

Xenomai RTDM skin API Reference Manual

2.3

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Chapter 1

Xenomai RTDM skin API Module Index

1.1 Xenomai RTDM skin API Modules

Here is a list of all modules:

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Chapter 2

Xenomai RTDM skin API Hierarchical Index

2.1 Xenomai RTDM skin API Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

can_bittime	111
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rt dm_dev_context	116
rt dm_device	117
rt dm_operations	119
rt ser_config	121
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Chapter 3

Xenomai RTDM skin API Data Structure Index

3.1 Xenomai RTDM skin API Data Structures

Here are the data structures with brief descriptions:

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can_bittime_btr (Hardware-specific BTR bit-times)	112
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can_filter (Filter for reception of CAN messages)	114
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rtdm_dev_context (Device context)	116
rtdm_device (RTDM device)	117
rtdm_operations (Device operations)	119
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rtser_status (Serial device status)	123
sockaddr_can (Socket address structure for the CAN address family)	124

Chapter 4

Xenomai RTDM skin API File Index

4.1 Xenomai RTDM skin API File List

Here is a list of all documented files with brief descriptions:

include/rtdm/ rtcan.h (Real-Time Driver Model for RT-Socket-CAN, CAN device profile header)	125
include/rtdm/ rtdm.h (Real-Time Driver Model for Xenomai, user API header)	135
include/rtdm/ rtdm_driver.h (Real-Time Driver Model for Xenomai, driver API header)	137
include/rtdm/ rtserial.h (Real-Time Driver Model for Xenomai, serial device profile header)	143
include/rtdm/ rttesting.h (Real-Time Driver Model for Xenomai, testing device profile header)	148
include/rtdm/ syscall.h	??
ksrc/skins/rtdm/ core.c (Real-Time Driver Model for Xenomai, device operation multiplexing)	157
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Chapter 5

Xenomai RTDM skin API Module Documentation

5.1 CAN Devices

5.1.1 Detailed Description

This is the common interface a RTDM-compliant CAN device has to provide. Feel free to report bugs and comments on this profile to the "Socketcan" mailing list (Socketcan-core@lists.berlios.de) or directly to the authors (wg@grandegger.com or Sebastian.Smolorz@stud.uni-hannover.de).

Device Characteristics

Device Flags: RTDM_PROTOCOL_DEVICE

Protocol Family: PF_CAN

Socket Type: SOCK_RAW

Device Class: RTDM_CLASS_CAN

Supported Operations

Socket

Environments: non-RT (RT optional)

Specific return values:

- -EPROTONOSUPPORT (Protocol is not supported by the driver. See [CAN protocols](#) for possible protocols.)

Close

Blocking calls to any of the [Send](#) or [Receive](#) functions will be unblocked when the socket is closed and return with an error.

Environments: non-RT (RT optional)

Specific return values: none

IOCTL

Mandatory Environments: see [below](#)

Specific return values: see [below](#)

Bind

Binds a socket to one or all CAN devices (see struct [sockaddr_can](#)). If a filter list has been defined with setsockopt (see [Sockopts](#)), it will be used upon reception of CAN frames to decide whether the bound socket will receive a frame. If no filter has been defined, the socket will receive **all** CAN frames on the specified interface(s).

Binding to special interface index 0 will make the socket receive CAN frames from all CAN interfaces.

Binding to an interface index is also relevant for the [Send](#) functions because they will transmit a message over the interface the socket is bound to when no socket address is given to them. Environments: non-RT (RT optional)

Specific return values:

- -EFAULT (It was not possible to access user space memory area at the specified address.)
- -ENOMEM (Not enough memory to fulfill the operation)
- -EINVAL (Invalid address family, or invalid length of address structure)
- -ENODEV (Invalid CAN interface index)
- -ENOSPC (No enough space for filter list)
- -EBADF (Socket is about to be closed)
- -EAGAIN (Too many receivers. Old binding (if any) is still active. Close some sockets and try again.)

Setsockopt, Getsockopt

These functions allow to set and get various socket options. Currently, only CAN raw sockets are supported.

Supported Levels and Options:

- Level **SOL_CAN_RAW** : CAN RAW protocol (see [CAN_PROTO_RAW](#))
 - Option [CAN_RAW_FILTER](#) : CAN filter list
 - Option [CAN_RAW_ERR_FILTER](#) : CAN error mask
 - Option [CAN_RAW_TX_LOOPBACK](#) : CAN TX loopback to local sockets

Environments: non-RT (RT optional)

Specific return values: see links to options above.

Recv, Recvfrom, Recvmsg

These functions receive CAN messages from a socket. Only one message per call can be received, so only one buffer with the correct length must be passed. For SOCK_RAW, this is the size of struct [can_frame](#).

Unlike a call to one of the [Send](#) functions, a Recv function will not return with an error if an interface is down (due to bus-off or setting of stop mode) or in sleep mode. Moreover, in such a case there may still be some CAN messages in the socket buffer which could be read out successfully.

It is possible to receive a high precision timestamp with every CAN message. The condition is a former instruction to the socket via [RTCAN_RTIOC_TAKE_TIMESTAMP](#). The timestamp will be copied to the msg_control buffer of struct `msghdr` if it points to a valid memory location with size of [nanosecs_abs_t](#). If this is a NULL pointer the timestamp will be discarded silently.

Note: A msg_controllen of 0 upon completion of the function call indicates that no timestamp is available for that message.

Supported Flags [in]:

- MSG_DONTWAIT (By setting this flag the operation will only succeed if it would not block, i.e. if there is a message in the socket buffer. This flag takes precedence over a timeout specified by [RTCAN_RTIOC_RCV_TIMEOUT](#).)
- MSG_PEEK (Receive a message but leave it in the socket buffer. The next receive operation will get that message again.)

Supported Flags [out]: none

Environments: RT (non-RT optional)

Specific return values:

- Non-negative value (Indicating the successful reception of a CAN message. For `SOCK_RAW`, this is the size of struct [can_frame](#) regardless of the actual size of the payload.)
- `-EFAULT` (It was not possible to access user space memory area at one of the specified addresses.)
- `-EINVAL` (Unsupported flag detected, or invalid length of socket address buffer, or invalid length of message control buffer)
- `-EMSGSIZE` (Zero or more than one iovec buffer passed, or buffer too small)
- `-EAGAIN` (No data available in non-blocking mode)
- `-EBADF` (Socket was closed.)
- `-EINTR` (Operation was interrupted explicitly or by signal.)
- `-ETIMEDOUT` (Timeout)

Send, Sendto, Sendmsg

These functions send out CAN messages. Only one message per call can be transmitted, so only one buffer with the correct length must be passed. For `SOCK_RAW`, this is the size of struct [can_frame](#).

The following only applies to `SOCK_RAW`: If a socket address of struct [sockaddr_can](#) is given, only `can_ifindex` is used. It is also possible to omit the socket address. Then the interface the socket is bound to will be used for sending messages.

If an interface goes down (due to bus-off or setting of stop mode) all senders that were blocked on this interface will be woken up.

Supported Flags:

- `MSG_DONTWAIT` (By setting this flag the transmit operation will only succeed if it would not block. This flag takes precedence over a timeout specified by [RTCAN_RTIOC_SND_TIMEOUT](#).)

Environments: RT (non-RT optional)

Specific return values:

- Non-negative value equal to given buffer size (Indicating the successful completion of the function call. See also note.)
- `-EOPNOTSUPP` (`MSG_OOB` flag is not supported.)
- `-EINVAL` (Unsupported flag detected *or*: Invalid length of socket address *or*: Invalid address family *or*: Data length code of CAN frame not between 0 and 15 *or*: CAN standard frame has got an ID not between 0 and 2031)
- `-EMSGSIZE` (Zero or more than one buffer passed or invalid size of buffer)
- `-EFAULT` (It was not possible to access user space memory area at one of the specified addresses.)
- `-ENXIO` (Invalid CAN interface index - 0 is not allowed here - or socket not bound or rather bound to all interfaces.)
- `-ENETDOWN` (Controller is bus-off or in stopped state.)
- `-ECOMM` (Controller is sleeping)
- `-EAGAIN` (Cannot transmit without blocking but a non-blocking call was requested.)
- `-EINTR` (Operation was interrupted explicitly or by signal)
- `-EBADF` (Socket was closed.)
- `-ETIMEDOUT` (Timeout)

Note: A successful completion of the function call does not implicate a successful transmission of the message.

Files

- file [rtcan.h](#)
Real-Time Driver Model for RT-Socket-CAN, CAN device profile header.

Data Structures

- struct [can_bittime_std](#)
Standard bit-time parameters according to Bosch.
- struct [can_bittime_btr](#)
Hardware-specific BTR bit-times.
- struct [can_bittime](#)
Custom CAN bit-time definition.
- struct [can_filter](#)
Filter for reception of CAN messages.
- struct [sockaddr_can](#)
Socket address structure for the CAN address family.
- struct [can_frame](#)
Raw CAN frame.

CAN ID masks

Bit masks for masking CAN IDs

- #define [CAN_EFF_MASK](#) 0x1FFFFFFF
Bit mask for extended CAN IDs.
- #define [CAN_SFF_MASK](#) 0x000007FF
Bit mask for standard CAN IDs.

CAN ID flags

Flags within a CAN ID indicating special CAN frame attributes

- #define [CAN_EFF_FLAG](#) 0x80000000
extended frame
- #define [CAN_RTR_FLAG](#) 0x40000000
remote transmission flag
- #define [CAN_ERR_FLAG](#) 0x20000000
error frame (see [Errors](#))

CAN controller modes

Special CAN controllers modes, which can be or'ed together.

- #define `CAN_CTRLMODE_LISTENONLY` 0x1
Listen-Only mode.
- #define `CAN_CTRLMODE_LOOPBACK` 0x2
Loopback mode.

Timestamp switches

Arguments to pass to `RTCAN_RTIOC_TAKE_TIMESTAMP`

- #define `RTCAN_TAKE_NO_TIMESTAMPS` 0
Switch off taking timestamps.
- #define `RTCAN_TAKE_TIMESTAMPS` 1
Do take timestamps.

RAW socket options

Setting and getting CAN RAW socket options.

- #define `CAN_RAW_FILTER` 0x1
CAN filter definition.
- #define `CAN_RAW_ERR_FILTER` 0x2
CAN error mask.
- #define `CAN_RAW_TX_LOOPBACK` 0x3
CAN TX loopback.

IOCTLs

CAN device IOCTLs

- #define `SIOCGIFINDEX` _IOWR(RTIOC_TYPE_CAN, 0x00, struct ifreq)
Get CAN interface index by name.
- #define `SIOCSCANBAUDRATE` _IOW(RTIOC_TYPE_CAN, 0x01, struct ifreq)
Set baud rate.
- #define `SIOCGCANBAUDRATE` _IOWR(RTIOC_TYPE_CAN, 0x02, struct ifreq)
Get baud rate.

- #define [SIOCSCANCUSTOMBITTIME](#) _IOW(RTIOC_TYPE_CAN, 0x03, struct ifreq)
Set custom bit time parameter.
- #define [SIOCGCANCUSTOMBITTIME](#) _IOWR(RTIOC_TYPE_CAN, 0x04, struct ifreq)
Get custom bit-time parameters.
- #define [SIOCSCANMODE](#) _IOW(RTIOC_TYPE_CAN, 0x05, struct ifreq)
Set operation mode of CAN controller.
- #define [SIOCGCANSTATE](#) _IOWR(RTIOC_TYPE_CAN, 0x06, struct ifreq)
Get current state of CAN controller.
- #define [SIOCSCANCTRLMODE](#) _IOW(RTIOC_TYPE_CAN, 0x07, struct ifreq)
Set special controller modes.
- #define [SIOCGCANCTRLMODE](#) _IOWR(RTIOC_TYPE_CAN, 0x08, struct ifreq)
Get special controller modes.
- #define [RTCAN_RTIOC_TAKE_TIMESTAMP](#) _IOW(RTIOC_TYPE_CAN, 0x09, int)
Enable or disable storing a high precision timestamp upon reception of a CAN frame.
- #define [RTCAN_RTIOC_RCV_TIMEOUT](#) _IOW(RTIOC_TYPE_CAN, 0x0A, nanosecs_rel_t)
Specify a reception timeout for a socket.
- #define [RTCAN_RTIOC_SND_TIMEOUT](#) _IOW(RTIOC_TYPE_CAN, 0x0B, nanosecs_rel_t)
Specify a transmission timeout for a socket.

Error mask

Error class (mask) in `can_id` field of struct [can_frame](#) to be used with [CAN_RAW_ERR_FILTER](#).

- #define [CAN_ERR_TX_TIMEOUT](#) 0x00000001U
TX timeout (netdevice driver).
- #define [CAN_ERR_LOSTARB](#) 0x00000002U
Lost arbitration (see [data\[0\]](#)).
- #define [CAN_ERR_CRTL](#) 0x00000004U
Controller problems (see [data\[1\]](#)).
- #define [CAN_ERR_PROT](#) 0x00000008U
Protocol violations (see [data\[2\]](#), [data\[3\]](#)).
- #define [CAN_ERR_TRX](#) 0x00000010U
Transceiver status (see [data\[4\]](#)).

- #define `CAN_ERR_ACK` 0x00000020U
Received no ACK on transmission.
- #define `CAN_ERR_BUSOFF` 0x00000040U
Bus off.
- #define `CAN_ERR_BUSERROR` 0x00000080U
Bus error (may flood!).
- #define `CAN_ERR_RESTARTED` 0x00000100U
Controller restarted.
- #define `CAN_ERR_MASK` 0x1FFFFFFFU
Omit EFF, RTR, ERR flags.

Arbitration lost error

Error in the data[0] field of struct `can_frame`.

- #define `CAN_ERR_LOSTARB_UNSPEC` 0x00
unspecified else bit number in bitstream

Controller problems

Error in the data[1] field of struct `can_frame`.

- #define `CAN_ERR_CRTL_UNSPEC` 0x00
unspecified
- #define `CAN_ERR_CRTL_RX_OVERFLOW` 0x01
RX buffer overflow.
- #define `CAN_ERR_CRTL_TX_OVERFLOW` 0x02
TX buffer overflow.
- #define `CAN_ERR_CRTL_RX_WARNING` 0x04
reached warning level for RX errors
- #define `CAN_ERR_CRTL_TX_WARNING` 0x08
reached warning level for TX errors
- #define `CAN_ERR_CRTL_RX_PASSIVE` 0x10
reached passive level for RX errors
- #define `CAN_ERR_CRTL_TX_PASSIVE` 0x20
reached passive level for TX errors

Protocol error type

Error in the data[2] field of struct [can_frame](#).

- #define [CAN_ERR_PROT_UNSPEC](#) 0x00
unspecified
- #define [CAN_ERR_PROT_BIT](#) 0x01
single bit error
- #define [CAN_ERR_PROT_FORM](#) 0x02
frame format error
- #define [CAN_ERR_PROT_STUFF](#) 0x04
bit stuffing error
- #define [CAN_ERR_PROT_BIT0](#) 0x08
unable to send dominant bit
- #define [CAN_ERR_PROT_BIT1](#) 0x10
unable to send recessive bit
- #define [CAN_ERR_PROT_OVERLOAD](#) 0x20
bus overload
- #define [CAN_ERR_PROT_ACTIVE](#) 0x40
active error announcement
- #define [CAN_ERR_PROT_TX](#) 0x80
error occurred on transmission

Protocol error location

Error in the data[3] field of struct [can_frame](#).

- #define [CAN_ERR_PROT_LOC_UNSPEC](#) 0x00
unspecified
- #define [CAN_ERR_PROT_LOC_SOF](#) 0x03
start of frame
- #define [CAN_ERR_PROT_LOC_ID28_21](#) 0x02
ID bits 28 - 21 (SFF: 10 - 3).
- #define [CAN_ERR_PROT_LOC_ID20_18](#) 0x06
ID bits 20 - 18 (SFF: 2 - 0).
- #define [CAN_ERR_PROT_LOC_SRTR](#) 0x04

substitute RTR (SFF: RTR)

- #define `CAN_ERR_PROT_LOC_IDE` 0x05
identifier extension
- #define `CAN_ERR_PROT_LOC_ID17_13` 0x07
ID bits 17-13.
- #define `CAN_ERR_PROT_LOC_ID12_05` 0x0F
ID bits 12-5.
- #define `CAN_ERR_PROT_LOC_ID04_00` 0x0E
ID bits 4-0.
- #define `CAN_ERR_PROT_LOC_RTR` 0x0C
RTR.
- #define `CAN_ERR_PROT_LOC_RES1` 0x0D
reserved bit 1
- #define `CAN_ERR_PROT_LOC_RES0` 0x09
reserved bit 0
- #define `CAN_ERR_PROT_LOC_DLC` 0x0B
data length code
- #define `CAN_ERR_PROT_LOC_DATA` 0x0A
data section
- #define `CAN_ERR_PROT_LOC_CRC_SEQ` 0x08
CRC sequence.
- #define `CAN_ERR_PROT_LOC_CRC_DEL` 0x18
CRC delimiter.
- #define `CAN_ERR_PROT_LOC_ACK` 0x19
ACK slot.
- #define `CAN_ERR_PROT_LOC_ACK_DEL` 0x1B
ACK delimiter.
- #define `CAN_ERR_PROT_LOC_EOF` 0x1A
end of frame
- #define `CAN_ERR_PROT_LOC_INTERM` 0x12
intermission

Protocol error location

Error in the data[4] field of struct `can_frame`.

- #define `CAN_ERR_TRX_UNSPEC` 0x00
0000 0000
- #define `CAN_ERR_TRX_CANH_NO_WIRE` 0x04
0000 0100
- #define `CAN_ERR_TRX_CANH_SHORT_TO_BAT` 0x05
0000 0101
- #define `CAN_ERR_TRX_CANH_SHORT_TO_VCC` 0x06
0000 0110
- #define `CAN_ERR_TRX_CANH_SHORT_TO_GND` 0x07
0000 0111
- #define `CAN_ERR_TRX_CANL_NO_WIRE` 0x40
0100 0000
- #define `CAN_ERR_TRX_CANL_SHORT_TO_BAT` 0x50
0101 0000
- #define `CAN_ERR_TRX_CANL_SHORT_TO_VCC` 0x60
0110 0000
- #define `CAN_ERR_TRX_CANL_SHORT_TO_GND` 0x70
0111 0000
- #define `CAN_ERR_TRX_CANL_SHORT_TO_CANH` 0x80
1000 0000

CAN protocols

Possible protocols for PF_CAN protocol family

- enum `CAN_PROTO` { `CAN_PROTO_RAW` }

CAN operation modes

Modes into which CAN controllers can be set

- enum `CAN_MODE` { `CAN_MODE_STOP` = 0, `CAN_MODE_START`, `CAN_MODE_SLEEP` }

CAN controller states

States a CAN controller can be in.

- enum [CAN_STATE](#) {
 [CAN_STATE_ACTIVE](#) = 0, [CAN_STATE_BUS_WARNING](#), [CAN_STATE_BUS_PASSIVE](#),
 [CAN_STATE_BUS_OFF](#),
 [CAN_STATE_SCANNING_BAUDRATE](#), [CAN_STATE_STOPPED](#), [CAN_STATE_SLEEPING](#) }

Defines

- #define [AF_CAN](#) 29
 CAN address family.
- #define [PF_CAN](#) [AF_CAN](#)
 CAN protocol family.

Typedefs

- typedef uint32_t [can_id_t](#)
 Type of CAN id (see [CAN_xxx_MASK](#) and [CAN_xxx_FLAG](#)).
- typedef [can_id_t](#) [can_err_mask_t](#)
 Type of CAN error mask.
- typedef uint32_t [can_baudrate_t](#)
 Baudrate definition in bits per second.
- typedef enum [CAN_BITTIME_TYPE](#) [can_bittime_type_t](#)
 See [CAN_BITTIME_TYPE](#).
- typedef enum [CAN_MODE](#) [can_mode_t](#)
 See [CAN_MODE](#).
- typedef int [can_ctrlmode_t](#)
 See [CAN_CTRLMODE](#).
- typedef enum [CAN_STATE](#) [can_state_t](#)
 See [CAN_STATE](#).
- typedef [can_filter](#) [can_filter_t](#)
 Filter for reception of CAN messages.
- typedef [can_frame](#) [can_frame_t](#)
 Raw CAN frame.

Enumerations

- enum [CAN_BITTIME_TYPE](#) { [CAN_BITTIME_STD](#), [CAN_BITTIME_BTR](#) }
Supported CAN bit-time types.

5.1.2 Define Documentation

5.1.2.1 #define CAN_RAW_ERR_FILTER 0x2

CAN error mask.

A CAN error mask (see [Errors](#)) can be set with `setsockopt`. This mask is then used to decide if error frames are sent to this socket in case of error conditions. The error frames are marked with the [CAN_ERR_FLAG](#) of [CAN_XXX_FLAG](#) and must be handled by the application properly. A detailed description of the error can be found in the `can_id` and the data fields of struct [can_frame](#) (see [Errors](#) for further details).

Parameters:

- ← *level* `SOL_CAN_RAW`
- ← *optname* `CAN_RAW_ERR_FILTER`
- ← *optval* Pointer to error mask of type `can_err_mask_t`.
- ← *optlen* Size of error mask: `sizeof(can_err_mask_t)`.

Environments: non-RT (RT optional)

Specific return values:

- EFAULT (It was not possible to access user space memory area at the specified address.)
- EINVAL (Invalid length "optlen")

5.1.2.2 #define CAN_RAW_FILTER 0x1

CAN filter definition.

A CAN raw filter list with elements of struct [can_filter](#) can be installed with `setsockopt`. This list is used upon reception of CAN frames to decide whether the bound socket will receive a frame. An empty filter list can also be defined using `optlen = 0`, which is recommended for write-only sockets.

If the socket was already bound with [Bind](#), the old filter list gets replaced with the new one. Be aware that already received, but not read out CAN frames may stay in the socket buffer.

Parameters:

- ← *level* `SOL_CAN_RAW`
- ← *optname* `CAN_RAW_FILTER`
- ← *optval* Pointer to array of struct [can_filter](#).
- ← *optlen* Size of filter list: `count * sizeof(struct can_filter)`.

Environments: non-RT (RT optional)

Specific return values:

- -EFAULT (It was not possible to access user space memory area at the specified address.)
- -ENOMEM (Not enough memory to fulfill the operation)
- -EINVAL (Invalid length "optlen")
- -ENOSPC (No space to store filter list, check RT-Socket-CAN kernel parameters)

5.1.2.3 #define CAN_RAW_TX_LOOPBACK 0x3

CAN TX loopback.

The TX loopback to other local sockets can be selected with this `setsockopt`.

Note:

The TX loopback feature must be enabled in the kernel and then the loopback to other local TX sockets is enabled by default.

Parameters:

- ← *level* `SOL_CAN_RAW`
- ← *optname* `CAN_RAW_TX_LOOPBACK`
- ← *optval* Pointer to integer value.
- ← *optlen* Size of int: `sizeof(int)`.

Environments: non-RT (RT optional)

Specific return values:

- -EFAULT (It was not possible to access user space memory area at the specified address.)
- -EINVAL (Invalid length "optlen")
- -EOPNOTSUPP (not supported, check RT-Socket-CAN kernel parameters).

5.1.2.4 #define RTCAN_RTIOC_RCV_TIMEOUT _IOW(RTIOC_TYPE_CAN, 0x0A, nanosecs_rel_t)

Specify a reception timeout for a socket.

Defines a timeout for all receive operations via a socket which will take effect when one of the [receive functions](#) is called without the `MSG_DONTWAIT` flag set.

The default value for a newly created socket is an infinite timeout.

Note:

The setting of the timeout value is not done atomically to avoid locks. Please set the value before receiving messages from the socket.

Parameters:

- ← *arg* Pointer to `nanosecs_rel_t` variable. The value is interpreted as relative timeout in nanoseconds in case of a positive value. See [Timeouts](#) for special timeouts.

Returns:

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.1.2.5 `#define RTCAN_RTIOC_SND_TIMEOUT _IOW(RTIOC_TYPE_CAN, 0x0B, nanosecs_rel_t)`

Specify a transmission timeout for a socket.

Defines a timeout for all send operations via a socket which will take effect when one of the [send functions](#) is called without the MSG_DONTWAIT flag set.

The default value for a newly created socket is an infinite timeout.

Note:

The setting of the timeout value is not done atomically to avoid locks. Please set the value before sending messages to the socket.

Parameters:

← *arg* Pointer to [nanosecs_rel_t](#) variable. The value is interpreted as relative timeout in nanoseconds in case of a positive value. See [Timeouts](#) for special timeouts.

Returns:

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.1.2.6 `#define RTCAN_RTIOC_TAKE_TIMESTAMP _IOW(RTIOC_TYPE_CAN, 0x09, int)`

Enable or disable storing a high precision timestamp upon reception of a CAN frame.

A newly created socket takes no timestamps by default.

Parameters:

← *arg* int variable, see [Timestamp switches](#)

Returns:

0 on success.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Note:

Activating taking timestamps only has an effect on newly received CAN messages from the bus. Frames that already are in the socket buffer do not have timestamps if it was deactivated before. See [Receive](#) for more details.

Rescheduling: never.

5.1.2.7 #define SIOCGCANBAUDRATE_IOWR(RTIOC_TYPE_CAN, 0x02, struct ifreq)

Get baud rate.

Parameters:

↔ *arg* Pointer to interface request structure buffer (struct ifreq from linux/if.h). ifr_name must hold a valid CAN interface name, ifr_ifru will be filled with an instance of [can_baudrate_t](#).

Returns:

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.
- -EINVAL: No baud rate was set yet.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.1.2.8 #define SIOCGCANCTRLMODE _IOWR(RTIOC_TYPE_CAN, 0x08, struct ifreq)

Get special controller modes.

Parameters:

← *arg* Pointer to interface request structure buffer (struct ifreq from linux/if.h). ifr_name must hold a valid CAN interface name, ifr_ifru must be filled with an instance of [can_ctrlmode_t](#).

Returns:

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.
- -EINVAL: No baud rate was set yet.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.1.2.9 #define SIOCGCANCUSTOMBITTIME _IOWR(RTIOC_TYPE_CAN, 0x04, struct ifreq)

Get custom bit-time parameters.

Parameters:

↔ *arg* Pointer to interface request structure buffer (struct ifreq from linux/if.h). ifr_name must hold a valid CAN interface name, ifr_ifru will be filled with an instance of struct [can_bittime](#).

Returns:

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.
- -EINVAL: No baud rate was set yet.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.1.2.10 #define SIOCGCANSTATE _IOWR(RTIOC_TYPE_CAN, 0x06, struct ifreq)

Get current state of CAN controller.

States are divided into main states and additional error indicators. A CAN controller is always in exactly one main state. CAN bus errors are registered by the CAN hardware and collected by the driver. There is one error indicator (bit) per error type. If this IOCTL is triggered the error types which occurred since the last call of this IOCTL are reported and thereafter the error indicators are cleared. See also [CAN controller states](#).

Parameters:

↔ *arg* Pointer to interface request structure buffer (`struct ifreq` from `linux/if.h`). `ifr_name` must hold a valid CAN interface name, `ifr_ifru` will be filled with an instance of `can_mode_t`.

Returns:

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.1.2.11 #define SIOCGIFINDEX _IOWR(RTIOC_TYPE_CAN, 0x00, struct ifreq)

Get CAN interface index by name.

Parameters:

↔ *arg* Pointer to interface request structure buffer (`struct ifreq` from `linux/if.h`). If `ifr_name` holds a valid CAN interface name `ifr_ifindex` will be filled with the corresponding interface index.

Returns:

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.1.2.12 `#define SIOCSCANBAUDRATE _IOW(RTIOC_TYPE_CAN, 0x01, struct ifreq)`

Set baud rate.

The baudrate must be specified in bits per second. The driver will try to calculate resonable CAN bit-timing parameters. You can use [SIOCSCANCUSTOMBITTIME](#) to set custom bit-timing.

Parameters:

← *arg* Pointer to interface request structure buffer (`struct ifreq` from `linux/if.h`). `ifr_name` must hold a valid CAN interface name, `ifr_ifru` must be filled with an instance of [can_baudrate_t](#).

Returns:

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.
- -EINVAL: No valid baud rate, see [can_baudrate_t](#).
- -EDOM : Baud rate not possible.
- -EAGAIN: Request could not be successully fulfilled. Try again.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Note:

Setting the baud rate is a configuration task. It should be done deliberately or otherwise CAN messages will likely be lost.

Rescheduling: possible.

5.1.2.13 `#define SIOCSCANCTRLMODE _IOW(RTIOC_TYPE_CAN, 0x07, struct ifreq)`

Set special controller modes.

Various special controller modes could be or'ed together (see [CAN_CTRLMODE](#) for further information).

Parameters:

← *arg* Pointer to interface request structure buffer (`struct ifreq` from `linux/if.h`). `ifr_name` must hold a valid CAN interface name, `ifr_ifru` must be filled with an instance of [can_ctrlmode_t](#).

Returns:

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.

- -EINVAL: No valid baud rate, see [can_baudrate_t](#).
- -EAGAIN: Request could not be successfully fulfilled. Try again.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Note:

Setting special controller modes is a configuration task. It should be done deliberately or otherwise CAN messages will likely be lost.

Rescheduling: possible.

5.1.2.14 `#define SIOCSCANCUSTOMBITTIME _IOW(RTIOC_TYPE_CAN, 0x03, struct ifreq)`

Set custom bit time parameter.

Custom-bit time could be defined in various formats (see struct [can_bittime](#)).

Parameters:

← *arg* Pointer to interface request structure buffer (struct `ifreq` from `linux/if.h`). `ifr_name` must hold a valid CAN interface name, `ifr_ifru` must be filled with an instance of struct [can_bittime](#).

Returns:

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.
- -EINVAL: No valid baud rate, see [can_baudrate_t](#).
- -EAGAIN: Request could not be successfully fulfilled. Try again.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Note:

Setting the bit-time is a configuration task. It should be done deliberately or otherwise CAN messages will likely be lost.

Rescheduling: possible.

5.1.2.15 #define SIOCSCANMODE_IOW(RTIOC_TYPE_CAN, 0x05, struct ifreq)

Set operation mode of CAN controller.

See [CAN controller modes](#) for available modes.

Parameters:

- ← *arg* Pointer to interface request structure buffer (struct ifreq from linux/if.h). ifr_name must hold a valid CAN interface name, ifr_ifru must be filled with an instance of [can_mode_t](#).

Returns:

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.
- -EAGAIN: ([CAN_MODE_START](#), [CAN_MODE_STOP](#)) Could not successfully set mode, hardware is busy. Try again.
- -EINVAL: ([CAN_MODE_START](#)) Cannot start controller, set baud rate first.
- -ENETDOWN: ([CAN_MODE_SLEEP](#)) Cannot go into sleep mode because controller is stopped or bus off.
- -EOPNOTSUPP: unknown mode

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Note:

Setting a CAN controller into normal operation after a bus-off can take some time (128 occurrences of 11 consecutive recessive bits). In such a case, although this IOCTL will return immediately with success and [SIOCGCANSTATE](#) will report [CAN_STATE_ACTIVE](#), bus-off recovery may still be in progress.

If a controller is bus-off, setting it into stop mode will return no error but the controller remains bus-off.

Rescheduling: possible.

5.1.3 Typedef Documentation

5.1.3.1 typedef struct [can_filter](#) [can_filter_t](#)

Filter for reception of CAN messages.

This filter works as follows: A received CAN ID is AND'ed bitwise with [can_mask](#) and then compared to [can_id](#). If this comparison is true the message will be received by the socket.

Multiple filters can be arranged in a filter list and set with [Sockopts](#). If one of these filters matches a CAN ID upon reception of a CAN frame, this frame is accepted.

Note:

Only `CAN_EFF_FLAG` of `CAN ID flags` is valid for `can_id` and none for `can_mask`. This means that the RTR bit is not taken into account while filtering messages.

Extended IDs are received only if `CAN_EFF_FLAG` is set in `can_id`. If it is cleared only standard IDs are accepted.

5.1.3.2 typedef struct `can_frame` `can_frame_t`

Raw CAN frame.

Central structure for receiving and sending CAN frames.

5.1.4 Enumeration Type Documentation**5.1.4.1 enum `CAN_BITTIME_TYPE`**

Supported CAN bit-time types.

Enumerator:

`CAN_BITTIME_STD` Standard bit-time definition according to Bosch.

`CAN_BITTIME_BTR` Hardware-specific BTR bit-time definition.

5.1.4.2 enum `CAN_MODE`**Enumerator:**

`CAN_MODE_STOP` Set controller in Stop mode (no reception / transmission possible).

`CAN_MODE_START` Set controller into normal operation.

Coming from stopped mode or bus off, the controller begins with no errors in `CAN_STATE_ACTIVE`.

`CAN_MODE_SLEEP` Set controller into Sleep mode.

This is only possible if the controller is not stopped or bus-off.

Notice that sleep mode will only be entered when there is no bus activity. If the controller detects bus activity while "sleeping" it will go into operating mode again.

To actively leave sleep mode again trigger `CAN_MODE_START`.

5.1.4.3 enum `CAN_PROTO`**Enumerator:**

`CAN_PROTO_RAW` Raw protocol of `PF_CAN`, applicable to socket type `SOCK_RAW`.

5.1.4.4 enum `CAN_STATE`**Enumerator:**

`CAN_STATE_ACTIVE` CAN controller is error active.

`CAN_STATE_BUS_WARNING` CAN controller is error active, warning level is reached.

CAN_STATE_BUS_PASSIVE CAN controller is error passive.

CAN_STATE_BUS_OFF CAN controller went into Bus Off.

CAN_STATE_SCANNING_BAUDRATE CAN controller is scanning to get the baudrate.

CAN_STATE_STOPPED CAN controller is in stopped mode.

CAN_STATE_SLEEPING CAN controller is in Sleep mode.

5.2 Real-Time Driver Model

5.2.1 Detailed Description

The Real-Time Driver Model (RTDM) provides a unified interface to both users and developers of real-time device drivers. Specifically, it addresses the constraints of mixed RT/non-RT systems like Xenomai. RTDM conforms to POSIX semantics (IEEE Std 1003.1) where available and applicable.

API Revision: 5

Modules

- [User API](#)
- [Driver Development API](#)
- [Device Profiles](#)

API Versioning

- `#define RTDM_API_VER 5`
Common user and driver API version.
- `#define RTDM_API_MIN_COMPAT_VER 5`
Minimum API revision compatible with the current release.

RTDM_TIMEOUT_XXX

Special timeout values

- `#define RTDM_TIMEOUT_INFINITE 0`
Block forever.
- `#define RTDM_TIMEOUT_NONE (-1)`
Any negative timeout means non-blocking.

Typedefs

- `typedef uint64_t nanosecs_abs_t`
RTDM type for representing absolute dates.
- `typedef int64_t nanosecs_rel_t`
RTDM type for representing relative intervals.

5.2.2 Typedef Documentation

5.2.2.1 typedef uint64_t [nanosecs_abs_t](#)

RTDM type for representing absolute dates.

Its base type is a 64 bit unsigned integer. The unit is 1 nanosecond.

5.2.2.2 typedef int64_t [nanosecs_rel_t](#)

RTDM type for representing relative intervals.

Its base type is a 64 bit signed integer. The unit is 1 nanosecond. Relative intervals can also encode the special timeouts "infinite" and "non-blocking", see [RTDM_TIMEOUT_xxx](#).

5.3 User API

5.3.1 Detailed Description

This is the upper interface of RTDM provided to application programs both in kernel and user space. Note that certain functions may not be implemented by every device. Refer to the [Device Profiles](#) for precise information.

Files

- file [rtdm.h](#)
Real-Time Driver Model for Xenomai, user API header.

Functions

- int [rt_dev_open](#) (const char *path, int oflag,...)
Open a device.
- int [rt_dev_socket](#) (int protocol_family, int socket_type, int protocol)
Create a socket.
- int [rt_dev_close](#) (int fd)
Close a device or socket.
- int [rt_dev_ioctl](#) (int fd, int request,...)
Issue an IOCTL.
- ssize_t [rt_dev_read](#) (int fd, void *buf, size_t nbyte)
Read from device.
- ssize_t [rt_dev_write](#) (int fd, const void *buf, size_t nbyte)
Write to device.
- ssize_t [rt_dev_recvmsg](#) (int fd, struct msghdr *msg, int flags)
Receive message from socket.
- ssize_t [rt_dev_recvfrom](#) (int fd, void *buf, size_t len, int flags, struct sockaddr *from, socklen_t *fromlen)
Receive message from socket.
- ssize_t [rt_dev_recv](#) (int fd, void *buf, size_t len, int flags)
Receive message from socket.
- ssize_t [rt_dev_sendmsg](#) (int fd, const struct msghdr *msg, int flags)
Transmit message to socket.
- ssize_t [rt_dev_sendto](#) (int fd, const void *buf, size_t len, int flags, const struct sockaddr *to, socklen_t tolen)

Transmit message to socket.

- `ssize_t rt_dev_send` (int fd, const void *buf, size_t len, int flags)
Transmit message to socket.
- `int rt_dev_bind` (int fd, const struct sockaddr *my_addr, socklen_t addrlen)
Bind to local address.
- `int rt_dev_connect` (int fd, const struct sockaddr *serv_addr, socklen_t addrlen)
Connect to remote address.
- `int rt_dev_listen` (int fd, int backlog)
Listen for incoming connection requests.
- `int rt_dev_accept` (int fd, struct sockaddr *addr, socklen_t *addrlen)
Accept a connection requests.
- `int rt_dev_shutdown` (int fd, int how)
Shut down parts of a connection.
- `int rt_dev_getsockopt` (int fd, int level, int optname, void *optval, socklen_t *optlen)
Get socket option.
- `int rt_dev_setsockopt` (int fd, int level, int optname, const void *optval, socklen_t optlen)
Set socket option.
- `int rt_dev_getsockname` (int fd, struct sockaddr *name, socklen_t *namelen)
Get local socket address.
- `int rt_dev_getpeername` (int fd, struct sockaddr *name, socklen_t *namelen)
Get socket destination address.

5.3.2 Function Documentation

5.3.2.1 `int rt_dev_accept` (int *fd*, struct sockaddr * *addr*, socklen_t * *addrlen*)

Accept a connection requests.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- *addr* Buffer for remote address
- ↔ *addrlen* Address buffer size

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

accept() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.2 int rt_dev_bind (int *fd*, const struct sockaddr * *my_addr*, socklen_t *addrlen*)

Bind to local address.

Parameters:

← *fd* File descriptor as returned by rt_dev_socket()

← *my_addr* Address buffer

← *addrlen* Address buffer size

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

bind() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.3 int rt_dev_close (int *fd*)

Close a device or socket.

Parameters:

← *fd* File descriptor as returned by rt_dev_open() or rt_dev_socket()

Returns:

0 on success, otherwise a negative error code.

Note:

If the matching rt_dev_open() or rt_dev_socket() call took place in non-real-time context, rt_dev_close() must be issued within non-real-time as well. Otherwise, the call will fail.

Killing a real-time task that is blocked on some device operation can lead to stalled file descriptors. To avoid such scenarios, always close the device before explicitly terminating any real-time task which may use it. To cleanup a stalled file descriptor, send its number to the open_fildes /proc entry, e.g. via

```
#> echo 3 > /proc/xenomai/rtdm/open_fildes
```

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

close() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.4 `int rt_dev_connect (int fd, const struct sockaddr * serv_addr, socklen_t addrlen)`

Connect to remote address.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- ← *serv_addr* Address buffer
- ← *addrlen* Address buffer size

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

`connect()` in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.5 `int rt_dev_getpeername (int fd, struct sockaddr * name, socklen_t * namelen)`

Get socket destination address.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- *name* Address buffer
- ↔ *namelen* Address buffer size

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

`getpeername()` in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.6 `int rt_dev_getsockname (int fd, struct sockaddr * name, socklen_t * namelen)`

Get local socket address.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- *name* Address buffer
- ↔ *namelen* Address buffer size

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

getsockname() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.7 int rt_dev_getsockopt (int *fd*, int *level*, int *optname*, void * *optval*, socklen_t * *optlen*)

Get socket option.

Parameters:

- ← *fd* File descriptor as returned by rt_dev_socket()
- ← *level* Addressed stack level
- ← *optname* Option name ID
- *optval* Value buffer
- ↔ *optlen* Value buffer size

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

getsockopt() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.8 int rt_dev_ioctl (int *fd*, int *request*, ...)

Issue an IOCTL.

Parameters:

- ← *fd* File descriptor as returned by rt_dev_open() or rt_dev_socket()
- ← *request* IOCTL code
- ... Optional third argument, depending on IOCTL function (void * or unsigned long)

Returns:

Positiv value on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

ioctl() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.9 int rt_dev_listen (int *fd*, int *backlog*)

Listen for incoming connection requests.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- ← *backlog* Maximum queue length

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

`listen()` in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.10 int rt_dev_open (const char * *path*, int *oflag*, ...)

Open a device.

Parameters:

- ← *path* Device name
- ← *oflag* Open flags
- ... Further parameters will be ignored.

Returns:

Positive file descriptor value on success, otherwise a negative error code.

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

`open()` in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.11 ssize_t rt_dev_read (int *fd*, void * *buf*, size_t *nbyte*)

Read from device.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_open()`
- *buf* Input buffer
- ← *nbyte* Number of bytes to read

Returns:

Number of bytes read, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

`read()` in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.12 `ssize_t rt_dev_recv (int fd, void * buf, size_t len, int flags)`

Receive message from socket.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- *buf* Message buffer
- ← *len* Message buffer size
- ← *flags* Message flags

Returns:

Number of bytes received, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

`recv()` in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.13 `ssize_t rt_dev_recvfrom (int fd, void * buf, size_t len, int flags, struct sockaddr * from, socklen_t * fromlen)`

Receive message from socket.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- *buf* Message buffer
- ← *len* Message buffer size
- ← *flags* Message flags
- *from* Buffer for message sender address
- ↔ *fromlen* Address buffer size

Returns:

Number of bytes received, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

recvfrom() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.14 ssize_t rt_dev_recvmsg (int *fd*, struct msghdr * *msg*, int *flags*)

Receive message from socket.

Parameters:

← *fd* File descriptor as returned by rt_dev_socket()

↔ *msg* Message descriptor

← *flags* Message flags

Returns:

Number of bytes received, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

recvmsg() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.15 ssize_t rt_dev_send (int *fd*, const void * *buf*, size_t *len*, int *flags*)

Transmit message to socket.

Parameters:

← *fd* File descriptor as returned by rt_dev_socket()

← *buf* Message buffer

← *len* Message buffer size

← *flags* Message flags

Returns:

Number of bytes sent, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

send() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.16 `ssize_t rt_dev_sendmsg (int fd, const struct msghdr * msg, int flags)`

Transmit message to socket.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- ← *msg* Message descriptor
- ← *flags* Message flags

Returns:

Number of bytes sent, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

`sendmsg()` in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.17 `ssize_t rt_dev_sendto (int fd, const void * buf, size_t len, int flags, const struct sockaddr * to, socklen_t tolen)`

Transmit message to socket.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- ← *buf* Message buffer
- ← *len* Message buffer size
- ← *flags* Message flags
- ← *to* Buffer for message destination address
- ← *tolen* Address buffer size

Returns:

Number of bytes sent, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

`sendto()` in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.18 `int rt_dev_setsockopt (int fd, int level, int optname, const void * optval, socklen_t optlen)`

Set socket option.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- ← *level* Addressed stack level
- ← *optname* Option name ID
- ← *optval* Value buffer
- ← *optlen* Value buffer size

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

`setsockopt()` in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.19 `int rt_dev_shutdown (int fd, int how)`

Shut down parts of a connection.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- ← *how* Specifies the part to be shut down (`SHUT_xxx`)

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

`shutdown()` in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.20 `int rt_dev_socket (int protocol_family, int socket_type, int protocol)`

Create a socket.

Parameters:

- ← *protocol_family* Protocol family (`PF_xxx`)

← *socket_type* Socket type (SOCK_XXX)

← *protocol* Protocol ID, 0 for default

Returns:

Positive file descriptor value on success, otherwise a negative error code.

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

socket() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.3.2.21 ssize_t rt_dev_write (int *fd*, const void * *buf*, size_t *nbyte*)

Write to device.

Parameters:

← *fd* File descriptor as returned by rt_dev_open()

← *buf* Output buffer

← *nbyte* Number of bytes to write

Returns:

Number of bytes written, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

write() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.4 Serial Devices

5.4.1 Detailed Description

This is a **preliminary** version of the common interface a RTDM-compliant serial device has to provide. This revision may still change until the final version. E.g., all definitions need to be reviewed if they do not contain too much 16550A-specifics or if significant features are missing. Feel free to comment on this profile via the Xenomai mailing list (Xenomai-help@gna.org) or directly to the author (jan.kiszka@web.de).

Device Characteristics

Device Flags: RTDM_NAMED_DEVICE, RTDM_EXCLUSIVE

Device Name: "rtser<N>", N >= 0

Device Class: RTDM_CLASS_SERIAL

Supported Operations

Open

Environments: non-RT (RT optional)

Specific return values: none

Close

Environments: non-RT (RT optional)

Specific return values: none

IOCTL

Mandatory Environments: see [below](#)

Specific return values: see [below](#)

Read

Environments: RT (non-RT optional)

Specific return values:

- -ETIMEDOUT
- -EINTR (interrupted explicitly or by signal)
- -EAGAIN (no data available in non-blocking mode)
- -EBADF (device has been closed while reading)
- -EIO (hardware error or broken bit stream)

Write

Environments: RT (non-RT optional)

Specific return values:

- -ETIMEDOUT
- -EINTR (interrupted explicitly or by signal)
- -EAGAIN (no data written in non-blocking mode)
- -EBADF (device has been closed while writing)

Files

- file [rtserial.h](#)

Real-Time Driver Model for Xenomai, serial device profile header.

Data Structures

- struct `rtser_config`
Serial device configuration.
- struct `rtser_status`
Serial device status.
- struct `rtser_event`
Additional information about serial device events.

RTSER_DEF_BAUD

Default baud rate

- `#define RTSER_DEF_BAUD 9600`

RTSER_xxx_PARITY

Number of parity bits

- `#define RTSER_NO_PARITY 0x00`
- `#define RTSER_ODD_PARITY 0x01`
- `#define RTSER_EVEN_PARITY 0x03`
- `#define RTSER_DEF_PARITY RTSER_NO_PARITY`

RTSER_xxx_BITS

Number of data bits

- `#define RTSER_5_BITS 0x00`
- `#define RTSER_6_BITS 0x01`
- `#define RTSER_7_BITS 0x02`
- `#define RTSER_8_BITS 0x03`
- `#define RTSER_DEF_BITS RTSER_8_BITS`

RTSER_xxx_STOPB

Number of stop bits

- `#define RTSER_1_STOPB 0x00`
- `#define RTSER_1_5_STOPB 0x01`
valid only in combination with 5 data bits
- `#define RTSER_2_STOPB 0x01`
- `#define RTSER_DEF_STOPB RTSER_1_STOPB`

RTSER_xxx_HAND

Handshake mechanisms

- `#define RTSER_NO_HAND 0x00`
- `#define RTSER_RTSCTS_HAND 0x01`
- `#define RTSER_DEF_HAND RTSER_NO_HAND`

RTSER_FIFO_xxx

Reception FIFO interrupt threshold

- `#define RTSER_FIFO_DEPTH_1 0x00`
- `#define RTSER_FIFO_DEPTH_4 0x40`
- `#define RTSER_FIFO_DEPTH_8 0x80`
- `#define RTSER_FIFO_DEPTH_14 0xC0`
- `#define RTSER_DEF_FIFO_DEPTH RTSER_FIFO_DEPTH_1`

RTSER_TIMEOUT_xxx

Special timeout values, see also [RTDM_TIMEOUT_xxx](#)

- `#define RTSER_TIMEOUT_INFINITE RTDM_TIMEOUT_INFINITE`
- `#define RTSER_TIMEOUT_NONE RTDM_TIMEOUT_NONE`
- `#define RTSER_DEF_TIMEOUT RTDM_TIMEOUT_INFINITE`

RTSER_xxx_TIMESTAMP_HISTORY

Timestamp history control

- `#define RTSER_RX_TIMESTAMP_HISTORY 0x01`
- `#define RTSER_DEF_TIMESTAMP_HISTORY 0x00`

RTSER_EVENT_xxx

Events bits

- `#define RTSER_EVENT_RXPEND 0x01`
- `#define RTSER_EVENT_ERRPEND 0x02`
- `#define RTSER_EVENT_MODEMHI 0x04`
- `#define RTSER_EVENT_MODEMLO 0x08`
- `#define RTSER_DEF_EVENT_MASK 0x00`

RTSER_SET_xxx

Configuration mask bits

- #define RTSER_SET_BAUD 0x0001
- #define RTSER_SET_PARITY 0x0002
- #define RTSER_SET_DATA_BITS 0x0004
- #define RTSER_SET_STOP_BITS 0x0008
- #define RTSER_SET_HANDSHAKE 0x0010
- #define RTSER_SET_FIFO_DEPTH 0x0020
- #define RTSER_SET_TIMEOUT_RX 0x0100
- #define RTSER_SET_TIMEOUT_TX 0x0200
- #define RTSER_SET_TIMEOUT_EVENT 0x0400
- #define RTSER_SET_TIMESTAMP_HISTORY 0x0800
- #define RTSER_SET_EVENT_MASK 0x1000

RTSER_LSR_xxx

Line status bits

- #define RTSER_LSR_DATA 0x01
- #define RTSER_LSR_OVERRUN_ERR 0x02
- #define RTSER_LSR_PARITY_ERR 0x04
- #define RTSER_LSR_FRAMING_ERR 0x08
- #define RTSER_LSR_BREAK_IND 0x10
- #define RTSER_LSR_THR_EMPTY 0x20
- #define RTSER_LSR_TRANSM_EMPTY 0x40
- #define RTSER_LSR_FIFO_ERR 0x80
- #define RTSER_SOFT_OVERRUN_ERR 0x0100

RTSER_MSR_xxx

Modem status bits

- #define RTSER_MSR_DCTS 0x01
- #define RTSER_MSR_DDSD 0x02
- #define RTSER_MSR_TERI 0x04
- #define RTSER_MSR_DDCD 0x08
- #define RTSER_MSR_CTS 0x10
- #define RTSER_MSR_DSR 0x20
- #define RTSER_MSR_RI 0x40
- #define RTSER_MSR_DCD 0x80

RTSER_MCR_XXX

Modem control bits

- #define **RTSER_MCR_DTR** 0x01
- #define **RTSER_MCR_RTS** 0x02
- #define **RTSER_MCR_OUT1** 0x04
- #define **RTSER_MCR_OUT2** 0x08
- #define **RTSER_MCR_LOOP** 0x10

IOCTLs

Serial device IOCTLs

- #define **RTSER_RTIOC_GET_CONFIG** _IOR(RTIOC_TYPE_SERIAL, 0x00, struct rtser_config)
Get serial device configuration.
- #define **RTSER_RTIOC_SET_CONFIG** _IOW(RTIOC_TYPE_SERIAL, 0x01, struct rtser_config)
Set serial device configuration.
- #define **RTSER_RTIOC_GET_STATUS** _IOR(RTIOC_TYPE_SERIAL, 0x02, struct rtser_status)
Get serial device status.
- #define **RTSER_RTIOC_GET_CONTROL** _IOR(RTIOC_TYPE_SERIAL, 0x03, int)
Get serial device's modem control register.
- #define **RTSER_RTIOC_SET_CONTROL** _IOW(RTIOC_TYPE_SERIAL, 0x04, int)
Set serial device's modem control register.
- #define **RTSER_RTIOC_WAIT_EVENT** _IOR(RTIOC_TYPE_SERIAL, 0x05, struct rtser_event)
Wait on serial device events according to previously set mask.

Typedefs

- typedef **rtser_config** **rtser_config_t**
Serial device configuration.
- typedef **rtser_status** **rtser_status_t**
Serial device status.
- typedef **rtser_event** **rtser_event_t**
Additional information about serial device events.

5.4.2 Define Documentation

5.4.2.1 `#define RTSER_RTIOC_GET_CONFIG _IOR(RTIOC_TYPE_SERIAL, 0x00, struct rtser_config)`

Get serial device configuration.

Parameters:

→ *arg* Pointer to configuration buffer (struct [rtser_config](#))

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.4.2.2 `#define RTSER_RTIOC_GET_CONTROL _IOR(RTIOC_TYPE_SERIAL, 0x03, int)`

Get serial device's modem control register.

Parameters:

→ *arg* Pointer to variable receiving the content (int, see [RTSER_MCR_xxx](#))

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.4.2.3 `#define RTSER_RTIOC_GET_STATUS _IOR(RTIOC_TYPE_SERIAL, 0x02, struct rtser_status)`

Get serial device status.

Parameters:

→ *arg* Pointer to status buffer (struct [rtser_status](#))

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Note:

The error states `RTSER_LSR_OVERRUN_ERR`, `RTSER_LSR_PARITY_ERR`, `RTSER_LSR_FRAMING_ERR`, and `RTSER_SOFT_OVERRUN_ERR` that may have occurred during previous read accesses to the device will be saved for being reported via this IOCTL. Upon return from `RTSER_RTIOC_GET_STATUS`, the saved state will be cleared.

Rescheduling: never.

5.4.2.4 `#define RTSER_RTIOC_SET_CONFIG _IOW(RTIOC_TYPE_SERIAL, 0x01, struct rtser_config)`

Set serial device configuration.

Parameters:

← *arg* Pointer to configuration buffer (struct [rtser_config](#))

Returns:

0 on success, otherwise:

- `-EPERM` is returned if the caller's context is invalid, see note below.
- `-ENOMEM` is returned if a new history buffer for timestamps cannot be allocated.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Note:

If [rtser_config](#) contains a valid `timestamp_history` and the addressed device has been opened in non-real-time context, this IOCTL must be issued in non-real-time context as well. Otherwise, this command will fail.

Rescheduling: never.

5.4.2.5 `#define RTSER_RTIOC_SET_CONTROL _IOW(RTIOC_TYPE_SERIAL, 0x04, int)`

Set serial device's modem control register.

Parameters:

← *arg* New control register content (int, see [RTSER_MCR_xxx](#))

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.4.2.6 `#define RTSER_RTIOC_WAIT_EVENT _IOR(RTIOC_TYPE_SERIAL, 0x05, struct rtser_event)`

Wait on serial device events according to previously set mask.

Parameters:

→ *arg* Pointer to event information buffer (struct [rtser_event](#))

Returns:

0 on success, otherwise:

- -EBUSY is returned if another task is already waiting on events of this device.
- -EBADF is returned if the file descriptor is invalid or the device has just been closed.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

5.5 Testing Devices

5.5.1 Detailed Description

This group of devices is intended to provide in-kernel testing results. Feel free to comment on this profile via the Xenomai mailing list (xenomai-core@gna.org) or directly to the author (jan.kiszka@web.de).

Device Characteristics

Device Flags: RTDM_NAMED_DEVICE

Device Name: "rtttest<N>", N >= 0

Device Class: RTDM_CLASS_TESTING

Supported Operations

Open

Environments: non-RT (RT optional)

Specific return values: none

Close

Environments: non-RT (RT optional)

Specific return values: none

IOCTL

Mandatory Environments: see [IOCTLs](#) below

Specific return values: see [IOCTLs](#) below

Files

- file [rttesting.h](#)

Real-Time Driver Model for Xenomai, testing device profile header.

IOCTLs

Testing device IOCTLs

- `#define RTTST_RTIOC_INTERM_BENCH_RES _IOWR(RTIOC_TYPE_TESTING, 0x00, struct rttst_interm_bench_res)`
- `#define RTTST_RTIOC_TMBENCH_START _IOW(RTIOC_TYPE_TESTING, 0x10, struct rttst_tmbench_config)`
- `#define RTTST_RTIOC_TMBENCH_STOP _IOWR(RTIOC_TYPE_TESTING, 0x11, struct rttst_overall_bench_res)`
- `#define RTTST_RTIOC_IRQBENCH_START _IOW(RTIOC_TYPE_TESTING, 0x20, struct rttst_irqbench_config)`
- `#define RTTST_RTIOC_IRQBENCH_STOP _IO(RTIOC_TYPE_TESTING, 0x21)`
- `#define RTTST_RTIOC_IRQBENCH_GET_STATS _IOR(RTIOC_TYPE_TESTING, 0x22, struct rttst_irqbench_stats)`
- `#define RTTST_RTIOC_IRQBENCH_WAIT_IRQ _IO(RTIOC_TYPE_TESTING, 0x23)`
- `#define RTTST_RTIOC_IRQBENCH_REPLY_IRQ _IO(RTIOC_TYPE_TESTING, 0x24)`
- `#define RTTST_RTIOC_SWTEST_SET_TASKS_COUNT _IOW(RTIOC_TYPE_TESTING, 0x30, unsigned long)`
- `#define RTTST_RTIOC_SWTEST_SET_CPU _IOW(RTIOC_TYPE_TESTING, 0x31, unsigned long)`

- `#define RTTST_RTIOC_SWTEST_REGISTER_UTASK _IOW(RTIOC_TYPE_TESTING, 0x32, struct rttst_swtest_task)`
- `#define RTTST_RTIOC_SWTEST_CREATE_KTASK _IOWR(RTIOC_TYPE_TESTING, 0x33, struct rttst_swtest_task)`
- `#define RTTST_RTIOC_SWTEST_PEND _IOR(RTIOC_TYPE_TESTING, 0x34, struct rttst_swtest_task)`
- `#define RTTST_RTIOC_SWTEST_SWITCH_TO _IOR(RTIOC_TYPE_TESTING, 0x35, struct rttst_swtest_dir)`
- `#define RTTST_RTIOC_SWTEST_GET_SWITCHES_COUNT _IOR(RTIOC_TYPE_TESTING, 0x36, unsigned long)`
- `#define RTTST_RTIOC_SWTEST_GET_LAST_ERROR _IOR(RTIOC_TYPE_TESTING, 0x37, struct rttst_swtest_error)`

5.6 Inter-Driver API

Functions

- `rt dm_dev_context * rt dm_context_get` (int fd)
Resolve file descriptor to device context.
- void `rt dm_context_lock` (struct `rt dm_dev_context` *context)
Increment context reference counter.
- void `rt dm_context_unlock` (struct `rt dm_dev_context` *context)
Decrement context reference counter.
- int `rt dm_open` (const char *path, int oflag,...)
Open a device.
- int `rt dm_socket` (int protocol_family, int socket_type, int protocol)
Create a socket.
- int `rt dm_close` (int fd)
Close a device or socket.
- int `rt dm_ioctl` (int fd, int request,...)
Issue an IOCTL.
- ssize_t `rt dm_read` (int fd, void *buf, size_t nbyte)
Read from device.
- ssize_t `rt dm_write` (int fd, const void *buf, size_t nbyte)
Write to device.
- ssize_t `rt dm_recvmmsg` (int fd, struct msghdr *msg, int flags)
Receive message from socket.
- ssize_t `rt dm_recvfrom` (int fd, void *buf, size_t len, int flags, struct sockaddr *from, socklen_t *fromlen)
Receive message from socket.
- ssize_t `rt dm_recv` (int fd, void *buf, size_t len, int flags)
Receive message from socket.
- ssize_t `rt dm_sendmsg` (int fd, const struct msghdr *msg, int flags)
Transmit message to socket.
- ssize_t `rt dm_sendto` (int fd, const void *buf, size_t len, int flags, const struct sockaddr *to, socklen_t tolen)
Transmit message to socket.
- ssize_t `rt dm_send` (int fd, const void *buf, size_t len, int flags)
Transmit message to socket.

- `int rtdm_bind (int fd, const struct sockaddr *my_addr, socklen_t addrlen)`
Bind to local address.
- `int rtdm_connect (int fd, const struct sockaddr *serv_addr, socklen_t addrlen)`
Connect to remote address.
- `int rtdm_listen (int fd, int backlog)`
Listen for incoming connection requests.
- `int rtdm_accept (int fd, struct sockaddr *addr, socklen_t *addrlen)`
Accept a connection requests.
- `int rtdm_shutdown (int fd, int how)`
Shut down parts of a connection.
- `int rtdm_getsockopt (int fd, int level, int optname, void *optval, socklen_t *optlen)`
Get socket option.
- `int rtdm_setsockopt (int fd, int level, int optname, const void *optval, socklen_t optlen)`
Set socket option.
- `int rtdm_getsockname (int fd, struct sockaddr *name, socklen_t *namelen)`
Get local socket address.
- `int rtdm_getpeername (int fd, struct sockaddr *name, socklen_t *namelen)`
Get socket destination address.

5.6.1 Function Documentation

5.6.1.1 `int rtdm_accept (int fd, struct sockaddr * addr, socklen_t * addrlen)`

Accept a connection requests.

Refer to `rt_dev_accept()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.2 `int rtdm_bind (int fd, const struct sockaddr * my_addr, socklen_t addrlen)`

Bind to local address.

Refer to `rt_dev_bind()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.3 `int rtdm_close (int fd)`

Close a device or socket.

Refer to `rt_dev_close()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.4 `int rtdm_connect (int fd, const struct sockaddr * serv_addr, socklen_t addrlen)`

Connect to remote address.

Refer to `rt_dev_connect()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.5 `struct rtdm_dev_context* rtdm_context_get (int fd)`

Resolve file descriptor to device context.

Parameters:

← *fd* File descriptor

Returns:

Pointer to associated device context, or NULL on error

Note:

The device context has to be unlocked using [rtdm_context_unlock\(\)](#) when it is no longer referenced.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.6.1.6 `void rtdm_context_lock (struct rtdm_dev_context * context)`

Increment context reference counter.

Parameters:

← *context* Device context

Note:

[rt dm_context_get\(\)](#) automatically increments the lock counter. You only need to call this function in special scenrios.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.6.1.7 void rtdm_context_unlock (struct [rt dm_dev_context](#) * *context*)

Decrement context reference counter.

Parameters:

← *context* Device context

Note:

Every successful call to [rt dm_context_get\(\)](#) must be matched by a [rt dm_context_unlock\(\)](#) invocation.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.6.1.8 int rtdm_getpeername (int *fd*, struct sockaddr * *name*, socklen_t * *namelen*)

Get socket destination address.

Refer to [rt_dev_getpeername\(\)](#) for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.9 int rtdm_getsockname (int *fd*, struct sockaddr * *name*, socklen_t * *namelen*)

Get local socket address.

Refer to `rt_dev_getsockname()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.10 int rtdm_getsockopt (int *fd*, int *level*, int *optname*, void * *optval*, socklen_t * *optlen*)

Get socket option.

Refer to `rt_dev_getsockopt()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.11 int rtdm_ioctl (int *fd*, int *request*, ...)

Issue an IOCTL.

Refer to `rt_dev_ioctl()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.12 int rtdm_listen (int *fd*, int *backlog*)

Listen for incoming connection requests.

Refer to `rt_dev_listen()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.13 int rtdm_open (const char * *path*, int *oflag*, ...)

Open a device.

Refer to `rt_dev_open()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.14 `ssize_t rtdm_read (int fd, void * buf, size_t nbyte)`

Read from device.

Refer to `rt_dev_read()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.15 `ssize_t rtdm_recv (int fd, void * buf, size_t len, int flags)`

Receive message from socket.

Refer to `rt_dev_recv()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.16 `ssize_t rtdm_recvfrom (int fd, void * buf, size_t len, int flags, struct sockaddr * from, socklen_t * fromlen)`

Receive message from socket.

Refer to `rt_dev_recvfrom()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.17 `ssize_t rtdm_recvmsg (int fd, struct msghdr * msg, int flags)`

Receive message from socket.

Refer to `rt_dev_recvmsg()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.18 `ssize_t rtdm_send (int fd, const void * buf, size_t len, int flags)`

Transmit message to socket.

Refer to `rt_dev_send()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.19 ssize_t rtdm_sendmsg (int *fd*, const struct msghdr * *msg*, int *flags*)

Transmit message to socket.

Refer to `rt_dev_sendmsg()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.20 ssize_t rtdm_sendto (int *fd*, const void * *buf*, size_t *len*, int *flags*, const struct sockaddr * *to*, socklen_t *tolen*)

Transmit message to socket.

Refer to `rt_dev_sendto()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.21 int rtdm_setsockopt (int *fd*, int *level*, int *optname*, const void * *optval*, socklen_t *optlen*)

Set socket option.

Refer to `rt_dev_setsockopt()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.22 int rtdm_shutdown (int *fd*, int *how*)

Shut down parts of a connection.

Refer to `rt_dev_shutdown()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.23 int rtdm_socket (int *protocol_family*, int *socket_type*, int *protocol*)

Create a socket.

Refer to `rt_dev_socket()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.24 `ssize_t rtdm_write (int fd, const void * buf, size_t nbyte)`

Write to device.

Refer to `rt_dev_write()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.7 Device Registration Services

Data Structures

- struct `rtdm_operations`
Device operations.
- struct `rtdm_dev_context`
Device context.
- struct `rtdm_device`
RTDM device.

Device Flags

Static flags describing a RTDM device

- #define `RTDM_EXCLUSIVE` 0x0001
If set, only a single instance of the device can be requested by an application.
- #define `RTDM_NAMED_DEVICE` 0x0010
If set, the device is addressed via a clear-text name.
- #define `RTDM_PROTOCOL_DEVICE` 0x0020
If set, the device is addressed via a combination of protocol ID and socket type.
- #define `RTDM_DEVICE_TYPE_MASK` 0x00F0
Mask selecting the device type.

Context Flags

Dynamic flags describing the state of an open RTDM device (bit numbers)

- #define `RTDM_CREATED_IN_NRT` 0
Set by RTDM if the device instance was created in non-real-time context.
- #define `RTDM_CLOSING` 1
Set by RTDM when the device is being closed.
- #define `RTDM_FORCED_CLOSING` 2
Set by RTDM if the device has to be closed regardless of possible pending locks held by other users.
- #define `RTDM_USER_CONTEXT_FLAG` 8
Lowest bit number the driver developer can use freely.

Driver Versioning

Current revisions of RTDM structures, encoding of driver versions. See [API Versioning](#) for the interface revision.

- `#define RTDM_DEVICE_STRUCT_VER 3`
Version of struct `rtdm_device`.
- `#define RTDM_CONTEXT_STRUCT_VER 3`
Version of struct `rtdm_dev_context`.
- `#define RTDM_SECURE_DEVICE 0x80000000`
Flag indicating a secure variant of RTDM (not supported here).
- `#define RTDM_DRIVER_VER(major, minor, patch) (((major & 0xFF) << 16) | ((minor & 0xFF) << 8) | (patch & 0xFF))`
Version code constructor for driver revisions.
- `#define RTDM_DRIVER_MAJOR_VER(ver) (((ver) >> 16) & 0xFF)`
Get major version number from driver revision code.
- `#define RTDM_DRIVER_MINOR_VER(ver) (((ver) >> 8) & 0xFF)`
Get minor version number from driver revision code.
- `#define RTDM_DRIVER_PATCH_VER(ver) ((ver) & 0xFF)`
Get patch version number from driver revision code.

Operation Handler Prototypes

- `typedef int(* rtdm_open_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, int oflag)`
Named device open handler.
- `typedef int(* rtdm_socket_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, int protocol)`
Socket creation handler for protocol devices.
- `typedef int(* rtdm_close_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info)`
Close handler.
- `typedef int(* rtdm_ioctl_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, int request, void *arg)`
IOCTL handler.
- `typedef ssize_t(* rtdm_read_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, void *buf, size_t nbyte)`
Read handler.

- typedef ssize_t(* [rtdm_write_handler_t](#))(struct [rtdm_dev_context](#) *context, [rtdm_user_info_t](#) *user_info, const void *buf, size_t nbyte)
Write handler.
- typedef ssize_t(* [rtdm_recvmmsg_handler_t](#))(struct [rtdm_dev_context](#) *context, [rtdm_user_info_t](#) *user_info, struct msghdr *msg, int flags)
Receive message handler.
- typedef ssize_t(* [rtdm_sendmsg_handler_t](#))(struct [rtdm_dev_context](#) *context, [rtdm_user_info_t](#) *user_info, const struct msghdr *msg, int flags)
Transmit message handler.

Functions

- int [rtdm_dev_register](#) (struct [rtdm_device](#) *device)
Register a RTDM device.
- int [rtdm_dev_unregister](#) (struct [rtdm_device](#) *device, unsigned int poll_delay)
Unregisters a RTDM device.

5.7.1 Typedef Documentation

- 5.7.1.1 typedef int(* [rtdm_close_handler_t](#))(struct [rtdm_dev_context](#) *context, [rtdm_user_info_t](#) *user_info)

Close handler.

Parameters:

- ← *context* Context structure associated with opened device instance
- ← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call

Returns:

0 on success, otherwise negative error code

See also:

close() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

- 5.7.1.2 typedef int(* [rtdm_ioctl_handler_t](#))(struct [rtdm_dev_context](#) *context, [rtdm_user_info_t](#) *user_info, int request, void *arg)

IOCTL handler.

Parameters:

- ← *context* Context structure associated with opened device instance
- ← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call

← *request* Request number as passed by the user

↔ *arg* Request argument as passed by the user

Returns:

Positive value on success, otherwise negative error code

See also:

ioctl() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.7.1.3 `typedef int(* rtdm_open_handler_t)(struct rtdm_dev_context *context,
rtdm_user_info_t *user_info, int oflag)`

Named device open handler.

Parameters:

← *context* Context structure associated with opened device instance

← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call

← *oflag* Open flags as passed by the user

Returns:

0 on success, otherwise negative error code

See also:

open() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.7.1.4 `typedef ssize_t(* rtdm_read_handler_t)(struct rtdm_dev_context *context,
rtdm_user_info_t *user_info, void *buf, size_t nbyte)`

Read handler.

Parameters:

← *context* Context structure associated with opened device instance

← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call

→ *buf* Input buffer as passed by the user

← *nbyte* Number of bytes the user requests to read

Returns:

On success, the number of bytes read, otherwise negative error code

See also:

read() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.7.1.5 `typedef ssize_t(* rtdm_recvmmsg_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, struct msghdr *msg, int flags)`

Receive message handler.

Parameters:

- ← *context* Context structure associated with opened device instance
- ← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call
- ↔ *msg* Message descriptor as passed by the user, automatically mirrored to safe kernel memory in case of user mode call
- ← *flags* Message flags as passed by the user

Returns:

On success, the number of bytes received, otherwise negative error code

See also:

recvmmsg() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.7.1.6 `typedef ssize_t(* rtdm_sendmsg_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, const struct msghdr *msg, int flags)`

Transmit message handler.

Parameters:

- ← *context* Context structure associated with opened device instance
- ← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call
- ← *msg* Message descriptor as passed by the user, automatically mirrored to safe kernel memory in case of user mode call
- ← *flags* Message flags as passed by the user

Returns:

On success, the number of bytes transmitted, otherwise negative error code

See also:

sendmsg() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.7.1.7 `typedef int(* rtdm_socket_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, int protocol)`

Socket creation handler for protocol devices.

Parameters:

- ← *context* Context structure associated with opened device instance
- ← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call

← *protocol* Protocol number as passed by the user

Returns:

0 on success, otherwise negative error code

See also:

socket() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.7.1.8 `typedef ssize_t(* rtdm_write_handler_t)(struct rtdm_dev_context *context,
rtdm_user_info_t *user_info, const void *buf, size_t nbyte)`

Write handler.

Parameters:

- ← *context* Context structure associated with opened device instance
- ← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call
- ← *buf* Output buffer as passed by the user
- ← *nbyte* Number of bytes the user requests to write

Returns:

On success, the number of bytes written, otherwise negative error code

See also:

write() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.7.2 Function Documentation

5.7.2.1 `int rtdm_dev_register (struct rtdm_device * device)`

Register a RTDM device.

Parameters:

- ← *device* Pointer to structure describing the new device.

Returns:

0 is returned upon success. Otherwise:

- -EINVAL is returned if the device structure contains invalid entries. Check kernel log in this case.
- -ENOMEM is returned if the context for an exclusive device cannot be allocated.
- -EEXIST is returned if the specified device name of protocol ID is already in use.
- -EAGAIN is returned if some /proc entry cannot be created.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code

Rescheduling: never.

5.7.2.2 `int rtdm_dev_unregister (struct rtdm_device * device, unsigned int poll_delay)`

Unregisters a RTDM device.

Parameters:

- ← *device* Pointer to structure describing the device to be unregistered.
- ← *poll_delay* Polling delay in milliseconds to check repeatedly for open instances of *device*, or 0 for non-blocking mode.

Returns:

0 is returned upon success. Otherwise:

- -ENODEV is returned if the device was not registered.
- -EAGAIN is returned if the device is busy with open instances and 0 has been passed for *poll_delay*.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code

Rescheduling: never.

5.8 Driver Development API

5.8.1 Detailed Description

This is the lower interface of RTDM provided to device drivers, currently limited to kernel-space. Real-time drivers should only use functions of this interface in order to remain portable.

Files

- file [rtm_driver.h](#)
Real-Time Driver Model for Xenomai, driver API header.

Modules

- [Inter-Driver API](#)
- [Device Registration Services](#)
- [Clock Services](#)
- [Task Services](#)
- [Synchronisation Services](#)
- [Interrupt Management Services](#)
- [Non-Real-Time Signalling Services](#)
- [Utility Services](#)

5.9 Clock Services

Functions

- [nanosecs_abs_t rtdm_clock_read](#) (void)
Get system time.

5.9.1 Function Documentation

5.9.1.1 [nanosecs_abs_t rtdm_clock_read](#) (void)

Get system time.

Returns:

The system time in nanoseconds is returned

Note:

The resolution of this service depends on the system timer. In particular, if the system timer is running in periodic mode, the return value will be limited to multiples of the timer tick period.

The system timer may have to be started to obtain valid results. Whether this happens automatically (as on Xenomai) or is controlled by the application depends on the RTDM host environment.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.10 Task Services

Task Priority Range

Maximum and minimum task priorities

- `#define RTDM_TASK_LOWEST_PRIORITY XNCORE_LOW_PRIO`
- `#define RTDM_TASK_HIGHEST_PRIORITY XNCORE_HIGH_PRIO`

Task Priority Modification

Raise or lower task priorities by one level

- `#define RTDM_TASK_RAISE_PRIORITY (+1)`
- `#define RTDM_TASK_LOWER_PRIORITY (-1)`

Typedefs

- `typedef void(* rtdm_task_proc_t)(void *arg)`
Real-time task procedure.

Functions

- `int rtdm_task_init (rtdm_task_t *task, const char *name, rtdm_task_proc_t task_proc, void *arg, int priority, nanosecs_rel_t period)`
Initialise and start a real-time task.
- `void rtdm_task_destroy (rtdm_task_t *task)`
Destroy a real-time task.
- `void rtdm_task_set_priority (rtdm_task_t *task, int priority)`
Adjust real-time task priority.
- `int rtdm_task_set_period (rtdm_task_t *task, nanosecs_rel_t period)`
Adjust real-time task period.
- `int rtdm_task_wait_period (void)`
Wait on next real-time task period.
- `int rtdm_task_unblock (rtdm_task_t *task)`
Activate a blocked real-time task.
- `rtdm_task_t * rtdm_task_current (void)`
Get current real-time task.
- `void rtdm_task_join_nrt (rtdm_task_t *task, unsigned int poll_delay)`
Wait on a real-time task to terminate.

- int `rtdm_task_sleep` (`nanosecs_rel_t` delay)
Sleep a specified amount of time.
- int `rtdm_task_sleep_until` (`nanosecs_abs_t` wakeup_time)
Sleep until a specified absolute time.
- void `rtdm_task_busy_sleep` (`nanosecs_rel_t` delay)
Busy-wait a specified amount of time.

5.10.1 Typedef Documentation

5.10.1.1 typedef void(* `rtdm_task_proc_t`)(void *arg)

Real-time task procedure.

Parameters:

↔ *arg* argument as passed to `rtdm_task_init()`

5.10.2 Function Documentation

5.10.2.1 void `rtdm_task_busy_sleep` (`nanosecs_rel_t` delay)

Busy-wait a specified amount of time.

Parameters:

← *delay* Delay in nanoseconds. Note that a zero delay does **not** have the meaning of `RTDM_TIMEOUT_INFINITE` here.

Note:

The caller must not be migratable to different CPUs while executing this service. Otherwise, the actual delay will be undefined.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine (should be avoided or kept short)
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never (except due to external interruptions).

5.10.2.2 `rtdm_task_t* rtdm_task_current (void)`

Get current real-time task.

Returns:

Pointer to task handle

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.10.2.3 `void rtdm_task_destroy (rtdm_task_t * task)`

Destroy a real-time task.

Parameters:

↔ *task* Task handle as returned by [rtdm_task_init\(\)](#)

Note:

Passing the same task handle to RTDM services after the completion of this function is not allowed.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.10.2.4 `int rtdm_task_init (rtdm_task_t * task, const char * name, rtdm_task_proc_t task_proc, void * arg, int priority, nanosecs_rel_t period)`

Intialise and start a real-time task.

After initialising a task, the task handle remains valid and can be passed to RTDM services until either [rtdm_task_destroy\(\)](#) or [rtdm_task_join_nrt\(\)](#) was invoked.

Parameters:

↔ *task* Task handle

← *name* Optional task name

← *task_proc* Procedure to be executed by the task

- ← *arg* Custom argument passed to `task_proc()` on entry
- ← *priority* Priority of the task, see also [Task Priority Range](#)
- ← *period* Period in nanosecons of a cyclic task, 0 for non-cyclic mode

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.10.2.5 void `rtdm_task_join_nrt` (`rtdm_task_t * task`, unsigned int `poll_delay`)

Wait on a real-time task to terminate.

Parameters:

- ↔ *task* Task handle as returned by [rtdm_task_init\(\)](#)
- ← *poll_delay* Polling delay in milliseconds

Note:

Passing the same task handle to RTDM services after the completion of this function is not allowed.

This service does not trigger the termination of the targeted task. The user has to take of this, otherwise [rtdm_task_join_nrt\(\)](#) will never return.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- User-space task (non-RT)

Rescheduling: possible.

5.10.2.6 int `rtdm_task_set_period` (`rtdm_task_t * task`, [nanosecs_rel_t](#) `period`)

Adjust real-time task period.

Parameters:

- ↔ *task* Task handle as returned by [rtdm_task_init\(\)](#)
- ← *period* New period in nanosecons of a cyclic task, 0 for non-cyclic mode

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.10.2.7 void `rtdm_task_set_priority` (`rtdm_task_t * task`, `int priority`)

Adjust real-time task priority.

Parameters:

- ↔ *task* Task handle as returned by [rtdm_task_init\(\)](#)
- ← *priority* New priority of the task, see also [Task Priority Range](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.10.2.8 int `rtdm_task_sleep` ([nanosecs_rel_t](#) *delay*)

Sleep a specified amount of time.

Parameters:

- ← *delay* Delay in nanoseconds, see [RTDM_TIMEOUT_xxx](#) for special values.

Returns:

0 on success, otherwise:

- -EINTR is returned if calling task has been unblock by a signal or explicitly via [rtdm_task_unblock\(\)](#).
- -EPERM *may* be returned if an illegal invocation environment is detected.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: always.

5.10.2.9 `int rtdm_task_sleep_until (nanosecs_abs_t wakeup_time)`

Sleep until a specified absolute time.

Parameters:

← *wakeup_time* Absolute timeout in nanoseconds

Returns:

0 on success, otherwise:

- -EINTR is returned if calling task has been unblock by a signal or explicitly via `rtdm_task_unblock()`.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: always, unless the specified time already passed.

5.10.2.10 `int rtdm_task_unblock (rtdm_task_t * task)`

Activate a blocked real-time task.

Returns:

Non-zero is returned if the task was actually unblocked from a pending wait state, 0 otherwise.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.10.2.11 `int rtdm_task_wait_period (void)`

Wait on next real-time task period.

Returns:

0 on success, otherwise:

- -EINVAL is returned if calling task is not in periodic mode.
- -ETIMEDOUT is returned if a timer overrun occurred, which indicates that a previous release point has been missed by the calling task.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: always, unless a timer overrun occurred.

5.11 Synchronisation Services

Global Lock across Scheduler Invocation

- `#define RTDM_EXECUTE_ATOMICALY(code_block)`
Execute code block atomically.

Spinlock with Preemption Deactivation

- `#define RTDM_LOCK_UNLOCKED RTHAL_SPIN_LOCK_UNLOCKED`
Static lock initialisation.
- `#define rtdm_lock_init(lock) rthal_spin_lock_init(lock)`
Dynamic lock initialisation.
- `#define rtdm_lock_get(lock) rthal_spin_lock(lock)`
Acquire lock from non-preemptible contexts.
- `#define rtdm_lock_put(lock) rthal_spin_unlock(lock)`
Release lock without preemption restoration.
- `#define rtdm_lock_get_irqsave(lock, context) rthal_spin_lock_irqsave(lock, context)`
Acquire lock and disable preemption.
- `#define rtdm_lock_put_irqrestore(lock, context) rthal_spin_unlock_irqrestore(lock, context)`
Release lock and restore preemption state.
- `#define rtdm_lock_irqsave(context) rthal_local_irq_save(context)`
Disable preemption locally.
- `#define rtdm_lock_irqrestore(context) rthal_local_irq_restore(context)`
Restore preemption state.
- `typedef rthal_spinlock_t rtdm_lock_t`
Lock variable.
- `typedef unsigned long rtdm_lockctx_t`
Variable to save the context while holding a lock.

Timeout Sequence Management

- `void rtdm_toseq_init(rtdm_toseq_t *timeout_seq, nanosecs_rel_t timeout)`
Initialise a timeout sequence.

Event Services

- void `rt dm_event_init` (rt dm_event_t *event, unsigned long pending)
Initialise an event.
- void `rt dm_event_destroy` (rt dm_event_t *event)
Destroy an event.
- void `rt dm_event_pulse` (rt dm_event_t *event)
Signal an event occurrence to currently listening waiters.
- void `rt dm_event_signal` (rt dm_event_t *event)
Signal an event occurrence.
- int `rt dm_event_wait` (rt dm_event_t *event)
Wait on event occurrence.
- int `rt dm_event_timedwait` (rt dm_event_t *event, nanosecs_rel_t timeout, rt dm_toseq_t *timeout_seq)
Wait on event occurrence with timeout.
- void `rt dm_event_clear` (rt dm_event_t *event)
Clear event state.

Semaphore Services

- void `rt dm_sem_init` (rt dm_sem_t *sem, unsigned long value)
Initialise a semaphore.
- void `rt dm_sem_destroy` (rt dm_sem_t *sem)
Destroy a semaphore.
- int `rt dm_sem_down` (rt dm_sem_t *sem)
Decrement a semaphore.
- int `rt dm_sem_timeddown` (rt dm_sem_t *sem, nanosecs_rel_t timeout, rt dm_toseq_t *timeout_seq)
Decrement a semaphore with timeout.
- void `rt dm_sem_up` (rt dm_sem_t *sem)
Increment a semaphore.

Mutex Services

- void `rt dm_mutex_init` (rt dm_mutex_t *mutex)
Initialise a mutex.

- void [rt dm_mutex_destroy](#) (rt dm_mutex_t *mutex)
Destroy a mutex.
- void [rt dm_mutex_unlock](#) (rt dm_mutex_t *mutex)
Release a mutex.
- int [rt dm_mutex_lock](#) (rt dm_mutex_t *mutex)
Request a mutex.
- int [rt dm_mutex_timedlock](#) (rt dm_mutex_t *mutex, [nanosecs_rel_t](#) timeout, rt dm_toseq_t *timeout_seq)
Request a mutex with timeout.

5.11.1 Define Documentation

5.11.1.1 #define RTDM_EXECUTE_ATOMICALY(code_block)

Value:

```
{
    spl_t    s;
    xnlock_get_irqsave(&nklock, s);
    code_block;
    xnlock_put_irqrestore(&nklock, s);
}
```

Execute code block atomically.

Generally, it is illegal to suspend the current task by calling [rt dm_task_sleep\(\)](#), [rt dm_event_wait\(\)](#), etc. while holding a spinlock. In contrast, this macro allows to combine several operations including a potentially rescheduling call to an atomic code block with respect to other [RTDM_EXECUTE_ATOMICALY\(\)](#) blocks. The macro is a light-weight alternative for protecting code blocks via mutexes, and it can even be used to synchronise real-time and non-real-time contexts.

Parameters:

code_block Commands to be executed atomically

Note:

It is not allowed to leave the code block explicitly by using `break`, `return`, `goto`, etc. This would leave the global lock held during the code block execution in an inconsistent state. Moreover, do not embed complex operations into the code block. Consider that they will be executed under preemption lock with interrupts switched-off. Also note that invocation of rescheduling calls may break the atomicity until the task gains the CPU again.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine

- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible, depends on functions called within *code_block*.

5.11.1.2 **#define rtdm_lock_get(lock) rthal_spin_lock(lock)**

Acquire lock from non-preemptible contexts.

Parameters:

lock Address of lock variable

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.1.3 **#define rtdm_lock_get_irqsave(lock, context) rthal_spin_lock_irqsave(lock, context)**

Acquire lock and disable preemption.

Parameters:

lock Address of lock variable

context name of local variable to store the context in

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.1.4 **#define rtdm_lock_init(lock) rthal_spin_lock_init(lock)**

Dynamic lock initialisation.

Parameters:

lock Address of lock variable

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.1.5 **#define rtdm_lock_irqrestore(context) rthal_local_irq_restore(context)**

Restore preemption state.

Parameters:

context name of local variable which stored the context

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.1.6 **#define rtdm_lock_irqsave(context) rthal_local_irq_save(context)**

Disable preemption locally.

Parameters:

context name of local variable to store the context in

Environments:

This service can be called from:

- Kernel module initialization/cleanup code

- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.1.7 `#define rtdm_lock_put(lock) rthal_spin_unlock(lock)`

Release lock without preemption restoration.

Parameters:

lock Address of lock variable

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.1.8 `#define rtdm_lock_put_irqrestore(lock, context) rthal_spin_unlock_irqrestore(lock, context)`

Release lock and restore preemption state.

Parameters:

lock Address of lock variable

context name of local variable which stored the context

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.2 Function Documentation

5.11.2.1 void rtdm_event_clear (rtdm_event_t * *event*)

Clear event state.

Parameters:

↔ *event* Event handle as returned by [rtdm_event_init\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.2.2 void rtdm_event_destroy (rtdm_event_t * *event*)

Destroy an event.

Parameters:

↔ *event* Event handle as returned by [rtdm_event_init\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.2.3 void rtdm_event_init (rtdm_event_t * *event*, unsigned long *pending*)

Initialise an event.

Parameters:

↔ *event* Event handle

← *pending* Non-zero if event shall be initialised as set, 0 otherwise

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.2.4 void rtdm_event_pulse (rtdm_event_t * event)

Signal an event occurrence to currently listening waiters.

This function wakes up all current waiters of the given event, but it does not change the event state. Subsequently callers of [rtdm_event_wait\(\)](#) or [rtdm_event_timedwait\(\)](#) will therefore be blocked first.

Parameters:

↔ *event* Event handle as returned by [rtdm_event_init\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.2.5 void rtdm_event_signal (rtdm_event_t * event)

Signal an event occurrence.

This function sets the given event and wakes up all current waiters. If no waiter is presently registered, the next call to [rtdm_event_wait\(\)](#) or [rtdm_event_timedwait\(\)](#) will return immediately.

Parameters:

↔ *event* Event handle as returned by [rtdm_event_init\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.2.6 `int rtdm_event_timedwait (rtdm_event_t * event, nanosecs_rel_t timeout, rtdm_toseq_t * timeout_seq)`

Wait on event occurrence with timeout.

This function waits or tests for the occurrence of the given event, taking the provided timeout into account. On successful return, the event is reset.

Parameters:

- ↔ *event* Event handle as returned by `rtdm_event_init()`
- ← *timeout* Relative timeout in nanoseconds, see `RTDM_TIMEOUT_XXX` for special values
- ↔ *timeout_seq* Handle of a timeout sequence as returned by `rtdm_toseq_init()` or `rtdm_toseq_absinit()`, or NULL

Returns:

- 0 on success, otherwise:
- -ETIMEDOUT is returned if the request has not been satisfied within the specified amount of time.
- -EINTR is returned if calling task has been unblock by a signal or explicitly via `rtdm_task_unblock()`.
- -EIDRM is returned if *event* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

5.11.2.7 `int rtdm_event_wait (rtdm_event_t * event)`

Wait on event occurrence.

This is the light-weight version of `rtdm_event_timedwait()`, implying an infinite timeout.

Parameters:

- ↔ *event* Event handle as returned by `rtdm_event_init()`

Returns:

- 0 on success, otherwise:
- -EINTR is returned if calling task has been unblock by a signal or explicitly via `rtdm_task_unblock()`.

- -EIDRM is returned if *event* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

5.11.2.8 void rtdm_mutex_destroy (rtdm_mutex_t * mutex)

Destroy a mutex.

Parameters:

↔ *mutex* Mutex handle as returned by [rtdm_mutex_init\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.2.9 void rtdm_mutex_init (rtdm_mutex_t * mutex)

Initialise a mutex.

This function initialises a basic mutex with priority inversion protection. "Basic", as it does not allow a mutex owner to recursively lock the same mutex again.

Parameters:

↔ *mutex* Mutex handle

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.2.10 `int rtdm_mutex_lock (rtdm_mutex_t * mutex)`

Request a mutex.

This is the light-weight version of [rtdm_mutex_timedlock\(\)](#), implying an infinite timeout.

Parameters:

↔ *mutex* Mutex handle as returned by [rtdm_mutex_init\(\)](#)

Returns:

0 on success, otherwise:

- -EIDRM is returned if *mutex* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

5.11.2.11 `int rtdm_mutex_timedlock (rtdm_mutex_t * mutex, nanosecs_rel_t timeout, rtdm_toseq_t * timeout_seq)`

Request a mutex with timeout.

This function tries to acquire the given mutex. If it is not available, the caller is blocked unless non-blocking operation was selected.

Parameters:

↔ *mutex* Mutex handle as returned by [rtdm_mutex_init\(\)](#)

← *timeout* Relative timeout in nanoseconds, see [RTDM_TIMEOUT_xxx](#) for special values

↔ *timeout_seq* Handle of a timeout sequence as returned by [rtdm_toseq_init\(\)](#) or [rtdm_toseq_absinit\(\)](#), or NULL

Returns:

0 on success, otherwise:

- -ETIMEDOUT is returned if the request has not been satisfied within the specified amount of time.
- -EWOULDBLOCK is returned if *timeout* is negative and the semaphore value is currently not positive.
- -EIDRM is returned if *mutex* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

5.11.2.12 void `rtdm_mutex_unlock` (`rtdm_mutex_t * mutex`)

Release a mutex.

This function releases the given mutex, waking up a potential waiter which was blocked upon [rtdm_mutex_lock\(\)](#) or [rtdm_mutex_timedlock\(\)](#).

Parameters:

↔ *mutex* Mutex handle as returned by [rtdm_mutex_init\(\)](#)

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.2.13 void `rtdm_sem_destroy` (`rtdm_sem_t * sem`)

Destroy a semaphore.

Parameters:

↔ *sem* Semaphore handle as returned by [rtdm_sem_init\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.2.14 `int rtdm_sem_down (rtdm_sem_t * sem)`

Decrement a semaphore.

This is the light-weight version of `rtdm_sem_timeddown()`, implying an infinite timeout.

Parameters:

↔ *sem* Semaphore handle as returned by `rtdm_sem_init()`

Returns:

0 on success, otherwise:

- -EINTR is returned if calling task has been unblock by a signal or explicitly via `rtdm_task_unblock()`.
- -EIDRM is returned if *sem* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

5.11.2.15 `void rtdm_sem_init (rtdm_sem_t * sem, unsigned long value)`

Initialise a semaphore.

Parameters:

↔ *sem* Semaphore handle

← *value* Initial value of the semaphore

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.2.16 `int rtdm_sem_timeddown (rtdm_sem_t * sem, nanosecs_rel_t timeout, rtdm_toseq_t * timeout_seq)`

Decrement a semaphore with timeout.

This function tries to decrement the given semaphore's value if it is positive on entry. If not, the caller is blocked unless non-blocking operation was selected.

Parameters:

- ↔ *sem* Semaphore handle as returned by [rtdm_sem_init\(\)](#)
- ↔ *timeout* Relative timeout in nanoseconds, see [RTDM_TIMEOUT_xxx](#) for special values
- ↔ *timeout_seq* Handle of a timeout sequence as returned by [rtdm_toseq_init\(\)](#) or [rtdm_toseq_absinit\(\)](#), or NULL

Returns:

0 on success, otherwise:

- -ETIMEDOUT is returned if the request has not been satisfied within the specified amount of time.
- -EWOULDBLOCK is returned if *timeout* is negative and the semaphore value is currently not positive.
- -EINTR is returned if calling task has been unblock by a signal or explicitly via [rtdm_task_unblock\(\)](#).
- -EIDRM is returned if *sem* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

5.11.2.17 `void rtdm_sem_up (rtdm_sem_t * sem)`

Increment a semaphore.

This function increments the given semaphore's value, waking up a potential waiter which was blocked upon [rtdm_sem_down\(\)](#).

Parameters:

- ↔ *sem* Semaphore handle as returned by [rtdm_sem_init\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.2.18 void rtdm_toseq_init(rtdm_toseq_t * timeout_seq, nanosecs_rel_t timeout)

Initialise a timeout sequence.

This service initialises a timeout sequence handle according to the given timeout value. Timeout sequences allow to maintain a continuous *timeout* across multiple calls of blocking synchronisation services. A typical application scenario is given below.

Parameters:

- ↔ *timeout_seq* Timeout sequence handle
- ← *timeout* Relative timeout in nanoseconds, see [RTDM_TIMEOUT_xxx](#) for special values

Application Scenario:

```
int device_service_routine(...)
{
    rtdm_toseq_t timeout_seq;
    ...

    rtdm_toseq_init(&timeout_seq, timeout);
    ...
    while (received < requested) {
        ret = rtdm_event_timedwait(&data_available, timeout, &timeout_seq);
        if (ret < 0)    // including -ETIMEDOUT
            break;

        // receive some data
        ...
    }
    ...
}
```

Using a timeout sequence in such a scenario avoids that the user-provided relative *timeout* is restarted on every call to [rtdm_event_timedwait\(\)](#), potentially causing an overall delay that is larger than specified by *timeout*. Moreover, all functions supporting timeout sequences also interpret special timeout values (infinite and non-blocking), disburdening the driver developer from handling them separately.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.12 Interrupt Management Services

RTDM_IRQTYPE_XXX

Interrupt registrations flags

- #define [RTDM_IRQTYPE_SHARED](#) XN_ISR_SHARED
Enable IRQ-sharing with other real-time drivers.
- #define [RTDM_IRQTYPE_EDGE](#) XN_ISR_EDGE
Mark IRQ as edge-triggered, relevant for correct handling of shared edge-triggered IRQs.

RTDM_IRQ_XXX

Return flags of interrupt handlers

- #define [RTDM_IRQ_NONE](#) XN_ISR_NONE
Unhandled interrupt.
- #define [RTDM_IRQ_HANDLED](#) XN_ISR_HANDLED
Denote handled interrupt.

Defines

- #define [rtdm_irq_get_arg](#)(irq_handle, type) ((type *)irq_handle → cookie)
Retrieve IRQ handler argument.

Typedefs

- typedef int(* [rtdm_irq_handler_t](#))(rtdm_irq_t *irq_handle)
Interrupt handler.

Functions

- int [rtdm_irq_request](#)(rtdm_irq_t *irq_handle, unsigned int irq_no, [rtdm_irq_handler_t](#) handler, unsigned long flags, const char *device_name, void *arg)
Register an interrupt handler.
- int [rtdm_irq_free](#)(rtdm_irq_t *irq_handle)
Release an interrupt handler.
- int [rtdm_irq_enable](#)(rtdm_irq_t *irq_handle)
Enable interrupt line.

- int [rt dm_irq_disable](#) (rt dm_irq_t *irq_handle)

Disable interrupt line.

5.12.1 Define Documentation

5.12.1.1 #define rt dm_irq_get_arg(irq_handle, type) ((type *)irq_handle → cookie)

Retrieve IRQ handler argument.

Parameters:

irq_handle IRQ handle

type Type of the pointer to return

Returns:

The argument pointer registered on [rt dm_irq_request\(\)](#) is returned, type-casted to the specified *type*.

Environments:

This service can be called from:

- Interrupt service routine

Rescheduling: never.

5.12.2 Typedef Documentation

5.12.2.1 typedef int(* [rt dm_irq_handler_t](#))(rt dm_irq_t *irq_handle)

Interrupt handler.

Parameters:

← *irq_handle* IRQ handle as returned by [rt dm_irq_request\(\)](#)

Returns:

0 or a combination of [RTDM_IRQ_XXX](#) flags

5.12.3 Function Documentation

5.12.3.1 int [rt dm_irq_disable](#) (rt dm_irq_t * *irq_handle*)

Disable interrupt line.

Parameters:

↔ *irq_handle* IRQ handle as returned by [rt dm_irq_request\(\)](#)

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.12.3.2 `int rtdm_irq_enable (rtdm_irq_t * irq_handle)`

Enable interrupt line.

Parameters:

↔ *irq_handle* IRQ handle as returned by [rtdm_irq_request\(\)](#)

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.12.3.3 `int rtdm_irq_free (rtdm_irq_t * irq_handle)`

Release an interrupt handler.

Parameters:

↔ *irq_handle* IRQ handle as returned by [rtdm_irq_request\(\)](#)

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.12.3.4 `int rtdm_irq_request(rtdm_irq_t * irq_handle, unsigned int irq_no, rtdm_irq_handler_t handler, unsigned long flags, const char * device_name, void * arg)`

Register an interrupt handler.

Parameters:

- ↔ *irq_handle* IRQ handle
- ← *irq_no* Line number of the addressed IRQ
- ← *handler* Interrupt handler
- ← *flags* Registration flags, see [RTDM_IRQTYPE_xxx](#) for details
- ← *device_name* Optional device name to show up in real-time IRQ lists (not yet implemented)
- ← *arg* Pointer to be passed to the interrupt handler on invocation

Returns:

0 on success, otherwise:

- -EINVAL is returned if an invalid parameter was passed.
- -EBUSY is returned if the specified IRQ line is already in use.

Note:

To receive interrupts on the requested line, you have to call [rtdm_irq_enable\(\)](#) after registering the handler.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.13 Non-Real-Time Signalling Services

5.13.1 Detailed Description

These services provide a mechanism to request the execution of a specified handler in non-real-time context. The triggering can safely be performed in real-time context without suffering from unknown delays. The handler execution will be deferred until the next time the real-time subsystem releases the CPU to the non-real-time part.

Typedefs

- typedef void(* [rt dm_nrtsig_handler_t](#))(rt dm_nrtsig_t nrt_sig)
Non-real-time signal handler.

Functions

- int [rt dm_nrtsig_init](#) (rt dm_nrtsig_t *nrt_sig, [rt dm_nrtsig_handler_t](#) handler)
Register a non-real-time signal handler.
- void [rt dm_nrtsig_destroy](#) (rt dm_nrtsig_t *nrt_sig)
Release a non-realtime signal handler.
- void [rt dm_nrtsig_pend](#) (rt dm_nrtsig_t *nrt_sig)
Trigger non-real-time signal.

5.13.2 Typedef Documentation

5.13.2.1 typedef void(* [rt dm_nrtsig_handler_t](#))(rt dm_nrtsig_t nrt_sig)

Non-real-time signal handler.

Parameters:

← *nrt_sig* signal handle as returned by [rt dm_nrtsig_init\(\)](#)

Note:

The signal handler will run in soft-IRQ context of the non-real-time subsystem. Note the implications of this context, e.g. no invocation of blocking operations.

5.13.3 Function Documentation

5.13.3.1 void [rt dm_nrtsig_destroy](#) (rt dm_nrtsig_t * *nrt_sig*)

Release a non-realtime signal handler.

Parameters:

↔ *nrt_sig* Signal handle

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.13.3.2 `int rtdm_nrtsig_init(rtdm_nrtsig_t * nrt_sig, rtdm_nrtsig_handler_t handler)`

Register a non-real-time signal handler.

Parameters:

- ↔ *nrt_sig* Signal handle
- ← *handler* Non-real-time signal handler

Returns:

- 0 on success, otherwise:
- -EAGAIN is returned if no free signal slot is available.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.13.3.3 `void rtdm_nrtsig_pend(rtdm_nrtsig_t * nrt_sig)`

Trigger non-real-time signal.

Parameters:

- ↔ *nrt_sig* Signal handle

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never in real-time context, possible in non-real-time environments.

5.14 Utility Services

Functions

- `int rtdm_mmap_to_user` (`rtdm_user_info_t *user_info`, `void *src_addr`, `size_t len`, `int prot`, `void **pptr`, `struct vm_operations_struct *vm_ops`, `void *vm_private_data`)
Map a kernel memory range into the address space of the user.
- `int rtdm_iomap_to_user` (`rtdm_user_info_t *user_info`, `unsigned long src_addr`, `size_t len`, `int prot`, `void **pptr`, `struct vm_operations_struct *vm_ops`, `void *vm_private_data`)
Map an I/O memory range into the address space of the user.
- `int rtdm_munmap` (`rtdm_user_info_t *user_info`, `void *ptr`, `size_t len`)
Unmap a user memory range.
- `void rtdm_printk` (`const char *format`,...)
Real-time safe message printing on kernel console.
- `void * rtdm_malloc` (`size_t size`)
Allocate memory block in real-time context.
- `void rtdm_free` (`void *ptr`)
Release real-time memory block.
- `int rtdm_read_user_ok` (`rtdm_user_info_t *user_info`, `const void __user *ptr`, `size_t size`)
Check if read access to user-space memory block is safe.
- `int rtdm_rw_user_ok` (`rtdm_user_info_t *user_info`, `const void __user *ptr`, `size_t size`)
Check if read/write access to user-space memory block is safe.
- `int rtdm_copy_from_user` (`rtdm_user_info_t *user_info`, `void *dst`, `const void __user *src`, `size_t size`)
Copy user-space memory block to specified buffer.
- `int rtdm_safe_copy_from_user` (`rtdm_user_info_t *user_info`, `void *dst`, `const void __user *src`, `size_t size`)
Check if read access to user-space memory block and copy it to specified buffer.
- `int rtdm_copy_to_user` (`rtdm_user_info_t *user_info`, `void __user *dst`, `const void *src`, `size_t size`)
Copy specified buffer to user-space memory block.
- `int rtdm_safe_copy_to_user` (`rtdm_user_info_t *user_info`, `void __user *dst`, `const void *src`, `size_t size`)
Check if read/write access to user-space memory block is safe and copy specified buffer to it.
- `int rtdm_strncpy_from_user` (`rtdm_user_info_t *user_info`, `char *dst`, `const char __user *src`, `size_t count`)
Copy user-space string to specified buffer.

- `int rtdm_in_rt_context` (void)
Test if running in a real-time task.

5.14.1 Function Documentation

5.14.1.1 `int rtdm_copy_from_user (rtdm_user_info_t * user_info, void * dst, const void __user * src, size_t size)`

Copy user-space memory block to specified buffer.

Parameters:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *dst* Destination buffer address
- ← *src* Address of the user-space memory block
- ← *size* Size of the memory block

Returns:

0 on success, otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note:

Before invoking this service, verify via `rtdm_read_user_ok()` that the provided user-space address can securely be accessed.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.2 `int rtdm_copy_to_user (rtdm_user_info_t * user_info, void __user * dst, const void * src, size_t size)`

Copy specified buffer to user-space memory block.

Parameters:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *dst* Address of the user-space memory block
- ← *src* Source buffer address
- ← *size* Size of the memory block

Returns:

0 on success, otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note:

Before invoking this service, verify via [rt dm_rw_user_ok\(\)](#) that the provided user-space address can securely be accessed.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.3 void rtdm_free (void * ptr)

Release real-time memory block.

Parameters:

← *ptr* Pointer to memory block as returned by [rtdm_malloc\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine (consider the overhead!)
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.4 int rtdm_in_rt_context (void)

Test if running in a real-time task.

Returns:

Non-zero is returned if the caller resides in real-time context, 0 otherwise.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.5 `int rtdm_iomap_to_user(rtdm_user_info_t * user_info, unsigned long src_addr, size_t len, int prot, void ** pptr, struct vm_operations_struct * vm_ops, void * vm_private_data)`

Map an I/O memory range into the address space of the user.

Parameters:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *src_addr* physical I/O address to be mapped
- ← *len* Length of the memory range
- ← *prot* Protection flags for the user's memory range, typically either PROT_READ or PROT_READ|PROT_WRITE
- ↔ *pptr* Address of a pointer containing the desired user address or NULL on entry and the finally assigned address on return
- ← *vm_ops* vm_operations to be executed on the vma_area of the user memory range or NULL
- ← *vm_private_data* Private data to be stored in the vma_area, primarily useful for vm_operation handlers

Returns:

0 on success, otherwise (most common values):

- -EINVAL is returned if an invalid start address, size, or destination address was passed.
- -ENOMEM is returned if there is insufficient free memory or the limit of memory mapping for the user process was reached.
- -EAGAIN is returned if too much memory has been already locked by the user process.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Note:

RTDM supports two models for unmapping the user memory range again. One is explicit unmapping via `rtdm_munmap()`, either performed when the user requests it via an IOCTL etc. or when the related device is closed. The other is automatic unmapping, triggered by the user invoking standard `munmap()` or by the termination of the related process. To track release of the mapping and therefore relinquishment of the referenced physical memory, the caller of `rtdm_iomap_to_user()` can pass a `vm_operations_struct` on invocation, defining a close handler for the `vm_area`. See Linux documentaion (e.g. Linux Device Drivers book) on virtual memory management for details.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- User-space task (non-RT)

Rescheduling: possible.

5.14.1.6 `void* rtdm_malloc (size_t size)`

Allocate memory block in real-time context.

Parameters:

← *size* Requested size of the memory block

Returns:

The pointer to the allocated block is returned on success, NULL otherwise.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine (consider the overhead!)
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.7 `int rtdm_mmap_to_user (rtdm_user_info_t * user_info, void * src_addr, size_t len, int prot, void ** pptr, struct vm_operations_struct * vm_ops, void * vm_private_data)`

Map a kernel memory range into the address space of the user.

Parameters:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *src_addr* Kernel virtual address to be mapped
- ← *len* Length of the memory range
- ← *prot* Protection flags for the user's memory range, typically either PROT_READ or PROT_READ|PROT_WRITE
- ↔ *pptr* Address of a pointer containing the desired user address or NULL on entry and the finally assigned address on return
- ← *vm_ops* vm_operations to be executed on the vma_area of the user memory range or NULL
- ← *vm_private_data* Private data to be stored in the vma_area, primarily useful for vm_-operation handlers

Returns:

0 on success, otherwise (most common values):

- -EINVAL is returned if an invalid start address, size, or destination address was passed.
- -ENOMEM is returned if there is insufficient free memory or the limit of memory mapping for the user process was reached.
- -EAGAIN is returned if too much memory has been already locked by the user process.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Note:

This service only works on memory regions allocated via `kmalloc()` or `vmalloc()`. To map physical I/O memory to user-space use `rtdm_iomap_to_user()` instead.

RTDM supports two models for unmapping the user memory range again. One is explicit unmapping via `rtdm_munmap()`, either performed when the user requests it via an IOCTL etc. or when the related device is closed. The other is automatic unmapping, triggered by the user invoking standard `munmap()` or by the termination of the related process. To track release of the mapping and therefore relinquishment of the referenced physical memory, the caller of `rtdm_mmap_to_user()` can pass a `vm_operations_struct` on invocation, defining a close handler for the `vm_area`. See Linux documentation (e.g. Linux Device Drivers book) on virtual memory management for details.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- User-space task (non-RT)

Rescheduling: possible.

5.14.1.8 `int rtdm_munmap (rtdm_user_info_t * user_info, void * ptr, size_t len)`

Unmap a user memory range.

Parameters:

- ← *user_info* User information pointer as passed to `rtdm_mmap_to_user()` when requesting to map the memory range
- ← *ptr* User address or the memory range
- ← *len* Length of the memory range

Returns:

0 on success, otherwise:

- -EINVAL is returned if an invalid address or size was passed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- User-space task (non-RT)

Rescheduling: possible.

5.14.1.9 void rtdm_printk (const char * *format*, ...)

Real-time safe message printing on kernel console.

Parameters:

- ← *format* Format string (conforming standard printf())
- ... Arguments referred by *format*

Returns:

On success, this service returns the number of characters printed. Otherwise, a negative error code is returned.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine (consider the overhead!)
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never in real-time context, possible in non-real-time environments.

5.14.1.10 int rtdm_read_user_ok (rtdm_user_info_t * *user_info*, const void __user * *ptr*, size_t *size*)

Check if read access to user-space memory block is safe.

Parameters:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *ptr* Address of the user-provided memory block
- ← *size* Size of the memory block

Returns:

Non-zero is return when it is safe to read from the specified memory block, 0 otherwise.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.11 `int rtdm_rw_user_ok (rtdm_user_info_t * user_info, const void __user * ptr, size_t size)`

Check if read/write access to user-space memory block is safe.

Parameters:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *ptr* Address of the user-provided memory block
- ← *size* Size of the memory block

Returns:

Non-zero is return when it is safe to read from or write to the specified memory block, 0 otherwise.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.12 `int rtdm_safe_copy_from_user (rtdm_user_info_t * user_info, void * dst, const void __user * src, size_t size)`

Check if read access to user-space memory block and copy it to specified buffer.

Parameters:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *dst* Destination buffer address
- ← *src* Address of the user-space memory block
- ← *size* Size of the memory block

Returns:

0 on success, otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note:

This service is a combination of `rtdm_read_user_ok` and `rtdm_copy_from_user`.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.13 `int rtdm_safe_copy_to_user (rtdm_user_info_t * user_info, void __user * dst, const void * src, size_t size)`

Check if read/write access to user-space memory block is safe and copy specified buffer to it.

Parameters:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *dst* Address of the user-space memory block
- ← *src* Source buffer address
- ← *size* Size of the memory block

Returns:

0 on success, otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note:

This service is a combination of `rtdm_rw_user_ok` and `rtdm_copy_to_user`.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.14 `int rtdm_strncpy_from_user (rtdm_user_info_t * user_info, char * dst, const char __user * src, size_t count)`

Copy user-space string to specified buffer.

Parameters:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *dst* Destination buffer address
- ← *src* Address of the user-space string
- ← *count* Maximum number of bytes to copy, including the trailing '0'

Returns:

Length of the string on success (not including the trailing '0'), otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note:

This services already includes a check of the source address, calling `rtdm_read_user_ok()` for *src* explicitly is not required.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.15 Device Profiles

5.15.1 Detailed Description

Device profiles define which operation handlers a driver of a certain class has to implement, which name or protocol it has to register, which IOCTLs it has to provide, and further details. Sub-classes can be defined in order to extend a device profile with more hardware-specific functions.

Modules

- [CAN Devices](#)
- [Serial Devices](#)
- [Testing Devices](#)

RTDM_CLASS_xxx

Device classes

- `#define RTDM_CLASS_PARPORT 1`
- `#define RTDM_CLASS_SERIAL 2`
- `#define RTDM_CLASS_CAN 3`
- `#define RTDM_CLASS_NETWORK 4`
- `#define RTDM_CLASS_RTMAC 5`
- `#define RTDM_CLASS_TESTING 6`
- `#define RTDM_CLASS_EXPERIMENTAL 224`
- `#define RTDM_CLASS_MAX 255`

Device Naming

Maximum length of device names (excluding the final null character)

- `#define RTDM_MAX_DEVNAME_LEN 31`

RTDM_PURGE_xxx_BUFFER

Flags selecting buffers to be purged

- `#define RTDM_PURGE_RX_BUFFER 0x0001`
- `#define RTDM_PURGE_TX_BUFFER 0x0002`

Common IOCTLs

The following IOCTLs shall be supported by any device profile if applicable

- `#define RTIOC_PURGE _IOW(RTIOC_TYPE_COMMON, 0x10, int)`
Purge internal device or socket buffers.

5.15.2 Define Documentation

5.15.2.1 `#define RTIOC_PURGE_IOW(RTIOC_TYPE_COMMON, 0x10, int)`

Purge internal device or socket buffers.

Parameters:

← *arg* Purge mask, see [RTDM_PURGE_xxx_BUFFER](#)

Chapter 6

Xenomai RTDM skin API Data Structure Documentation

6.1 `can_bittime` Struct Reference

```
#include <rtcan.h>
```

6.1.1 Detailed Description

Custom CAN bit-time definition.

Data Fields

- [can_bittime_type_t](#) `type`
Type of bit-time definition.
- [can_bittime_std](#) `std`
Standard bit-time.
- [can_bittime_btr](#) `btr`
Hardware-specific BTR bit-time.

The documentation for this struct was generated from the following file:

- `include/rtdm/rtcan.h`

6.2 can_bittime_btr Struct Reference

```
#include <rtcan.h>
```

6.2.1 Detailed Description

Hardware-specific BTR bit-times.

Data Fields

- `uint8_t btr0`
Bus timing register 0.
- `uint8_t btr1`
Bus timing register 1.

The documentation for this struct was generated from the following file:

- `include/rtdm/rtcan.h`

6.3 can_bittime_std Struct Reference

```
#include <rtcan.h>
```

6.3.1 Detailed Description

Standard bit-time parameters according to Bosch.

Data Fields

- `uint32_t brp`
Baud rate prescaler.
- `uint8_t prop_seg`
from 1 to 8
- `uint8_t phase_seg1`
from 1 to 8
- `uint8_t phase_seg2`
from 1 to 8
- `uint8_t sjw:7`
from 1 to 4
- `uint8_t sam:1`
1 - enable triple sampling

The documentation for this struct was generated from the following file:

- `include/rtdm/rtcan.h`

6.4 can_filter Struct Reference

```
#include <rtcan.h>
```

6.4.1 Detailed Description

Filter for reception of CAN messages.

This filter works as follows: A received CAN ID is AND'ed bitwise with `can_mask` and then compared to `can_id`. If this comparison is true the message will be received by the socket.

Multiple filters can be arranged in a filter list and set with [Sockopts](#). If one of these filters matches a CAN ID upon reception of a CAN frame, this frame is accepted.

Note:

Only [CAN_EFF_FLAG](#) of [CAN ID flags](#) is valid for `can_id` and none for `can_mask`. This means that the RTR bit is not taken into account while filtering messages.

Extended IDs are received only if [CAN_EFF_FLAG](#) is set in `can_id`. If it is cleared only standard IDs are accepted.

Data Fields

- `uint32_t can_id`
CAN ID which must match with incoming IDs after passing the mask.
- `uint32_t can_mask`
Mask which is applied to incoming IDs.

6.4.2 Field Documentation

6.4.2.1 `uint32_t can_filter::can_mask`

Mask which is applied to incoming IDs.

See [CAN ID masks](#) if exactly one CAN ID should come through.

The documentation for this struct was generated from the following file:

- `include/rtdm/rtcan.h`

6.5 can_frame Struct Reference

```
#include <rtcan.h>
```

6.5.1 Detailed Description

Raw CAN frame.

Central structure for receiving and sending CAN frames.

Data Fields

- [can_id_t can_id](#)
CAN ID of the frame.
- [uint8_t can_dlc](#)
Size of the payload in bytes.
- [uint8_t data](#) [8]
Payload data bytes.

6.5.2 Field Documentation

6.5.2.1 [can_id_t can_frame::can_id](#)

CAN ID of the frame.

See [CAN ID flags](#) for special bits.

The documentation for this struct was generated from the following file:

- `include/rtdm/rtcan.h`

6.6 rtdm_dev_context Struct Reference

```
#include <rtdm_driver.h>
```

6.6.1 Detailed Description

Device context.

A device context structure is associated with every open device instance. RTDM takes care of its creation and destruction and passes it to the operation handlers when being invoked.

Drivers can attach arbitrary data immediately after the official structure. The size of this data is provided via [rtdm_device.context_size](#) during device registration.

Data Fields

- unsigned long [context_flags](#)
Context flags, see [Context Flags](#) for details.
- int [fd](#)
Associated file descriptor.
- atomic_t [close_lock_count](#)
Lock counter of context, held while structure is referenced by an operation handler.
- [rtdm_operations](#) * [ops](#)
Set of active device operation handlers.
- [rtdm_device](#) * [device](#)
Reference to owning device.
- char [dev_private](#) [0]
Begin of driver defined context data structure.

The documentation for this struct was generated from the following file:

- include/rtdm/[rtdm_driver.h](#)

6.7 rtdm_device Struct Reference

```
#include <rtdm_driver.h>
```

6.7.1 Detailed Description

RTDM device.

This structure specifies a RTDM device. As some fields, especially the reserved area, will be modified by RTDM during runtime, the structure must not reside in write-protected memory.

Data Fields

- `int struct_version`
Revision number of this structure, see [Driver Versioning](#) defines.
- `int device_flags`
Device flags, see [Device Flags](#) for details.
- `size_t context_size`
Size of driver defined appendix to struct [rtdm_dev_context](#).
- `char device_name [RTDM_MAX_DEVNAME_LEN+1]`
Named device identification (orthogonal to Linux device name space).
- `int protocol_family`
Protocol device identification: protocol family (PF_XXX).
- `int socket_type`
Protocol device identification: socket type (SOCK_XXX).
- `rtdm_open_handler_t open_rt`
Named device instance creation for real-time contexts, optional if `open_nrt` is non-NULL, ignored for protocol devices.
- `rtdm_open_handler_t open_nrt`
Named device instance creation for non-real-time contexts, optional if `open_rt` is non-NULL, ignored for protocol devices.
- `rtdm_socket_handler_t socket_rt`
Protocol socket creation for real-time contexts, optional if `socket_nrt` is non-NULL, ignored for named devices.
- `rtdm_socket_handler_t socket_nrt`
Protocol socket creation for non-real-time contexts, optional if `socket_rt` is non-NULL, ignored for named devices.
- `rtdm_operations ops`
Default operations on newly opened device instance.

- int [device_class](#)
Device class ID, see [RTDM_CLASS_xxx](#).
- int [device_sub_class](#)
Device sub-class, see [RTDM_SUBCLASS_xxx](#) definition in the [Device Profiles](#).
- const char * [driver_name](#)
Informational driver name (reported via /proc).
- int [driver_version](#)
Driver version, see [Driver Versioning](#) defines.
- const char * [peripheral_name](#)
Informational peripheral name the device is attached to (reported via /proc).
- const char * [provider_name](#)
Informational driver provider name (reported via /proc).
- const char * [proc_name](#)
Name of /proc entry for the device, must not be NULL.
- proc_dir_entry * [proc_entry](#)
Set to device's /proc root entry after registration, do not modify.
- int [device_id](#)
Driver definable device ID.
- rtdm_dev_reserved [reserved](#)
Data stored by RTDM inside a registered device (internal use only).

The documentation for this struct was generated from the following file:

- include/rtdm/[rtdm_driver.h](#)

6.8 rtdm_operations Struct Reference

```
#include <rtdm_driver.h>
```

6.8.1 Detailed Description

Device operations.

Data Fields

Common Operations

- [rtdm_close_handler_t close_rt](#)
Close handler for real-time contexts (optional).
- [rtdm_close_handler_t close_nrt](#)
Close handler for non-real-time contexts (required).
- [rtdm_ioctl_handler_t ioctl_rt](#)
IOCTL from real-time context (optional).
- [rtdm_ioctl_handler_t ioctl_nrt](#)
IOCTL from non-real-time context (optional).

Stream-Oriented Device Operations

- [rtdm_read_handler_t read_rt](#)
Read handler for real-time context (optional).
- [rtdm_read_handler_t read_nrt](#)
Read handler for non-real-time context (optional).
- [rtdm_write_handler_t write_rt](#)
Write handler for real-time context (optional).
- [rtdm_write_handler_t write_nrt](#)
Write handler for non-real-time context (optional).

Message-Oriented Device Operations

- [rtdm_recvmsg_handler_t recvmsg_rt](#)
Receive message handler for real-time context (optional).
- [rtdm_recvmsg_handler_t recvmsg_nrt](#)
Receive message handler for non-real-time context (optional).
- [rtdm_sendmsg_handler_t sendmsg_rt](#)
Transmit message handler for real-time context (optional).

- [rtdm_sendmsg_handler_t sendmsg_nrt](#)

Transmit message handler for non-real-time context (optional).

The documentation for this struct was generated from the following file:

- [include/rtdm/rtdm_driver.h](#)

6.9 rtser_config Struct Reference

```
#include <rtserial.h>
```

6.9.1 Detailed Description

Serial device configuration.

Data Fields

- int [config_mask](#)
mask specifying valid fields, see [RTSER_SET_xxx](#)
- int [baud_rate](#)
baud rate, default [RTSER_DEF_BAUD](#)
- int [parity](#)
number of parity bits, see [RTSER_xxx_PARITY](#)
- int [data_bits](#)
number of data bits, see [RTSER_xxx_BITS](#)
- int [stop_bits](#)
number of stop bits, see [RTSER_xxx_STOPB](#)
- int [handshake](#)
handshake mechanisms, see [RTSER_xxx_HAND](#)
- int [fifo_depth](#)
reception FIFO interrupt threshold, see [RTSER_FIFO_xxx](#)
- [nanosecs_rel_t rx_timeout](#)
reception timeout, see [RTSER_TIMEOUT_xxx](#) for special values
- [nanosecs_rel_t tx_timeout](#)
transmission timeout, see [RTSER_TIMEOUT_xxx](#) for special values
- [nanosecs_rel_t event_timeout](#)
event timeout, see [RTSER_TIMEOUT_xxx](#) for special values
- int [timestamp_history](#)
enable timestamp history, see [RTSER_xxx_TIMESTAMP_HISTORY](#)
- int [event_mask](#)
event mask to be used with [RTSER_RTIOC_WAIT_EVENT](#), see [RTSER_EVENT_xxx](#)

The documentation for this struct was generated from the following file:

- [include/rtdm/rtserial.h](#)

6.10 rtser_event Struct Reference

```
#include <rtserial.h>
```

6.10.1 Detailed Description

Additional information about serial device events.

Data Fields

- `int events`
signalled events, see [RTSER_EVENT_XXX](#)
- `int rx_pending`
number of pending input characters
- `nanosecs_abs_t last_timestamp`
last interrupt timestamp
- `nanosecs_abs_t rxpend_timestamp`
reception timestamp of oldest character in input queue

The documentation for this struct was generated from the following file:

- `include/rtdm/rtserial.h`

6.11 rtser_status Struct Reference

```
#include <rtserial.h>
```

6.11.1 Detailed Description

Serial device status.

Data Fields

- int [line_status](#)
line status register, see [RTSER_LSR_xxx](#)
- int [modem_status](#)
modem status register, see [RTSER_MSR_xxx](#)

The documentation for this struct was generated from the following file:

- [include/rtdm/rtserial.h](#)

6.12 sockaddr_can Struct Reference

```
#include <rtcan.h>
```

6.12.1 Detailed Description

Socket address structure for the CAN address family.

Data Fields

- sa_family_t [can_family](#)
CAN address family, must be AF_CAN.
- int [can_ifindex](#)
Interface index of CAN controller.

6.12.2 Field Documentation

6.12.2.1 int [sockaddr_can::can_ifindex](#)

Interface index of CAN controller.

See [SIOCGIFINDEX](#).

The documentation for this struct was generated from the following file:

- include/rtdm/[rtcan.h](#)

Chapter 7

Xenomai RTDM skin API File Documentation

7.1 include/rtdm/rtdm.h File Reference

7.1.1 Detailed Description

Real-Time Driver Model for RT-Socket-CAN, CAN device profile header.

Note:

Copyright (C) 2006 Wolfgang Grandegger <wg@grandegger.com>

Copyright (C) 2005, 2006 Sebastian Smolorz <Sebastian.Smolorz@stud.uni-hannover.de>

This RTDM CAN device profile header is based on:

include/linux/can.h, include/linux/socket.h, net/can/pf_can.h in linux-can.patch, a CAN socket framework for Linux

Copyright (C) 2004, 2005, Robert Schwebel, Benedikt Spranger, Marc Kleine-Budde, Pengutronix

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```
#include <net/if.h>
```

```
#include <rtdm/rtdm.h>
```

Data Structures

- struct [can_bittime_std](#)

Standard bit-time parameters according to Bosch.

- struct [can_bittime_btr](#)
Hardware-specific BTR bit-times.
- struct [can_bittime](#)
Custom CAN bit-time definition.
- struct [can_filter](#)
Filter for reception of CAN messages.
- struct [sockaddr_can](#)
Socket address structure for the CAN address family.
- struct [can_frame](#)
Raw CAN frame.

CAN ID masks

Bit masks for masking CAN IDs

- #define [CAN_EFF_MASK](#) 0x1FFFFFFF
Bit mask for extended CAN IDs.
- #define [CAN_SFF_MASK](#) 0x000007FF
Bit mask for standard CAN IDs.

CAN ID flags

Flags within a CAN ID indicating special CAN frame attributes

- #define [CAN_EFF_FLAG](#) 0x80000000
extended frame
- #define [CAN_RTR_FLAG](#) 0x40000000
remote transmission flag
- #define [CAN_ERR_FLAG](#) 0x20000000
error frame (see [Errors](#))

CAN controller modes

Special CAN controllers modes, which can be or'ed together.

- #define [CAN_CTRLMODE_LISTENONLY](#) 0x1

Listen-Only mode.

- #define `CAN_CTRLMODE_LOOPBACK` 0x2
Loopback mode.

Timestamp switches

Arguments to pass to `RTCAN_RTIOC_TAKE_TIMESTAMP`

- #define `RTCAN_TAKE_NO_TIMESTAMPS` 0
Switch off taking timestamps.
- #define `RTCAN_TAKE_TIMESTAMPS` 1
Do take timestamps.

RAW socket options

Setting and getting CAN RAW socket options.

- #define `CAN_RAW_FILTER` 0x1
CAN filter definition.
- #define `CAN_RAW_ERR_FILTER` 0x2
CAN error mask.
- #define `CAN_RAW_TX_LOOPBACK` 0x3
CAN TX loopback.

IOCTLs

CAN device IOCTLs

- #define `SIOCGINDEX` _IOW(RTIOC_TYPE_CAN, 0x00, struct ifreq)
Get CAN interface index by name.
- #define `SIOCSCANBAUDRATE` _IOW(RTIOC_TYPE_CAN, 0x01, struct ifreq)
Set baud rate.
- #define `SIOCGCANBAUDRATE` _IOWR(RTIOC_TYPE_CAN, 0x02, struct ifreq)
Get baud rate.
- #define `SIOCSCANCUSTOMBITTIME` _IOW(RTIOC_TYPE_CAN, 0x03, struct ifreq)
Set custom bit time parameter.
- #define `SIOCGCANCUSTOMBITTIME` _IOWR(RTIOC_TYPE_CAN, 0x04, struct ifreq)

Get custom bit-time parameters.

- #define [SIOCSCANMODE](#) _IOW(RTIOC_TYPE_CAN, 0x05, struct ifreq)
Set operation mode of CAN controller.
- #define [SIOCGCANSTATE](#) _IOWR(RTIOC_TYPE_CAN, 0x06, struct ifreq)
Get current state of CAN controller.
- #define [SIOCSCANCTRLMODE](#) _IOW(RTIOC_TYPE_CAN, 0x07, struct ifreq)
Set special controller modes.
- #define [SIOCGCANCTRLMODE](#) _IOWR(RTIOC_TYPE_CAN, 0x08, struct ifreq)
Get special controller modes.
- #define [RTCAN_RTIOC_TAKE_TIMESTAMP](#) _IOW(RTIOC_TYPE_CAN, 0x09, int)
Enable or disable storing a high precision timestamp upon reception of a CAN frame.
- #define [RTCAN_RTIOC_RCV_TIMEOUT](#) _IOW(RTIOC_TYPE_CAN, 0x0A, nanosecs_rel_t)
Specify a reception timeout for a socket.
- #define [RTCAN_RTIOC_SND_TIMEOUT](#) _IOW(RTIOC_TYPE_CAN, 0x0B, nanosecs_rel_t)
Specify a transmission timeout for a socket.

Error mask

Error class (mask) in `can_id` field of struct [can_frame](#) to be used with [CAN_RAW_ERR_FILTER](#).

- #define [CAN_ERR_TX_TIMEOUT](#) 0x00000001U
TX timeout (netdevice driver).
- #define [CAN_ERR_LOSTARB](#) 0x00000002U
Lost arbitration (see [data\[0\]](#)).
- #define [CAN_ERR_CRTL](#) 0x00000004U
Controller problems (see [data\[1\]](#)).
- #define [CAN_ERR_PROT](#) 0x00000008U
Protocol violations (see [data\[2\]](#), [data\[3\]](#)).
- #define [CAN_ERR_TRX](#) 0x00000010U
Transceiver status (see [data\[4\]](#)).
- #define [CAN_ERR_ACK](#) 0x00000020U
Received no ACK on transmission.
- #define [CAN_ERR_BUSOFF](#) 0x00000040U

Bus off.

- #define [CAN_ERR_BUSERROR](#) 0x00000080U
Bus error (may flood!).
- #define [CAN_ERR_RESTARTED](#) 0x00000100U
Controller restarted.
- #define [CAN_ERR_MASK](#) 0x1FFFFFFFU
Omit EFF, RTR, ERR flags.

Arbitration lost error

Error in the data[0] field of struct [can_frame](#).

- #define [CAN_ERR_LOSTARB_UNSPEC](#) 0x00
unspecified else bit number in bitstream

Controller problems

Error in the data[1] field of struct [can_frame](#).

- #define [CAN_ERR_CTRL_UNSPEC](#) 0x00
unspecified
- #define [CAN_ERR_CTRL_RX_OVERFLOW](#) 0x01
RX buffer overflow.
- #define [CAN_ERR_CTRL_TX_OVERFLOW](#) 0x02
TX buffer overflow.
- #define [CAN_ERR_CTRL_RX_WARNING](#) 0x04
reached warning level for RX errors
- #define [CAN_ERR_CTRL_TX_WARNING](#) 0x08
reached warning level for TX errors
- #define [CAN_ERR_CTRL_RX_PASSIVE](#) 0x10
reached passive level for RX errors
- #define [CAN_ERR_CTRL_TX_PASSIVE](#) 0x20
reached passive level for TX errors

Protocol error type

Error in the data[2] field of struct [can_frame](#).

- #define [CAN_ERR_PROT_UNSPEC](#) 0x00
unspecified
- #define [CAN_ERR_PROT_BIT](#) 0x01
single bit error
- #define [CAN_ERR_PROT_FORM](#) 0x02
frame format error
- #define [CAN_ERR_PROT_STUFF](#) 0x04
bit stuffing error
- #define [CAN_ERR_PROT_BIT0](#) 0x08
unable to send dominant bit
- #define [CAN_ERR_PROT_BIT1](#) 0x10
unable to send recessive bit
- #define [CAN_ERR_PROT_OVERLOAD](#) 0x20
bus overload
- #define [CAN_ERR_PROT_ACTIVE](#) 0x40
active error announcement
- #define [CAN_ERR_PROT_TX](#) 0x80
error occurred on transmission

Protocol error location

Error in the data[3] field of struct [can_frame](#).

- #define [CAN_ERR_PROT_LOC_UNSPEC](#) 0x00
unspecified
- #define [CAN_ERR_PROT_LOC_SOF](#) 0x03
start of frame
- #define [CAN_ERR_PROT_LOC_ID28_21](#) 0x02
ID bits 28 - 21 (SFF: 10 - 3).
- #define [CAN_ERR_PROT_LOC_ID20_18](#) 0x06
ID bits 20 - 18 (SFF: 2 - 0).
- #define [CAN_ERR_PROT_LOC_SRTR](#) 0x04

substitute RTR (SFF: RTR)

- #define [CAN_ERR_PROT_LOC_IDE](#) 0x05
identifier extension
- #define [CAN_ERR_PROT_LOC_ID17_13](#) 0x07
ID bits 17-13.
- #define [CAN_ERR_PROT_LOC_ID12_05](#) 0x0F
ID bits 12-5.
- #define [CAN_ERR_PROT_LOC_ID04_00](#) 0x0E
ID bits 4-0.
- #define [CAN_ERR_PROT_LOC_RTR](#) 0x0C
RTR.
- #define [CAN_ERR_PROT_LOC_RES1](#) 0x0D
reserved bit 1
- #define [CAN_ERR_PROT_LOC_RES0](#) 0x09
reserved bit 0
- #define [CAN_ERR_PROT_LOC_DLC](#) 0x0B
data length code
- #define [CAN_ERR_PROT_LOC_DATA](#) 0x0A
data section
- #define [CAN_ERR_PROT_LOC_CRC_SEQ](#) 0x08
CRC sequence.
- #define [CAN_ERR_PROT_LOC_CRC_DEL](#) 0x18
CRC delimiter.
- #define [CAN_ERR_PROT_LOC_ACK](#) 0x19
ACK slot.
- #define [CAN_ERR_PROT_LOC_ACK_DEL](#) 0x1B
ACK delimiter.
- #define [CAN_ERR_PROT_LOC_EOF](#) 0x1A
end of frame
- #define [CAN_ERR_PROT_LOC_INTERM](#) 0x12
intermission

Protocol error location

Error in the data[4] field of struct `can_frame`.

- `#define CAN_ERR_TRX_UNSPEC 0x00`
`0000 0000`
- `#define CAN_ERR_TRX_CANH_NO_WIRE 0x04`
`0000 0100`
- `#define CAN_ERR_TRX_CANH_SHORT_TO_BAT 0x05`
`0000 0101`
- `#define CAN_ERR_TRX_CANH_SHORT_TO_VCC 0x06`
`0000 0110`
- `#define CAN_ERR_TRX_CANH_SHORT_TO_GND 0x07`
`0000 0111`
- `#define CAN_ERR_TRX_CANL_NO_WIRE 0x40`
`0100 0000`
- `#define CAN_ERR_TRX_CANL_SHORT_TO_BAT 0x50`
`0101 0000`
- `#define CAN_ERR_TRX_CANL_SHORT_TO_VCC 0x60`
`0110 0000`
- `#define CAN_ERR_TRX_CANL_SHORT_TO_GND 0x70`
`0111 0000`
- `#define CAN_ERR_TRX_CANL_SHORT_TO_CANH 0x80`
`1000 0000`

CAN protocols

Possible protocols for PF_CAN protocol family

- `enum CAN_PROTO { CAN_PROTO_RAW }`

CAN operation modes

Modes into which CAN controllers can be set

- `enum CAN_MODE { CAN_MODE_STOP = 0, CAN_MODE_START, CAN_MODE_SLEEP }`

CAN controller states

States a CAN controller can be in.

- enum [CAN_STATE](#) {
 [CAN_STATE_ACTIVE](#) = 0, [CAN_STATE_BUS_WARNING](#), [CAN_STATE_BUS_PASSIVE](#),
 [CAN_STATE_BUS_OFF](#),
 [CAN_STATE_SCANNING_BAUDRATE](#), [CAN_STATE_STOPPED](#), [CAN_STATE_SLEEPING](#) }

Defines

- #define [AF_CAN](#) 29
 CAN address family.
- #define [PF_CAN](#) [AF_CAN](#)
 CAN protocol family.

Typedefs

- typedef uint32_t [can_id_t](#)
 Type of CAN id (see [CAN_xxx_MASK](#) and [CAN_xxx_FLAG](#)).
- typedef [can_id_t](#) [can_err_mask_t](#)
 Type of CAN error mask.
- typedef uint32_t [can_baudrate_t](#)
 Baudrate definition in bits per second.
- typedef enum [CAN_BITTIME_TYPE](#) [can_bittime_type_t](#)
 See [CAN_BITTIME_TYPE](#).
- typedef enum [CAN_MODE](#) [can_mode_t](#)
 See [CAN_MODE](#).
- typedef int [can_ctrlmode_t](#)
 See [CAN_CTRLMODE](#).
- typedef enum [CAN_STATE](#) [can_state_t](#)
 See [CAN_STATE](#).
- typedef [can_filter](#) [can_filter_t](#)
 Filter for reception of CAN messages.
- typedef [can_frame](#) [can_frame_t](#)
 Raw CAN frame.

Enumerations

- enum `CAN_BITTIME_TYPE` { `CAN_BITTIME_STD`, `CAN_BITTIME_BTR` }
Supported CAN bit-time types.

7.2 include/rtdm/rtdm.h File Reference

7.2.1 Detailed Description

Real-Time Driver Model for Xenomai, user API header.

Note:

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```
#include <fcntl.h>
#include <stdint.h>
#include <sys/ioctl.h>
#include <sys/socket.h>
```

API Versioning

- #define `RTDM_API_VER` 5
Common user and driver API version.
- #define `RTDM_API_MIN_COMPAT_VER` 5
Minimum API revision compatible with the current release.

RTDM_TIMEOUT_xxx

Special timeout values

- #define `RTDM_TIMEOUT_INFINITE` 0
Block forever.
- #define `RTDM_TIMEOUT_NONE` (-1)
Any negative timeout means non-blocking.

RTDM_CLASS_xxx

Device classes

- `#define RTDM_CLASS_PARPORT 1`
- `#define RTDM_CLASS_SERIAL 2`
- `#define RTDM_CLASS_CAN 3`
- `#define RTDM_CLASS_NETWORK 4`
- `#define RTDM_CLASS_RTMAC 5`
- `#define RTDM_CLASS_TESTING 6`
- `#define RTDM_CLASS_EXPERIMENTAL 224`
- `#define RTDM_CLASS_MAX 255`

Device Naming

Maximum length of device names (excluding the final null character)

- `#define RTDM_MAX_DEVNAME_LEN 31`

RTDM_PURGE_XXX_BUFFER

Flags selecting buffers to be purged

- `#define RTDM_PURGE_RX_BUFFER 0x0001`
- `#define RTDM_PURGE_TX_BUFFER 0x0002`

Common IOCTLs

The following IOCTLs shall be supported by any device profile if applicable

- `#define RTIOC_PURGE_IOW(RTIOC_TYPE_COMMON, 0x10, int)`
Purge internal device or socket buffers.

Typedefs

- `typedef uint64_t nanosecs_abs_t`
RTDM type for representing absolute dates.
- `typedef int64_t nanosecs_rel_t`
RTDM type for representing relative intervals.

7.3 include/rtdm/rtdm_driver.h File Reference

7.3.1 Detailed Description

Real-Time Driver Model for Xenomai, driver API header.

Note:

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```
#include <asm/atomic.h>
#include <linux/list.h>
#include <nucleus/xenomai.h>
#include <nucleus/core.h>
#include <nucleus/heap.h>
#include <nucleus/pod.h>
#include <nucleus/synch.h>
#include <rtdm/rtdm.h>
#include <nucleus/assert.h>
```

Data Structures

- struct [rtdm_operations](#)
Device operations.
- struct [rtdm_dev_context](#)
Device context.
- struct [rtdm_device](#)
RTDM device.

Device Flags

Static flags describing a RTDM device

- #define [RTDM_EXCLUSIVE](#) 0x0001

If set, only a single instance of the device can be requested by an application.

- #define [RTDM_NAMED_DEVICE](#) 0x0010
If set, the device is addressed via a clear-text name.
- #define [RTDM_PROTOCOL_DEVICE](#) 0x0020
If set, the device is addressed via a combination of protocol ID and socket type.
- #define [RTDM_DEVICE_TYPE_MASK](#) 0x00F0
Mask selecting the device type.

Context Flags

Dynamic flags describing the state of an open RTDM device (bit numbers)

- #define [RTDM_CREATED_IN_NRT](#) 0
Set by RTDM if the device instance was created in non-real-time context.
- #define [RTDM_CLOSING](#) 1
Set by RTDM when the device is being closed.
- #define [RTDM_FORCED_CLOSING](#) 2
Set by RTDM if the device has to be closed regardless of possible pending locks held by other users.
- #define [RTDM_USER_CONTEXT_FLAG](#) 8
Lowest bit number the driver developer can use freely.

Driver Versioning

Current revisions of RTDM structures, encoding of driver versions. See [API Versioning](#) for the interface revision.

- #define [RTDM_DEVICE_STRUCT_VER](#) 3
Version of struct [rtdm_device](#).
- #define [RTDM_CONTEXT_STRUCT_VER](#) 3
Version of struct [rtdm_dev_context](#).
- #define [RTDM_SECURE_DEVICE](#) 0x80000000
Flag indicating a secure variant of RTDM (not supported here).
- #define [RTDM_DRIVER_VER](#)(major, minor, patch) (((major & 0xFF) << 16) | ((minor & 0xFF) << 8) | (patch & 0xFF))
Version code constructor for driver revisions.
- #define [RTDM_DRIVER_MAJOR_VER](#)(ver) (((ver) >> 16) & 0xFF)
Get major version number from driver revision code.

- #define [RTDM_DRIVER_MINOR_VER](#)(ver) (((ver) >> 8) & 0xFF)
Get minor version number from driver revision code.
- #define [RTDM_DRIVER_PATCH_VER](#)(ver) ((ver) & 0xFF)
Get patch version number from driver revision code.

Global Lock across Scheduler Invocation

- #define [RTDM_EXECUTE_ATOMICALLY](#)(code_block)
Execute code block atomically.

Spinlock with Preemption Deactivation

- #define [RTDM_LOCK_UNLOCKED](#) RTHAL_SPIN_LOCK_UNLOCKED
Static lock initialisation.
- #define [rtdm_lock_init](#)(lock) rthal_spin_lock_init(lock)
Dynamic lock initialisation.
- #define [rtdm_lock_get](#)(lock) rthal_spin_lock(lock)
Acquire lock from non-preemptible contexts.
- #define [rtdm_lock_put](#)(lock) rthal_spin_unlock(lock)
Release lock without preemption restoration.
- #define [rtdm_lock_get_irqsave](#)(lock, context) rthal_spin_lock_irqsave(lock, context)
Acquire lock and disable preemption.
- #define [rtdm_lock_put_irqrestore](#)(lock, context) rthal_spin_unlock_irqrestore(lock, context)
Release lock and restore preemption state.
- #define [rtdm_lock_irqsave](#)(context) rthal_local_irq_save(context)
Disable preemption locally.
- #define [rtdm_lock_irqrestore](#)(context) rthal_local_irq_restore(context)
Restore preemption state.
- typedef rthal_spinlock_t [rtdm_lock_t](#)
Lock variable.
- typedef unsigned long [rtdm_lockctx_t](#)
Variable to save the context while holding a lock.

RTDM_IRQTYPE_xxx

Interrupt registrations flags

- #define `RTDM_IRQTYPE_SHARED` `XN_ISR_SHARED`
Enable IRQ-sharing with other real-time drivers.
- #define `RTDM_IRQTYPE_EDGE` `XN_ISR_EDGE`
Mark IRQ as edge-triggered, relevant for correct handling of shared edge-triggered IRQs.

RTDM_IRQ_xxx

Return flags of interrupt handlers

- #define `RTDM_IRQ_NONE` `XN_ISR_NONE`
Unhandled interrupt.
- #define `RTDM_IRQ_HANDLED` `XN_ISR_HANDLED`
Denote handled interrupt.

Task Priority Range

Maximum and minimum task priorities

- #define `RTDM_TASK_LOWEST_PRIORITY` `XNCORE_LOW_Prio`
- #define `RTDM_TASK_HIGHEST_PRIORITY` `XNCORE_HIGH_Prio`

Task Priority Modification

Raise or lower task priorities by one level

- #define `RTDM_TASK_RAISE_PRIORITY` (+1)
- #define `RTDM_TASK_LOWER_PRIORITY` (-1)

Operation Handler Prototypes

- typedef int(* `rtdm_open_handler_t`)(struct `rtdm_dev_context` *context, `rtdm_user_info_t` *user_info, int oflag)
Named device open handler.
- typedef int(* `rtdm_socket_handler_t`)(struct `rtdm_dev_context` *context, `rtdm_user_info_t` *user_info, int protocol)
Socket creation handler for protocol devices.
- typedef int(* `rtdm_close_handler_t`)(struct `rtdm_dev_context` *context, `rtdm_user_info_t` *user_info)

Close handler.

- typedef int(* [rtdm_ioctl_handler_t](#))(struct [rtdm_dev_context](#) *context, [rtdm_user_info_t](#) *user_info, int request, void *arg)

IOCTL handler.

- typedef ssize_t(* [rtdm_read_handler_t](#))(struct [rtdm_dev_context](#) *context, [rtdm_user_info_t](#) *user_info, void *buf, size_t nbyte)

Read handler.

- typedef ssize_t(* [rtdm_write_handler_t](#))(struct [rtdm_dev_context](#) *context, [rtdm_user_info_t](#) *user_info, const void *buf, size_t nbyte)

Write handler.

- typedef ssize_t(* [rtdm_recvmmsg_handler_t](#))(struct [rtdm_dev_context](#) *context, [rtdm_user_info_t](#) *user_info, struct msghdr *msg, int flags)

Receive message handler.

- typedef ssize_t(* [rtdm_sendmmsg_handler_t](#))(struct [rtdm_dev_context](#) *context, [rtdm_user_info_t](#) *user_info, const struct msghdr *msg, int flags)

Transmit message handler.

Defines

- #define [rtdm_irq_get_arg](#)(irq_handle, type) ((type *)irq_handle → cookie)

Retrieve IRQ handler argument.

Typedefs

- typedef int(* [rtdm_irq_handler_t](#))(rtdm_irq_t *irq_handle)

Interrupt handler.

- typedef void(* [rtdm_nrtsig_handler_t](#))(rtdm_nrtsig_t nrt_sig)

Non-real-time signal handler.

- typedef void(* [rtdm_task_proc_t](#))(void *arg)

Real-time task procedure.

Functions

- int [rtdm_dev_register](#) (struct [rtdm_device](#) *device)

Register a RTDM device.

- int [rtdm_dev_unregister](#) (struct [rtdm_device](#) *device, unsigned int poll_delay)

Unregisters a RTDM device.

- [rt dm_dev_context * rt dm_context_get](#) (int fd)
Resolve file descriptor to device context.
- int [rt dm_task_init](#) (rt dm_task_t *task, const char *name, [rt dm_task_proc_t](#) task_proc, void *arg, int priority, [nanosecs_rel_t](#) period)
Initialise and start a real-time task.
- int [rt dm_task_sleep](#) ([nanosecs_rel_t](#) delay)
Sleep a specified amount of time.
- int [rt dm_task_sleep_until](#) ([nanosecs_abs_t](#) wakeup_time)
Sleep until a specified absolute time.
- void [rt dm_task_busy_sleep](#) ([nanosecs_rel_t](#) delay)
Busy-wait a specified amount of time.
- int [rt dm_event_wait](#) (rt dm_event_t *event)
Wait on event occurrence.
- int [rt dm_event_timedwait](#) (rt dm_event_t *event, [nanosecs_rel_t](#) timeout, rt dm_toseq_t *timeout_seq)
Wait on event occurrence with timeout.
- void [rt dm_event_signal](#) (rt dm_event_t *event)
Signal an event occurrence.
- void [rt dm_event_clear](#) (rt dm_event_t *event)
Clear event state.
- int [rt dm_sem_down](#) (rt dm_sem_t *sem)
Decrement a semaphore.
- int [rt dm_sem_timeddown](#) (rt dm_sem_t *sem, [nanosecs_rel_t](#) timeout, rt dm_toseq_t *timeout_seq)
Decrement a semaphore with timeout.
- void [rt dm_sem_up](#) (rt dm_sem_t *sem)
Increment a semaphore.
- int [rt dm_mutex_lock](#) (rt dm_mutex_t *mutex)
Request a mutex.
- int [rt dm_mutex_timedlock](#) (rt dm_mutex_t *mutex, [nanosecs_rel_t](#) timeout, rt dm_toseq_t *timeout_seq)
Request a mutex with timeout.

7.4 include/rtdm/rtserial.h File Reference

7.4.1 Detailed Description

Real-Time Driver Model for Xenomai, serial device profile header.

Note:

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```
#include <rtdm/rtdm.h>
```

Data Structures

- struct [rtser_config](#)
Serial device configuration.
- struct [rtser_status](#)
Serial device status.
- struct [rtser_event](#)
Additional information about serial device events.

RTSER_DEF_BAUD

Default baud rate

- #define RTSER_DEF_BAUD 9600

RTSER_xxx_PARITY

Number of parity bits

- #define RTSER_NO_PARITY 0x00
- #define RTSER_ODD_PARITY 0x01
- #define RTSER_EVEN_PARITY 0x03
- #define RTSER_DEF_PARITY RTSER_NO_PARITY

RTSER_xxx_BITS

Number of data bits

- `#define RTSER_5_BITS 0x00`
- `#define RTSER_6_BITS 0x01`
- `#define RTSER_7_BITS 0x02`
- `#define RTSER_8_BITS 0x03`
- `#define RTSER_DEF_BITS RTSER_8_BITS`

RTSER_xxx_STOPB

Number of stop bits

- `#define RTSER_1_STOPB 0x00`
- `#define RTSER_1_5_STOPB 0x01`
valid only in combination with 5 data bits
- `#define RTSER_2_STOPB 0x01`
- `#define RTSER_DEF_STOPB RTSER_1_STOPB`

RTSER_xxx_HAND

Handshake mechanisms

- `#define RTSER_NO_HAND 0x00`
- `#define RTSER_RTSCTS_HAND 0x01`
- `#define RTSER_DEF_HAND RTSER_NO_HAND`

RTSER_FIFO_xxx

Reception FIFO interrupt threshold

- `#define RTSER_FIFO_DEPTH_1 0x00`
- `#define RTSER_FIFO_DEPTH_4 0x40`
- `#define RTSER_FIFO_DEPTH_8 0x80`
- `#define RTSER_FIFO_DEPTH_14 0xC0`
- `#define RTSER_DEF_FIFO_DEPTH RTSER_FIFO_DEPTH_1`

RTSER_TIMEOUT_xxx

Special timeout values, see also [RTDM_TIMEOUT_xxx](#)

- `#define RTSER_TIMEOUT_INFINITE RTDM_TIMEOUT_INFINITE`
- `#define RTSER_TIMEOUT_NONE RTDM_TIMEOUT_NONE`
- `#define RTSER_DEF_TIMEOUT RTDM_TIMEOUT_INFINITE`

RTSER_XXX_TIMESTAMP_HISTORY

Timestamp history control

- #define RTSER_RX_TIMESTAMP_HISTORY 0x01
- #define RTSER_DEF_TIMESTAMP_HISTORY 0x00

RTSER_EVENT_XXX

Events bits

- #define RTSER_EVENT_RXPEND 0x01
- #define RTSER_EVENT_ERRPEND 0x02
- #define RTSER_EVENT_MODEMHI 0x04
- #define RTSER_EVENT_MODEMLO 0x08
- #define RTSER_DEF_EVENT_MASK 0x00

RTSER_SET_XXX

Configuration mask bits

- #define RTSER_SET_BAUD 0x0001
- #define RTSER_SET_PARITY 0x0002
- #define RTSER_SET_DATA_BITS 0x0004
- #define RTSER_SET_STOP_BITS 0x0008
- #define RTSER_SET_HANDSHAKE 0x0010
- #define RTSER_SET_FIFO_DEPTH 0x0020
- #define RTSER_SET_TIMEOUT_RX 0x0100
- #define RTSER_SET_TIMEOUT_TX 0x0200
- #define RTSER_SET_TIMEOUT_EVENT 0x0400
- #define RTSER_SET_TIMESTAMP_HISTORY 0x0800
- #define RTSER_SET_EVENT_MASK 0x1000

RTSER_LSR_XXX

Line status bits

- #define RTSER_LSR_DATA 0x01
- #define RTSER_LSR_OVERRUN_ERR 0x02
- #define RTSER_LSR_PARITY_ERR 0x04
- #define RTSER_LSR_FRAMING_ERR 0x08
- #define RTSER_LSR_BREAK_IND 0x10
- #define RTSER_LSR_THR_EMPTY 0x20
- #define RTSER_LSR_TRANSM_EMPTY 0x40
- #define RTSER_LSR_FIFO_ERR 0x80
- #define RTSER_SOFT_OVERRUN_ERR 0x0100

RTSER_MSR_xxx

Modem status bits

- #define **RTSER_MSR_DCTS** 0x01
- #define **RTSER_MSR_DDSR** 0x02
- #define **RTSER_MSR_TERI** 0x04
- #define **RTSER_MSR_DDCD** 0x08
- #define **RTSER_MSR_CTS** 0x10
- #define **RTSER_MSR_DSR** 0x20
- #define **RTSER_MSR_RI** 0x40
- #define **RTSER_MSR_DCD** 0x80

RTSER_MCR_xxx

Modem control bits

- #define **RTSER_MCR_DTR** 0x01
- #define **RTSER_MCR_RTS** 0x02
- #define **RTSER_MCR_OUT1** 0x04
- #define **RTSER_MCR_OUT2** 0x08
- #define **RTSER_MCR_LOOP** 0x10

IOCTLs

Serial device IOCTLs

- #define **RTSER_RTIOC_GET_CONFIG** _IOR(RTIOC_TYPE_SERIAL, 0x00, struct rtser_config)
Get serial device configuration.
- #define **RTSER_RTIOC_SET_CONFIG** _IOW(RTIOC_TYPE_SERIAL, 0x01, struct rtser_config)
Set serial device configuration.
- #define **RTSER_RTIOC_GET_STATUS** _IOR(RTIOC_TYPE_SERIAL, 0x02, struct rtser_status)
Get serial device status.
- #define **RTSER_RTIOC_GET_CONTROL** _IOR(RTIOC_TYPE_SERIAL, 0x03, int)
Get serial device's modem control register.
- #define **RTSER_RTIOC_SET_CONTROL** _IOW(RTIOC_TYPE_SERIAL, 0x04, int)
Set serial device's modem control register.
- #define **RTSER_RTIOC_WAIT_EVENT** _IOR(RTIOC_TYPE_SERIAL, 0x05, struct rtser_event)
Wait on serial device events according to previously set mask.

Typedefs

- typedef [rtser_config](#) [rtser_config_t](#)
Serial device configuration.
- typedef [rtser_status](#) [rtser_status_t](#)
Serial device status.
- typedef [rtser_event](#) [rtser_event_t](#)
Additional information about serial device events.

7.5 include/rtdm/rttesting.h File Reference

7.5.1 Detailed Description

Real-Time Driver Model for Xenomai, testing device profile header.

Note:

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```
#include <rtdm/rtdm.h>
```

IOCTLs

Testing device IOCTLs

- `#define RTTST_RTIOC_INTERM_BENCH_RES _IOW(RTIOC_TYPE_TESTING, 0x00, struct rttst_interm_bench_res)`
- `#define RTTST_RTIOC_TMBENCH_START _IOW(RTIOC_TYPE_TESTING, 0x10, struct rttst_tmbench_config)`
- `#define RTTST_RTIOC_TMBENCH_STOP _IOW(RTIOC_TYPE_TESTING, 0x11, struct rttst_overall_bench_res)`
- `#define RTTST_RTIOC_IRQBENCH_START _IOW(RTIOC_TYPE_TESTING, 0x20, struct rttst_irqbench_config)`
- `#define RTTST_RTIOC_IRQBENCH_STOP _IO(RTIOC_TYPE_TESTING, 0x21)`
- `#define RTTST_RTIOC_IRQBENCH_GET_STATS _IOR(RTIOC_TYPE_TESTING, 0x22, struct rttst_irqbench_stats)`
- `#define RTTST_RTIOC_IRQBENCH_WAIT_IRQ _IO(RTIOC_TYPE_TESTING, 0x23)`
- `#define RTTST_RTIOC_IRQBENCH_REPLY_IRQ _IO(RTIOC_TYPE_TESTING, 0x24)`
- `#define RTTST_RTIOC_SWTEST_SET_TASKS_COUNT _IOW(RTIOC_TYPE_TESTING, 0x30, unsigned long)`
- `#define RTTST_RTIOC_SWTEST_SET_CPU _IOW(RTIOC_TYPE_TESTING, 0x31, unsigned long)`
- `#define RTTST_RTIOC_SWTEST_REGISTER_UTASK _IOW(RTIOC_TYPE_TESTING, 0x32, struct rttst_swtest_task)`
- `#define RTTST_RTIOC_SWTEST_CREATE_KTASK _IOW(RTIOC_TYPE_TESTING, 0x33, struct rttst_swtest_task)`
- `#define RTTST_RTIOC_SWTEST_PEND _IOR(RTIOC_TYPE_TESTING, 0x34, struct rttst_swtest_task)`
- `#define RTTST_RTIOC_SWTEST_SWITCH_TO _IOR(RTIOC_TYPE_TESTING, 0x35, struct rttst_swtest_dir)`

- `#define RTTST_RTIOC_SWTEST_GET_SWITCHES_COUNT _IOR(RTIOC_TYPE_TESTING, 0x36, unsigned long)`
- `#define RTTST_RTIOC_SWTEST_GET_LAST_ERROR _IOR(RTIOC_TYPE_TESTING, 0x37, struct rttst_swtest_error)`

7.6 ksrc/skins/rtdm/device.c File Reference

7.6.1 Detailed Description

Real-Time Driver Model for Xenomai, device management.

Note:

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```
#include <linux/module.h>
```

```
#include <linux/delay.h>
```

```
#include "rtdm/device.h"
```

```
#include "rtdm/proc.h"
```

Functions

- int [rtdm_dev_register](#) (struct [rtdm_device](#) *device)
Register a RTDM device.
- int [rtdm_dev_unregister](#) (struct [rtdm_device](#) *device, unsigned int poll_delay)
Unregisters a RTDM device.

7.7 ksrc/skins/rtdm/drvlib.c File Reference

7.7.1 Detailed Description

Real-Time Driver Model for Xenomai, driver library.

Note:

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```
#include <asm/page.h>
#include <asm/io.h>
#include <asm/pgtable.h>
#include <linux/delay.h>
#include <linux/mman.h>
#include <linux/highmem.h>
#include <rtdm/rtdm_driver.h>
```

Timeout Sequence Management

- void [rtdm_toseq_init](#) (rtdm_toseq_t *timeout_seq, [nanosecs_rel_t](#) timeout)
Initialise a timeout sequence.

Event Services

- void [rtdm_event_init](#) (rtdm_event_t *event, unsigned long pending)
Initialise an event.
- void [rtdm_event_destroy](#) (rtdm_event_t *event)
Destroy an event.
- void [rtdm_event_pulse](#) (rtdm_event_t *event)
Signal an event occurrence to currently listening waiters.
- void [rtdm_event_signal](#) (rtdm_event_t *event)
Signal an event occurrence.

- int [rt dm_event_wait](#) (rt dm_event_t *event)
Wait on event occurrence.
- int [rt dm_event_timedwait](#) (rt dm_event_t *event, [nanosecs_rel_t](#) timeout, rt dm_toseq_t *timeout_seq)
Wait on event occurrence with timeout.
- void [rt dm_event_clear](#) (rt dm_event_t *event)
Clear event state.

Semaphore Services

- void [rt dm_sem_init](#) (rt dm_sem_t *sem, unsigned long value)
Initialise a semaphore.
- void [rt dm_sem_destroy](#) (rt dm_sem_t *sem)
Destroy a semaphore.
- int [rt dm_sem_down](#) (rt dm_sem_t *sem)
Decrement a semaphore.
- int [rt dm_sem_timeddown](#) (rt dm_sem_t *sem, [nanosecs_rel_t](#) timeout, rt dm_toseq_t *timeout_seq)
Decrement a semaphore with timeout.
- void [rt dm_sem_up](#) (rt dm_sem_t *sem)
Increment a semaphore.

Mutex Services

- void [rt dm_mutex_init](#) (rt dm_mutex_t *mutex)
Initialise a mutex.
- void [rt dm_mutex_destroy](#) (rt dm_mutex_t *mutex)
Destroy a mutex.
- void [rt dm_mutex_unlock](#) (rt dm_mutex_t *mutex)
Release a mutex.
- int [rt dm_mutex_lock](#) (rt dm_mutex_t *mutex)
Request a mutex.
- int [rt dm_mutex_timedlock](#) (rt dm_mutex_t *mutex, [nanosecs_rel_t](#) timeout, rt dm_toseq_t *timeout_seq)
Request a mutex with timeout.

Functions

- [nanosecs_abs_t rtdm_clock_read](#) (void)
Get system time.
- [int rtdm_task_init](#) (rtdm_task_t *task, const char *name, [rtdm_task_proc_t](#) task_proc, void *arg, int priority, [nanosecs_rel_t](#) period)
Intialise and start a real-time task.
- [void rtdm_task_destroy](#) (rtdm_task_t *task)
Destroy a real-time task.
- [void rtdm_task_set_priority](#) (rtdm_task_t *task, int priority)
Adjust real-time task priority.
- [int rtdm_task_set_period](#) (rtdm_task_t *task, [nanosecs_rel_t](#) period)
Adjust real-time task period.
- [int rtdm_task_wait_period](#) (void)
Wait on next real-time task period.
- [int rtdm_task_unblock](#) (rtdm_task_t *task)
Activate a blocked real-time task.
- [rtdm_task_t * rtdm_task_current](#) (void)
Get current real-time task.
- [void rtdm_task_join_nrt](#) (rtdm_task_t *task, unsigned int poll_delay)
Wait on a real-time task to terminate.
- [int rtdm_task_sleep](#) ([nanosecs_rel_t](#) delay)
Sleep a specified amount of time.
- [int rtdm_task_sleep_until](#) ([nanosecs_abs_t](#) wakeup_time)
Sleep until a specified absolute time.
- [void rtdm_task_busy_sleep](#) ([nanosecs_rel_t](#) delay)
Busy-wait a specified amount of time.
- [int rtdm_irq_request](#) (rtdm_irq_t *irq_handle, unsigned int irq_no, [rtdm_irq_handler_t](#) handler, unsigned long flags, const char *device_name, void *arg)
Register an interrupt handler.
- [int rtdm_irq_free](#) (rtdm_irq_t *irq_handle)
Release an interrupt handler.
- [int rtdm_irq_enable](#) (rtdm_irq_t *irq_handle)
Enable interrupt line.
- [int rtdm_irq_disable](#) (rtdm_irq_t *irq_handle)

Disable interrupt line.

- int [rt dm_nrtsig_init](#) (rt dm_nrtsig_t *nrt_sig, [rt dm_nrtsig_handler_t](#) handler)
Register a non-real-time signal handler.
- void [rt dm_nrtsig_destroy](#) (rt dm_nrtsig_t *nrt_sig)
Release a non-realtime signal handler.
- void [rt dm_nrtsig_pend](#) (rt dm_nrtsig_t *nrt_sig)
Trigger non-real-time signal.
- int [rt dm_mmap_to_user](#) (rt dm_user_info_t *user_info, void *src_addr, size_t len, int prot, void **pptr, struct vm_operations_struct *vm_ops, void *vm_private_data)
Map a kernel memory range into the address space of the user.
- int [rt dm_iomap_to_user](#) (rt dm_user_info_t *user_info, unsigned long src_addr, size_t len, int prot, void **pptr, struct vm_operations_struct *vm_ops, void *vm_private_data)
Map an I/O memory range into the address space of the user.
- int [rt dm_munmap](#) (rt dm_user_info_t *user_info, void *ptr, size_t len)
Unmap a user memory range.
- void [rt dm_printk](#) (const char *format,...)
Real-time safe message printing on kernel console.
- void * [rt dm_malloc](#) (size_t size)
Allocate memory block in real-time context.
- void [rt dm_free](#) (void *ptr)
Release real-time memory block.
- int [rt dm_read_user_ok](#) (rt dm_user_info_t *user_info, const void __user *ptr, size_t size)
Check if read access to user-space memory block is safe.
- int [rt dm_rw_user_ok](#) (rt dm_user_info_t *user_info, const void __user *ptr, size_t size)
Check if read/write access to user-space memory block is safe.
- int [rt dm_copy_from_user](#) (rt dm_user_info_t *user_info, void *dst, const void __user *src, size_t size)
Copy user-space memory block to specified buffer.
- int [rt dm_safe_copy_from_user](#) (rt dm_user_info_t *user_info, void *dst, const void __user *src, size_t size)
Check if read access to user-space memory block and copy it to specified buffer.
- int [rt dm_copy_to_user](#) (rt dm_user_info_t *user_info, void __user *dst, const void *src, size_t size)
Copy specified buffer to user-space memory block.
- int [rt dm_safe_copy_to_user](#) (rt dm_user_info_t *user_info, void __user *dst, const void *src, size_t size)

Check if read/write access to user-space memory block is safe and copy specified buffer to it.

- int [rtdm_strncpy_from_user](#) (rtdm_user_info_t *user_info, char *dst, const char __user *src, size_t count)

Copy user-space string to specified buffer.

- int [rtdm_in_rt_context](#) (void)

Test if running in a real-time task.

7.8 ksrc/skins/rtdm/module.c File Reference

7.8.1 Detailed Description

Real-Time Driver Model for Xenomai.

Note:

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```
#include <nucleus/pod.h>
```

```
#include "rtdm/device.h"
```

```
#include "rtdm/proc.h"
```


7.9 ksrc/skins/rtdm/core.c File Reference

7.9.1 Detailed Description

Real-Time Driver Model for Xenomai, device operation multiplexing.

Note:

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```
#include <linux/module.h>
#include <nucleus/pod.h>
#include <nucleus/heap.h>
#include <rtdm/syscall.h>
#include <rtdm/rtdm_driver.h>
#include "rtdm/core.h"
#include "rtdm/device.h"
```

Functions

- `rtdm_dev_context * rtdm_context_get` (int fd)
Resolve file descriptor to device context.
- void `rtdm_context_lock` (struct `rtdm_dev_context` *context)
Increment context reference counter.
- void `rtdm_context_unlock` (struct `rtdm_dev_context` *context)
Decrement context reference counter.
- int `rtdm_open` (const char *path, int oflag,...)
Open a device.
- int `rtdm_socket` (int protocol_family, int socket_type, int protocol)
Create a socket.
- int `rtdm_close` (int fd)
Close a device or socket.

- `int rtdm_ioctl` (int fd, int request,...)
Issue an IOCTL.
- `ssize_t rtdm_read` (int fd, void *buf, size_t nbyte)
Read from device.
- `ssize_t rtdm_write` (int fd, const void *buf, size_t nbyte)
Write to device.
- `ssize_t rtdm_recvmmsg` (int fd, struct msghdr *msg, int flags)
Receive message from socket.
- `ssize_t rtdm_recvfrom` (int fd, void *buf, size_t len, int flags, struct sockaddr *from, socklen_t *fromlen)
Receive message from socket.
- `ssize_t rtdm_recv` (int fd, void *buf, size_t len, int flags)
Receive message from socket.
- `ssize_t rtdm_sendmsg` (int fd, const struct msghdr *msg, int flags)
Transmit message to socket.
- `ssize_t rtdm_sendto` (int fd, const void *buf, size_t len, int flags, const struct sockaddr *to, socklen_t tolen)
Transmit message to socket.
- `ssize_t rtdm_send` (int fd, const void *buf, size_t len, int flags)
Transmit message to socket.
- `int rtdm_bind` (int fd, const struct sockaddr *my_addr, socklen_t addrlen)
Bind to local address.
- `int rtdm_connect` (int fd, const struct sockaddr *serv_addr, socklen_t addrlen)
Connect to remote address.
- `int rtdm_listen` (int fd, int backlog)
Listen for incoming connection requests.
- `int rtdm_accept` (int fd, struct sockaddr *addr, socklen_t *addrlen)
Accept a connection requests.
- `int rtdm_shutdown` (int fd, int how)
Shut down parts of a connection.
- `int rtdm_getsockopt` (int fd, int level, int optname, void *optval, socklen_t *optlen)
Get socket option.
- `int rtdm_setsockopt` (int fd, int level, int optname, const void *optval, socklen_t optlen)
Set socket option.

- `int rtdm_getsockname` (int fd, struct sockaddr *name, socklen_t *namelen)
Get local socket address.
- `int rtdm_getpeername` (int fd, struct sockaddr *name, socklen_t *namelen)
Get socket destination address.
- `int rt_dev_open` (const char *path, int oflag,...)
Open a device.
- `int rt_dev_socket` (int protocol_family, int socket_type, int protocol)
Create a socket.
- `int rt_dev_close` (int fd)
Close a device or socket.
- `int rt_dev_ioctl` (int fd, int request,...)
Issue an IOCTL.
- `ssize_t rt_dev_read` (int fd, void *buf, size_t nbyte)
Read from device.
- `ssize_t rt_dev_write` (int fd, const void *buf, size_t nbyte)
Write to device.
- `ssize_t rt_dev_recvmsg` (int fd, struct msghdr *msg, int flags)
Receive message from socket.
- `ssize_t rt_dev_recvfrom` (int fd, void *buf, size_t len, int flags, struct sockaddr *from, socklen_t *fromlen)
Receive message from socket.
- `ssize_t rt_dev_recv` (int fd, void *buf, size_t len, int flags)
Receive message from socket.
- `ssize_t rt_dev_sendmsg` (int fd, const struct msghdr *msg, int flags)
Transmit message to socket.
- `ssize_t rt_dev_sendto` (int fd, const void *buf, size_t len, int flags, const struct sockaddr *to, socklen_t tolen)
Transmit message to socket.
- `ssize_t rt_dev_send` (int fd, const void *buf, size_t len, int flags)
Transmit message to socket.
- `int rt_dev_bind` (int fd, const struct sockaddr *my_addr, socklen_t addrlen)
Bind to local address.
- `int rt_dev_connect` (int fd, const struct sockaddr *serv_addr, socklen_t addrlen)
Connect to remote address.

- int [rt_dev_listen](#) (int fd, int backlog)
Listen for incoming connection requests.
- int [rt_dev_accept](#) (int fd, struct sockaddr *addr, socklen_t *addrlen)
Accept a connection requests.
- int [rt_dev_shutdown](#) (int fd, int how)
Shut down parts of a connection.
- int [rt_dev_getsockopt](#) (int fd, int level, int optname, void *optval, socklen_t *optlen)
Get socket option.
- int [rt_dev_setsockopt](#) (int fd, int level, int optname, const void *optval, socklen_t optlen)
Set socket option.
- int [rt_dev_getsockname](#) (int fd, struct sockaddr *name, socklen_t *namelen)
Get local socket address.
- int [rt_dev_getpeername](#) (int fd, struct sockaddr *name, socklen_t *namelen)
Get socket destination address.

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