.  One is
when you divide by 2 through divide by 32, the cpu acts as normal.
When you go
to one of the LOW modes, the serial port(keyboard) interrupt will
wake you up.  When
you divide by 64, you cannot wakeup from the serial port
interrupt(can only assume some
hardware problem).  When you use the divide by 256, it will not wake
up from a serial
```

```
port interrupt and it will also give a 244 error, which means a read
error from the
serial port.  So there seems to be a problem with trying to use the
64 or 256 values.
Example, use only 2,4,8,16&32.
*/

                if (state == MPC821_PWR_CPU_NRMLLOW) {
                HIGH(ldptr->regs->pll_regs.plprcr,CSRCBIT); /* set
the CSRC bit */
                }
                if (state == MPC821_PWR_CPU_DOZEHIGH){
                ldptr->regs->pll_regs.plprcr |= PLL_HIDOZE; /* go to
high doze mode */
                }
                if (state == MPC821_PWR_CPU_DOZELOW){
                ldptr->regs->pll_regs.plprcr |= (PLL_LODOZE |
PLL_CSRC); /* go to low doze mode */
                }

/******* OPTIONAL for the sleep, deep sleep, power down modes
********/
                if (state == MPC821_PWR_CPU_SLEEP){
                ldptr->regs->pll_regs.plprcr |= PLL_SLEEP; /* go to
sleep mode */
                }
                if (state == MPC821_PWR_CPU_DEEP_SLEEP){
                ldptr->regs->pll_regs.plprcr |= PLL_DEEP_SLEEP; /* go
to deep sleep mode */
                }
                if (state == MPC821_PWR_CPU_PWRDWN){
                ldptr->regs->pll_regs.plprcr |= PLL_PWRDWN; /* go to
power down mode */
                }
/******* OPTIONAL for the sleep, deep sleep, power down modes
********/

            }
            irq_restore(svirq); /* restore mask */
         }
      }

      /* turn off real-time clock alarm interrupt */
      (void)rtc_alarm_stop(ldptr);

      /* calculate the time we were not at full power */
      (void)downtime(ldptr);
```

```
      /* turn on ticker and PIT(if needed) */
      ldptr->regs->tbr_regs.tbscr |= TBR_ENABLE; /* Turn on
ticker(DEC) */
      ldptr->regs->pit_regs.piscr |= PIT_ENABLE; /* OPTIONAL,
depending on if you use it or not */
   }
   return;
}


/* This section sets up the current time.  It also calculates the
time we */
/* were down!!!!!  */
void downtime(Localdata ldptr)
{
   /* update system globals */
   u_int32 sc;
   u_int32 ticks;

   /* This next section is to calculate the time we were not at full
power */
   /* and to generate the updated time(current time).  We get the
secs     */
   /* from the RTC hardware.  This will give me the current time.
*/
   /* We then take the time we kept in the globals, which is the time
we   */
   /* stored before we went to a lower power state, and calculate the
time */
   /* we were not at full power and update it to the current time.*/

   /* get current time */
   sc = ldptr->regs->rtc_regs.rtc; /* get the seconds value */

   /* compute # of ticks we were asleep */
   ticks = (sc - ldptr->sec);
   ticks *= ldptr->sysglob->d_tcksec;

   /* update system global fields */
   ldptr->sysglob->d_ticks += ticks;
   ldptr->sysglob->d_slice = 0;

   /* force OS sleep/alarm recomputation */
   ldptr->sysglob->d_elapse = 1;

   /* reset clock from real-time clock */
```

```
    (void)_os_setime(sc);

    return;
}


/* This function just stores the time before we power down to a state
other than */
/* full power!!!!!!!! */
void currentime(Localdata ldptr)
{
    /* get current time and save the time in static storage */
    ldptr->sec = ldptr->regs->rtc_regs.rtc;

    return;
}


/* check to see if there are any active processes pending */
u_int32 check(Localdata ldptr)
{
    Sysglobs sysglob = ldptr->sysglob;
    pr_desc* aproc = FAKEHD(pr_desc*,sysglob->d_activq[0],p_queuen);
    status_reg oldirq;

    oldirq = irq_maskget();      /* mask irqs */
    {
        /* check for empty active process queue (head pointing to
itself) */
        if (aproc->p_queuen == aproc) {
            irq_restore(oldirq);
            return(0); /* Go ahead and power down because there are no
active process */
        }
    }
    irq_restore(oldirq);   /* unmask irqs */
    return(1); /* Can't power down because there is an active process
*/
}
```

rtclock.c

```
/*****************************************************************
**********
** ADS821 System Module
**
```

```
**********************************************************************
**********
** Copyright 1995-1997 by Microware Systems Corporation
**
** Copyright 2001 by RadiSys Corporation
**
** Reproduced Under License
**
**
**
** This source code is the proprietary confidential property of
**
** Microware Systems Corporation, and is provided to licensee
**
** solely for documentation and educational purposes. Reproduction,
**
** publication, or distribution in any form to any party other than
**
** the licensee is strictly prohibited.
**
**********************************************************************
**********
** Edition History:
**
** #   Date     Comments                                          By
**
** --- -------- ------------------------------------------------- --
------- **
**   1 03/25/96 Creation  jgm**
**   2 04/10/96 Added OS9000 support for the ADS821 PPC board    jgm
**
**   3 06/04/96 Cleaned up to ship out with the Beta release     jgm
**
**   4 01/16/97 Modified to work with MPC821 Rev A chip         ecm
**
**********************************************************************
*********/

/*
** Header Files
*/

#include <regs.h>
#include <types.h>
#include <defs.h>


/*
```

```
** Initialize Real-Time Clock Sub-System
*/
error_code rtc_init(Localdata ldptr)
{
   error_code err;
   u_int32 old_rtcsck;

   /* set up RTC isr */
   if ((err =
_os_irq(RTC_IRQ_VECTOR,RTC_IRQ_PRIORITY,rtc_isr,ldptr)) != SUCCESS)
{
      return(err);
   }

   /* save the old, and set the RTCSCK register */
   old_rtcsck = ldptr->regs->key_regs.rtcsck;
   ldptr->regs->key_regs.rtcsck = 0x55ccaa33;
   {
      /* make sure the RTC is enabled */
      ldptr->regs->rtc_regs.rtcsc |= RTC_ENABLE;
   }
   /* restore the RTCSCK register with the old value */
/* ldptr->regs->key_regs.rtcsck = old_rtcsck; */

   /* make sure everything is cleared */
   (void)rtc_alarm_stop(ldptr);

   return(SUCCESS);
}

/*
** De-Initialize Real-Time Clock Sub-System
*/
error_code rtc_term(Localdata ldptr)
{
   /* make sure everything is cleared */
   (void)rtc_alarm_stop(ldptr);

   /* remove RTC isr */
   (void)_os_irq(RTC_IRQ_VECTOR,RTC_IRQ_PRIORITY,NULL,ldptr);

   return(SUCCESS);
}

/*
** Set Real-Time Clock Alarm Interrupt
```

```
*/
error_code rtc_alarm_set(Localdata ldptr,u_int32 sec)
{
   u_int32 old_rtcsck;
   u_int32 old_rtcalk;

   /* make sure the interrupts are shut off */
   (void)rtc_alarm_stop(ldptr);

   /* save the old, and set the RTCALK register */
   old_rtcalk = ldptr->regs->key_regs.rtcalk;
   ldptr->regs->key_regs.rtcalk = 0x55ccaa33;
   {
      /* set up the alarm register to wake up at this time */
      ldptr->regs->rtc_regs.rtcal = sec; /* set the RTC alarm time
register */
   }
   /* restore the RTCALK register with the old value */
/* ldptr->regs->key_regs.rtcalk = old_rtcalk;*/

   /* save the old, and set the RTCSCK register */
   old_rtcsck = ldptr->regs->key_regs.rtcsck;
   ldptr->regs->key_regs.rtcsck = 0x55ccaa33;
   {
      /* turn on rtclock alarm interrupts */
      ldptr->regs->rtc_regs.rtcsc |= RTCIRQ_LVL; /* set the RTC IRQ
level */
      ldptr->regs->rtc_regs.rtcsc |= ALM_ENABLE; /* enable the RTC
alarm interrupt */
   }
   /* restore the RTCSCK register with the old value */
/* ldptr->regs->key_regs.rtcsck = old_rtcsck; */

   return(SUCCESS);
}

/*
** Stop Real-Time Clock Alarm Interrupt
*/
error_code rtc_alarm_stop(Localdata ldptr)
{
   status_reg oldsr;
   u_int32 old_rtcsck;
   u_int32 old_rtcalk;

   /* turn off interrupts */
```

```
   oldsr = irq_maskget();
   {
      /* save the old, and set the RTCSCK register */
      old_rtcsck = ldptr->regs->key_regs.rtcsck;
      ldptr->regs->key_regs.rtcsck = 0x55ccaa33;
      {
         /* turn off rtclock interrupts */
         ldptr->regs->rtc_regs.rtcsc &= ~(ALM_ENABLE); /* disable
alarm interrupt */
         ldptr->regs->rtc_regs.rtcsc &= ~(SEC_ENABLE); /* disable
seconds interrupt */

         /* clear any pending alarms */
         ldptr->regs->rtc_regs.rtcsc |= (ALM_STATUS | SEC_STATUS);
      }
      /* restore the RTCSCK register with the old value */
/*    ldptr->regs->key_regs.rtcsck = old_rtcsck; */

      /* save the old, and set the RTCALK register */
      old_rtcalk = ldptr->regs->key_regs.rtcalk;
      ldptr->regs->key_regs.rtcalk = 0x55ccaa33;
      {
         /* clear alarm register */
         ldptr->regs->rtc_regs.rtcal = 0x00000000; /* set the time
to 0 */
      }
      /* restore the RTCALK register with the old value */
/*    ldptr->regs->key_regs.rtcalk = old_rtcalk;*/

   }
   irq_restore(oldsr); /* enable interrupts */

   return(SUCCESS);
}

/*
**      Real-Time Clock Interrupt Service Routine
*/
error_code rtc_isr(Localdata ldptr)
{
   status_reg oldsr;

   /* is this us? */
   if ((ldptr->regs->rtc_regs.rtcsc & ALM_STATUS) == 0) {
      return(EOS_NOTME); /* this is not a RTC alarm interrupt */
   }
```

```
    /* woke up from the alarm interrup */
    (void)rtc_alarm_stop(ldptr);

    return(SUCCESS);
}
```

6 Programming Guidelines

This chapter provides power management programming guidelines for the various OS-9 for 68K and OS-9 sub-systems. These guidelines must be followed to produce a working power managed system.

General compatibility guidelines for development of components in a power managed system involve:

- Boot Code
- Applications
- Device Drivers
- File Managers

Boot Code

- The boot-code should leave hardware subsystems (except the CPU) in a powered-down state when control is passed to the kernel. The appropriate high-level device driver (or other hardware-specific module) is then responsible for powering-up the corresponding hardware subsystem. The idea here is to keep idle subsystems powered down whenever possible.
- For consistency, use the "`PWR_AWARE`" `#ifdef` macro in sources (when needed) to indicate code sections used only in power aware systems. If the power aware code also works in non-power aware system, then `#ifdef` is not required.
- `PwrMan` should be in the `M$PreIO` list of the init module within `systype.d` since it should be initialized prior to IO. `SysIF` should go in the `M$Extens` list. Following is the section of `systype.d` that configures the initialization module for OS-9.
- Reference the ***OS-9 for 68K Technical Manual*** for information on the initialization module and the `PreIO` and `Extens` lists. Reference the ***OS-9 Technical Manual*** for information on the initialization module and the `m_preio` and `m_extens` list.

```
CONFIG macro

* specific defs for the Eval Board
MainFram dc.b "Motorola M68328ADS Board",0

 ifdef SYSGO

* name of initial module to execute
SysStart dc.b "sysgo",0
* parameters to pass to initial module
SysParam dc.b "",0

 else

* name of initial module to execute
SysStart dc.b "shell",0
* parameters to pass to initial module
SysParam dc.b "",0

 endc

SysDev   dc.b "/dd",0          * default disk
ConsolNm dc.b "/term",0        * console terminal pathlist
ClockNm  dc.b "tk68328",0      * clock module name

PreIO dc.b "OS9PreIO "
 ifdef PWRMAN
```

```
   dc.b "pwrman "
 endc
   dc.b 0

Extens  dc.b "OS9P2 "
 dc.b "fpu "
 ifdef SYSMBUF
   dc.b "SysMbuf "
 endc
 ifdef PWRMAN
   dc.b "sysif "
 endc
   dc.b 0
```

- Similarly, for OS-9, `PwrMan` should be in the `PREIOS` list of the initialization module for OS-9. `SysIF` should be in the `EXTENSIONS` list. Following is an example OS-9 initialization module definition within `systype.h`.

```
/*
 * Init Module variable definitions
 */
#ifdef INITMOD
#include <init.h>

#define INSTALNAME             "MPC821ADS"            /* installation
name string */
#define OS9K_REVSTR             "OS-9000 for the PowerPC(tm)"   /*
revision string */


#ifdef INIT_DD
/* name of initial module to execute */
#define SYS_START               "shell"

/* params to pass to initial module     */
#define SYS_PARAMS              "chd /dd; mbinstall; ex shell"
/* #define SYS_PARAMS              "mbinstall; undpd -s <>>>/nil* ex
shell" */

/* initial system disk pathlist */
#define SYS_DEVICE              "/dd"
#endif  /* INIT_DD */
```

```
#ifdef INIT_VCONS
/* name of initial module to execute */
#define SYS_START               "shell"

/* params to pass to initial module     */
#define SYS_PARAMS              "mbinstall; ex shell"
/* #define SYS_PARAMS              "mbinstall; undpd -s <>>>/nil* ex
shell" */

/* initial system disk pathlist */
#define SYS_DEVICE              ""
#endif  /* INIT_VCONS */


#ifdef INIT_NODISK
/* name of initial module to execute */
#define SYS_START               "shell"

/* params to pass to initial module     */
#define SYS_PARAMS              "mbinstall; ex shell"
/* #define SYS_PARAMS              "mbinstall; undpd -s <>>>/nil* ex
shell" */


/* initial system disk pathlist */
#define SYS_DEVICE              ""
#endif  /* INIT_NODISK  */


#ifdef INIT_VCONS
#define CONS_NAME               "/vcons"        /* console terminal
pathlist */
#else
#define CONS_NAME               "/term"         /* console terminal
pathlist */
#endif
#define TICK_NAME              "tkdec"        /* clock ticker module
name */
#define RTC_NAME                "rtc821"        /* real time clock
module name */
/* The order of the following list is important.  Please see release
notes. */
#define PREIOS     "siuirq cpicirq ssm cache pwrman"   /* pre-I/O
extension module list */
#define IOMAN_NAME             "Ioman"        /* I/O manager name */
```

```
#define COMPAT                  B_WIPEMEM       /* Debug memory flag */
#define EXTENSIONS      "OS9P2 fpu abort sysif"       /* extension
modules */
```

Applications

Guidelines for application development are necessary to ensure integration of power management services.

- Applications should be interrupt driven; polling loops should be avoided. This will cause idle applications to sleep or wait outside the active process queue, providing `PwrPlcy` with an easy indication when the entire system is idle.
- For consistency, use the `PWR_AWARE` `#ifdef` macro in sources (when needed) to indicate code sections used only in power aware systems. If the power aware code also works in non-power aware system, then the `#ifdef` macro is not needed.

Device Drivers

- To remain compatible with systems not power managed by the Power Management Subsystem, a device driver must default to a powered-up state during initialization.
- Device drivers should keep hardware subsystems powered down when possible to conserve power (e.g., during deiniz or when the hardware is not in use even though it has been initialized). Care must be taken to share information when powering down a shared device (such as a 2-port 68681 UART).
- Pending operations (I/O or other) must be completed before committing to a power state change (via the `PwrMan` callback routine). For example, an SPI-bus transfer must be completed before a driver can successfully be placed into a low power state.
- For consistency, use the "`PWR_AWARE`" `#ifdef` macro in sources (when needed) to indicate code sections used only in power aware systems. If the power aware code also works in non-power aware system, then the `#ifdef` macro is not needed.

File Managers

- Pending I/O operations must be completed before committing to a power state change request operation. For example, the RBF file manager must install a `PwrMan` power management callback routine to postpone any power state changes if RBF file activities are pending but not completed. This ensures disk data integrity.
- For consistency, use the "`PWR_AWARE`" `#ifdef` macro in sources (when needed) to indicate code sections used only in power aware systems. If the power aware

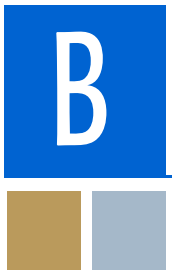
code also works in non-power aware system, then the `#ifdef` macro is not needed.

A OS-9 for 68K

68328 (OS-9/68000) Hardware Interface

Table A-1. 68328 State/Characteristics

Operation	Characteristics
Normal (default)	Phase lock loop (PLL) enabled CPU clock enabled (100% duty cycle) LCD clock enabled System clock enabled Interrupts wake up CPU immediately and disable power controller (interrupt service routines (ISRs) must reset power-controller if lower duty cycle is desired)
Gear	PLL enabled CPU clock at 3%-97% [3% increment] duty cycle LCD clock enabled System clock enabled Interrupts wake up CPU immediately and disable power controller (ISRs must reset power controller if lower duty cycle is desired)
Doze	PLL enabled CPU clock disabled (0% duty cycle) LCD clock enabled System clock enabled Interrupts wake up CPU immediately
Sleep	PLL disabled CPU clock disabled LCD clock disabled System clock disabled Interrupts wake up CPU within 2ms (maximum PLL synch latency)



PowerPC

PPC821 (OS-9/ PPC) Hardware Interface

Table B-1. PPC821 State/Characteristics

Operation	Characteristics
Normal (default)	Phase Lock Loop (PLL) enabled CPU clock enabled (100% duty cycle) System clock enabled LCD enabled Interrupts wake up CPU immediately (within 4 maximum system clocks)
Gear	PLL enabled CPU clock at [Full/(2 ^ DivisionFactor)]% duty cycle System clock enabled LCD enabled Interrupts wake up CPU immediately (within 4 maximum system clocks)
Doze	PLL enabled CPU clock disabled (0% duty cycle) System clock enabled LCD enabled Interrupts wake up CPU immediately (within 4 maximum system clocks)
Sleep	PLL enabled CPU clock disabled System clock disabled LCD disabled DRAM refresh disabled Interrupts wake up CPU immediately (within 4 maximum system clocks)

Table B-1. PPC821 State/Characteristics (Continued)

Operation	Characteristics
Deep Sleep	PLL disabled CPU clock disabled System clock disabled LCD disabled DRAM refresh disabled Interrupts wake up CPU within 500 PLL input frequency clock (15.6 ms @ 32KHz / 125 us @ 4MHz)
Power Down	PLL disabled CPU clock disabled System clock disabled LCD disabled DRAM refresh disabled Reset wakes up CPU within 500 PLL input frequency clock + power supply wake-up

C Assembly Interface for OS-9 for 68K

This appendix defines the `F$PwrMan` assembly interface for OS-9 for 68K.

F$PwrMan
Invoke Power Management

ASM Call

```
OS9 F$PwrMan
```

Input

(a0).l = Subcode parameter
(a3).l = Private static storage
(a4).l = Process descriptor pointer
(a5).l = Caller's registers
(a6).l = System global data pointer

Output

(cc).w = Carry clear

Error Output

(d1).w = Error code
(cc).w = Carry set

Description

`F$PwrMan` performs various operations depending on the subcode passed in.

Operations include registering and unregistering a device in the Device Registry Table, adding and removing an entry from the Power State Table, and changing power states.

Subcode values are defined in the following section of this document.

Sub-Codes

`PwrMan` sub-codes defined in assembly language follow.

```
* PwrMan Sub-Codes *

PWRMAN_MIN: equ     0x00    * minimum PwrMan subcode *
PWRMAN_CHECK: equ     0x00* check if PwrMan is going *
PWRMAN_REGISTER:equ     0x01    * register pwr-routine *
PWRMAN_UNREGISTER:equ     0x02    * unregister pwr-routine *
PWRMAN_STATEADD:equ     0x03    * add power state *
PWRMAN_STATEREMOVE:equ     0x04    * remove power state *
PWRMAN_DEBUG:           equ     0x05    * get pwrman globals for testing *
PWRMAN_CHANGE:          equ     0x06    * change power states *
PWRMAN_CALLBACK: equ     0x07    * call call-back function directly *
PWRMAN_LINK_PLCY    equ 0x08    * link to pwrplcy module *
PWRMAN_UNLINK_PLCY  equ 0x09    * unlink from pwrplcy module *
PWRMAN_COPYGLOB     equ 0x0a    * get a copy of pwrman globals *
PWRMAN_LINK_EXT         equ 0x0b        * link to pwrext module *
PWRMAN_UNLINK_EXT equ 0x0c        * unlink from pwrext module *
```

```
PWRMAN_MAX: equ     0x3F    * maximum PwrMan subcode *

PWRPLCY_MIN: equ 0x40        * min PwrPlcy subcode *
PWRPLCY_MW_MIN: equ 0x40        * min PwrPlcy Microware subcode *
PWRPLCY_INIT: equ 0x40        * PwrPlcy initialization *
PWRPLCY_DEINIT:        equ 0x41        * PwrPlcy deinitialization *
PWRPLCY_EV_NOTIFY:      equ 0x42        * notification power-event *
PWRPLCY_EV_REQUEST: equ 0x43        * request power-event *
PWRPLCY_STATE_OFF: equ 0x6C        * System OFF state *
PWRPLCY_STATE_SUSPEND:equ 0x6D        * System SUSPEND state *
PWRPLCY_STATE_IDLE:equ 0x6E        * System IDLE state *
PWRPLCY_STATE_ON:equ 0x6F        * System ON state *
PWRPLCY_MW_MAX:         equ 0x6F        * max PwrPlcy Microware subcode *
PWRPLCY_USR_MIN:        equ 0x70        * min PwrPlcy user subcode *
PWRPLCY_USR_MAX:        equ 0x9F        * max PwrPlcy user subcode *
PWRPLCY_MAX:            equ 0x9F        * max PwrPlcy subcode *

PWREXT_MIN:equ 0xA0 * min PwrExt subcode *
PWREXT_MW_MIN:          equ 0xA0        * min PwrExt Microware subcode *
PWREXT_INIT:            equ 0xA0        * PwrExt initialization *
PWREXT_DEINIT:          equ 0xA1        * PwrExt deinitialization *
PWREXT_MW_MAX:          equ 0xCf        * max PwrExt Microware subcode *
PWREXT_USR_MIN:         equ 0xD0        * min PwrExt user subcode *
PWREXT_USR_MAX:         equ 0xFF        * max PwrExt user subcode *
PWREXT_MAX:             equ 0xFF        * max PwrExt subcode *
```

Internal Structures

PwrMan internal structures defined in assembly language follow.

```
* type of device (with respect to power consumption/generation) *
pwr_devtype_consumer:       equ 0
pwr_devtype_supplier:       equ 1
pwr_devtype_neutral:        equ 2
pwr_devtype_other:          equ 3

* local power-mode structure for a power-aware device *
                            org 0
pwr_localmode_level:        do.l 1 * Local power mode level *
pwr_localmode_maxload:      do.l 1 * max energy load or drain (mW) *
pwr_localmode_minload:      do.l 1 * min energy load or drain (mW) *
pwr_localmode_entrytime:    do.l 1 * worst-case device entry time (ms) *
pwr_localmode_exittime:     do.l 1 * worst-case device exit time (ms) *
pwr_localmode_lpm_name:     do.b PWR_IDLEN * local power-mode name *
pwr_localmode_context_pres: do.b 1 * device context preserved flag *
pwr_localmode_rsv1:         do.b 11 * reserved *
pwr_localmode_size:         equ .

* energy condition structure for a power-aware device *
                            org 0
pwr_devcond_localpwrmd:     do.l 1 * ptr to local power mode array *
pwr_devcond_localpwrmd_num: do.l 1 * # of local power modes *
```

```
pwr_devcond_dev_type:       do.l 1 * device type *
pwr_devcond_pres_level:     do.l 1 * present power level *
pwr_devcond_pres_load:      do.l 1 * present energy level (mW) *
pwr_devcond_pres_drain:     do.l 1 * present energy drain (mW/hr) *
pwr_devcond_rsv1:           do.b 28 * reserved *
pwr_devcond_size:           equ .

* power-event structure *
                            org 0
pwr_event_devcond:          do.l 1 * ptr to device condition struct *
pwr_event_old_lpm:          do.l 1 * ptr to old local power mode *
pwr_event_new_lpm:          do.l 1 * ptr to new local power mode *
pwr_event_old_energy:       do.l 1 * old energy level (mW) *
pwr_event_new_energy:       do.l 1 * new energy level (mW) *
pwr_event_old_drain:        do.l 1 * old drain/[supply] (mW/hr) *
pwr_event_new_drain:        do.l 1 * new drain/[supply] (mW/hr) *
pwr_event_rsv1:             do.b 20 * reserved *
pwr_event_size:             equ .
```

Parameter Block Definitions

Parameter block definitions for calls into `PwrMan` follow.

```
* PwrMan System-Call Parameter-Block Types *
                                org 0
f_pwrman_pb_edition:            do.b 1 * current PwrMan version number *
f_pwrman_pb_subcode:            do.b 1 * PwrMan sub-code *
f_pwrman_pb_rsv:                do.b 3 * reserved *
f_pwrman_pb_size:               equ .

* F_PWRMAN/PWRMAN_CHECK *
                                org f_pwrman_pb_size
f_pwrman_check_pb_version:      do.l 1 * version string buffer ptr *
f_pwrman_check_pb_size:         equ .

* F_PWRMANPWRMAN_ADD *
                                org f_pwrman_pb_size
f_pwrman_add_pb_syslevel:       do.l 1 * state level *
f_pwrman_add_pb_priority:       do.l 1 * priority of entry *
f_pwrman_add_pb_devlevel:       do.l 1 * device level *
f_pwrman_add_pb_d:              do.l 1 * additional device param block *
f_pwrman_add_pb_id:             do.l 1 * entry id ptr *
f_pwrman_add_pb_size:           equ .

* F_PWRMANPWRMAN_REMOVE *
                                org f_pwrman_pb_size
f_pwrman_remove_pb_syslevel:    do.l 1 * state level *
f_pwrman_remove_pb_priority:    do.l 1 * priority of entry *
f_pwrman_remove_pb_devlevel:    do.l 1 * device level *
f_pwrman_remove_pb_devpb:       do.l 1 * additional device param block *
f_pwrman_remove_pb_id:          do.l 1 * entry id ptr *
f_pwrman_remove_pb_size:        equ .
```

```
* F_PWRMANPWRMAN_COPYGLOB *
       org f_pwrman_pb_size
f_pwrman_copyglob_pb_pwrglob:   do.l 1  * copy of powerman globals *
f_pwrman_copyglob_pb_size:       equ .


* F_PWRMANPWRMAN_DEBUG *
                                org f_pwrman_pb_size
f_pwrman_debug_pb_pwrglob:      do.l 1 * pointer to powerman globals *
f_pwrman_debug_pb_size:         equ .

* F_PWRMANPWRMAN_CHANGE *
                                org f_pwrman_pb_size
f_pwrman_change_pb_syslevel:    do.l 1 * PwrMan's state level to check *
f_pwrman_change_pb_size:        equ .

* F_PWRMANPWRMAN_CALLBACK *
                                org f_pwrman_pb_size
f_pwrman_callback_pb_devlevel:  do.l 1 * device level *
f_pwrman_callback_pb_devpb:     do.l 1 * additional device param block *
f_pwrman_callback_pb_id:        do.l 1 * entry id ptr *
f_pwrman_callback_pb_size:      equ .



* F_PWRMANPWRMAN_LINK_PLCY *
                                org f_pwrman_pb_size
f_pwrman_link_plcy_mname:        do.l 1  *  *
f_pwrman_link_plcy_pb_size:      equ .

* F_PWRMANPWRMAN_UNLINK_PLCY *
                                org f_pwrman_pb_size
f_pwrman_unlink_plcy_pb_size:   equ .

* F_PWRMANPWRMAN_LINK_EXT *
                                org f_pwrman_pb_size
f_pwrman_link_ext_mname:         do.l 1 *  *
f_pwrman_link_ext_pb_size:       equ .

* F_PWRMANPWRMAN_UNLINK_EXT *
                                org f_pwrman_pb_size
f_pwrman_unlink_ext_pb_size:         equ .



* F_PWRMANPWRMAN_REG *
                                org f_pwrman_pb_size
f_pwrman_reg_pb_func            do.l 1 * call-back function*
f_pwrman_reg_pb_funcparam:      do.l 1 * call-back parameter *
f_pwrman_reg_pb_devpwrdef:      do.l 1 * device power definition *
f_pwrman_reg_pb_id:             do.l 1 * entry id ptr *
```

```
f_pwrman_reg_pb_size:           equ .

* F_PWRMANPWRMAN_UNREG *
                                org f_pwrman_pb_size
f_pwrman_unreg_pb_func          do.l 1 * call-back function *
f_pwrman_unreg_pb_funcparam:    do.l 1 * call-back parameter *
f_pwrman_unreg_pb_devpwrdef:    do.l 1 * device power definition *
f_pwrman_unreg_pb_id:           do.l 1 * entry id ptr *
f_pwrman_unreg_pb_size:         equ .


* F_PWRMANPWRPLCY_INIT *
                                org f_pwrman_pb_size
f_pwrplcy_init_pb_size:         equ .

* F_PWRMANPWRPLCY_TERM *
                                org f_pwrman_pb_size
f_pwrplcy_term_pb_size:         equ .

* F_PWRMANPWRPLCY_EV_REQUEST *
                                   org f_pwrman_pb_size
f_pwrplcy_ev_request_pb_pwrevent:do.l 1 * Ptr to power-event structure *
f_pwrplcy_ev_request_pb_size:    equ .

* F_PWRMANPWRPLCY_EV_NOTIFY *
                                   org f_pwrman_pb_size
f_pwrplcy_ev_notify_pb_pwrevent: do.l 1 * Ptr to pwrevent structure *
f_pwrplcy_ev_notify_pb_size:          equ .


* F_PWRMANPWREXT_INIT *
                                   org f_pwrman_pb_size
f_pwrext_init_pb_size:            equ .

* F_PWRMANPWREXT_TERM *
                                   org f_pwrman_pb_size
f_pwrext_term_pb_size:            equ .
```

D SuperH

SH7709 (OS-9/ SH-3) Hardware Interface

Table 6-1. SH7709 State/Characteristics

Operation	Characteristics
Normal (default)	Clock Pulse Generator (CPG) is operating CPU, bus and peripheral clocks are enabled On-Chip supporting modules are operating External memory refreshing is on Graphics and serial (SCI, SCIF) devices are on Interrupts are served immediately
Sleep	Clock Pulse Generator (CPG) is operating CPU is halted (registers held) Bus and peripheral clocks are enabled On-Chip supporting modules are operating External memory refreshing is on Graphics device is off Serial (SCI, SCIF) devices are on System wakes up by interrupt or reset
Standby	Clock Pulse Generator (CPG) is halted CPU is halted (registers held) Bus and peripheral clocks are halted Most on-chip modules (except RTC) are halted External memory is in self-refresh mode and needs external clock source to hold content Graphics device are off Serial (SCI, SCIF) devices are off System wakes up by NMI, IRL or RTC interrupt or by reset and executes some initialization code in ROM to put external memory in auto-refresh mode before serving interrupts

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