Xenomai RTDM skin API Reference Manual

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5.1 CAN Devices

Collaboration diagram for 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).

Profile Revision: 2

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_RAW)
  - Option CAN_RAW_FILTER : CAN filter list
  - Option CAN_RAW_ERR_FILTER : CAN error mask
  - Option CAN_RAW_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_t

  Filter for reception of CAN messages.

- struct sockaddr_can

  Socket address structure for the CAN address family.

- struct can_frame_t

  Raw CAN frame.

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 }

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 frame.
- #define CAN_ERR_FLAG 0x20000000
  Error frame (see Errors), not valid in struct can_filter.
- #define CAN_INV_FILTER CAN_ERR_FLAG
  Invert CAN filter definition, only valid in struct can_filter.

Particular CAN protocols

Possible protocols for the PF_CAN protocol family

Currently only the RAW protocol is supported.

- #define CAN_RAW 1
  Raw protocol of `PF_CAN`*, applicable to socket type* `SOCK_RAW`*.*

CAN controller modes

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

Note:

These modes are hardware-dependent. Please consult the hardware manual of the CAN controller for more detailed information.

- #define CAN_CTRLMODE_LISTENONLY 0x1
- #define CAN_CTRLMODE_LOOPBACK 0x2

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_LOOPBACK 0x3
  CAN TX loopback.
- #define CAN_RAW_RECV_OWN_MSGS 0x4
  CAN receive own messages.

IOCTLs

CAN device IOCTLs

- #define SIOCGIFINDEX defined_by_kernel_header_file
  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 custum 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.

Note: Error reporting is hardware dependent and most CAN controllers report less detailed error conditions than the SJA1000.

Note: In case of a bus-off error condition (CAN_ERR_BUSOFF), the CAN controller is **not** restarted automatically. It is the application's responsibility to react appropriately, e.g. calling CAN_MODE_START.

Note: Bus error interrupts (CAN_ERR_BUSERROR) are enabled when an application is calling a Recv function on a socket listening on bus errors (using CAN_RAW_ERR_FILTER). After one bus error has occured, the interrupt will be disabled to allow the application time for error processing and to efficiently avoid bus error interrupt flooding.

- #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

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 occured 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

Defines

- #define AF_CAN 29
  CAN address family.
- #define PF_CAN AF_CAN

CAN protocol family.

- #define SOL_CAN_RAW 103
  CAN socket levels.

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.

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_CTRLMODE_LISTENONLY 0x1

Listen-Only mode

In this mode the CAN controller would give no acknowledge to the CAN-bus, even if a message is received successfully and messages would not be transmitted. This mode might be useful for bus-monitoring, hot-plugging or throughput analysis.

Examples:

rtcanconfig.c.

5.1.2.2 #define CAN_CTRLMODE_LOOPBACK 0x2

Loopback mode

In this mode the CAN controller does an internal loop-back, a message is transmitted and simultaneously received. That mode can be used for self test operation.

Examples:

rtcanconfig.c.

5.1.2.3 #define CAN_ERR_LOSTARB_UNSPEC 0x00

unspecified

else bit number in bitstream

5.1.2.4 #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 delivered to this socket in case of error condidtions. 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 errors can be found in the `can_id` and the `data` fields of struct can_frame (see Errors for futher 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")

Examples:

rtcanrecv.c.

5.1.2.5 #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 recommanded 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)

Examples:

rtcan_rtt.c, rtcanrecv.c, and rtcansend.c.

5.1.2.6 #define CAN_RAW_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_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).

Examples:

rtcansend.c.

5.1.2.7 #define CAN_RAW_RECV_OWN_MSGS 0x4

CAN receive own messages.

Not supported by RT-Socket-CAN, but defined for compatibility with Socket-CAN.

5.1.2.8 #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.

Examples:

rtcanrecv.c.

5.1.2.9 #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.

Examples:

rtcansend.c.

5.1.2.10 #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.

Examples:

rtcanrecv.c.

5.1.2.11 #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.

5.1.2.12 #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.

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

Get custum 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.

5.1.2.14 #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 occured 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.

5.1.2.15 #define SIOCGIFINDEX defined_by_kernel_header_file

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.

Examples:

rtcan_rtt.c, rtcanconfig.c, rtcanrecv.c, and rtcansend.c.

5.1.2.16 #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.

Examples:

rtcanconfig.c.

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

Rescheduling: possible.

Examples:

rtcanconfig.c.

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

Set custom bit time parameter.

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

Rescheduling: possible.

Examples:

rtcanconfig.c.

5.1.2.19 #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.

Examples:

rtcanconfig.c.

5.1.2.20 #define SOL_CAN_RAW 103

CAN socket levels.

Used for Sockopts for the particular protocols.

Examples:

rtcan_rtt.c, rtcanrecv.c, and rtcansend.c.

5.1.3 Enumeration Type Documentation

5.1.3.1 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.

5.1.3.2 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`.

5.1.3.3 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.

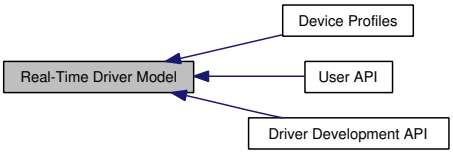
CAN_STATE_SCANNING_BAUDRATE CAN controller is scanning to get the baudrate.

CAN_STATE_STOPPED CAN controller is in stopped mode.

CAN_STATE_SLEEPING CAN controller is in Sleep mode.

5.2 Real-Time Driver Model

Collaboration diagram for 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: 6

Modules

- User API
- Driver Development API
- Device Profiles

API Versioning

- #define RTDM_API_VER 6

  Common user and driver API version.

- #define RTDM_API_MIN_COMPAT_VER 6

  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 Define Documentation

5.2.2.1 #define RTDM_TIMEOUT_INFINITE 0

Block forever.

5.2.2.2 #define RTDM_TIMEOUT_NONE (-1)

Any negative timeout means non-blocking.

5.2.3 Typedef Documentation

5.2.3.1 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.

Examples:

rtcanrecv.c.

5.2.3.2 typedef int64_t nanosecs_rel_t

RTDM type for representing relative intervals.

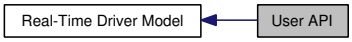
Its base type is a 64 bit signed integer. The unit is 1 nanosecond. Relative intervals can also encode the special timeouts "infinite" and "non-blocking", see RTDM_TIMEOUT_xxx.

Examples:

rtcanrecv.c, and rtcansend.c.

5.3 User API

Collaboration diagram for 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,...)
- int rt_dev_socket (int protocol_family, int socket_type, int protocol)
- int rt_dev_close (int fd)
- int rt_dev_ioctl (int fd, int request,...)
- ssize_t rt_dev_read (int fd, void *buf, size_t nbyte)
- ssize_t rt_dev_write (int fd, const void *buf, size_t nbyte)
- ssize_t rt_dev_recvmsg (int fd, struct msghdr *msg, int flags)
- ssize_t rt_dev_recvfrom (int fd, void *buf, size_t len, int flags, struct sockaddr *from, socklen_t *fromlen)
- ssize_t rt_dev_recv (int fd, void *buf, size_t len, int flags)
- ssize_t rt_dev_sendmsg (int fd, const struct msghdr *msg, int flags)
- ssize_t rt_dev_sendto (int fd, const void *buf, size_t len, int flags, const struct sockaddr *to, socklen_t tolen)
- ssize_t rt_dev_send (int fd, const void *buf, size_t len, int flags)
- int rt_dev_bind (int fd, const struct sockaddr *my_addr, socklen_t addrlen)
- int rt_dev_connect (int fd, const struct sockaddr *serv_addr, socklen_t addrlen)
- int rt_dev_listen (int fd, int backlog)
- int rt_dev_accept (int fd, struct sockaddr *addr, socklen_t *addrlen)
- int rt_dev_shutdown (int fd, int how)
- int rt_dev_getsockopt (int fd, int level, int optname, void *optval, socklen_t *optlen)
- int rt_dev_setsockopt (int fd, int level, int optname, const void *optval, socklen_t optlen)
- int rt_dev_getsockname (int fd, struct sockaddr *name, socklen_t *namelen)
- int rt_dev_getpeername (int fd, struct sockaddr *name, socklen_t *namelen)

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.

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 incomming 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:

`lsiten()` 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

Collaboration diagram for Serial Devices:

5.4.1 Detailed Description

This is the common interface a RTDM-compliant serial device has to provide. 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).

Profile Revision: 2

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_t

  Serial device configuration.

- struct rtser_status_t

  Serial device status.

- struct rtser_event_t

  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_EMTPY** 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

RTSER_BREAK_xxx

Break control

- #define **RTSER_BREAK_CLR** 0x00
- #define **RTSER_BREAK_SET** 0x01
- #define **RTIOC_TYPE_SERIAL** RTDM_CLASS_SERIAL

Sub-Classes of RTDM_CLASS_SERIAL

- #define **RTDM_SUBCLASS_16550A** 0

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 contol register.

- #define RTSER_RTIOC_SET_CONTROL _IOW(RTIOC_TYPE_SERIAL, 0x04, int)

  Set serial device's modem contol register.

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

  Wait on serial device events according to previously set mask.

Defines

- #define RTSER_RTIOC_BREAK_CTL _IOR(RTIOC_TYPE_SERIAL, 0x06, int)

  Set or clear break on UART output line.

5.4.2 Define Documentation

5.4.2.1 #define RTSER_RTIOC_BREAK_CTL _IOR(RTIOC_TYPE_SERIAL, 0x06, int)

Set or clear break on UART output line.

Parameters:

← *arg* RTSER_BREAK_SET or RTSER_BREAK_CLR (int)

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:

A set break condition may also be cleared on UART line reconfiguration.

Rescheduling: never.

5.4.2.2 #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.

5.4.2.3 #define RTSER_RTIOC_GET_CONTROL _IOR(RTIOC_TYPE_SERIAL, 0x03, int)

Get serial device's modem contol 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.

5.4.2.4 #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 occured 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.

5.4.2.5 #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.

Examples:

cross-link.c.

5.4.2.6 #define RTSER_RTIOC_SET_CONTROL _IOW(RTIOC_TYPE_SERIAL, 0x04, int)

Set serial device's modem contol 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.

5.4.2.7 #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.

Examples:

cross-link.c.

5.5 Testing Devices

Collaboration diagram for 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).

Profile Revision: 1

Device Characteristics

Device Flags: RTDM_NAMED_DEVICE
Device Name: "rttest<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 TSTIOCTLs below
Specific return values: see TSTIOCTLs below

Files

- file rttesting.h

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

Sub-Classes of RTDM_CLASS_TESTING

- #define **RTDM_SUBCLASS_TIMERBENCH** 0
- #define **RTDM_SUBCLASS_IRQBENCH** 1
- #define **RTDM_SUBCLASS_SWITCHTEST** 2

IOCTLs

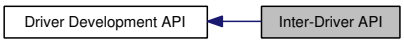
Testing device IOCTLs

- #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

Collaboration diagram for Inter-Driver API:



Functions

- struct rtdm_dev_context * rtdm_context_get (int fd)
- void rtdm_context_lock (struct rtdm_dev_context *context)
- void rtdm_context_unlock (struct rtdm_dev_context *context)
- int rtdm_open (const char *path, int oflag,...)
- int rtdm_socket (int protocol_family, int socket_type, int protocol)
- int rtdm_close (int fd)
- int rtdm_ioctl (int fd, int request,...)
- ssize_t rtdm_read (int fd, void *buf, size_t nbyte)
- ssize_t rtdm_write (int fd, const void *buf, size_t nbyte)
- ssize_t rtdm_recvmsg (int fd, struct msghdr *msg, int flags)
- ssize_t rtdm_recvfrom (int fd, void *buf, size_t len, int flags, struct sockaddr *from, socklen_t *fromlen)
- ssize_t rtdm_recv (int fd, void *buf, size_t len, int flags)
- ssize_t rtdm_sendmsg (int fd, const struct msghdr *msg, int flags)
- ssize_t rtdm_sendto (int fd, const void *buf, size_t len, int flags, const struct sockaddr *to, socklen_t tolen)
- ssize_t rtdm_send (int fd, const void *buf, size_t len, int flags)
- int rtdm_bind (int fd, const struct sockaddr *my_addr, socklen_t addrlen)
- int rtdm_connect (int fd, const struct sockaddr *serv_addr, socklen_t addrlen)
- int rtdm_listen (int fd, int backlog)
- int rtdm_accept (int fd, struct sockaddr *addr, socklen_t *addrlen)
- int rtdm_shutdown (int fd, int how)
- int rtdm_getsockopt (int fd, int level, int optname, void *optval, socklen_t *optlen)
- int rtdm_setsockopt (int fd, int level, int optname, const void *optval, socklen_t optlen)
- int rtdm_getsockname (int fd, struct sockaddr *name, socklen_t *namelen)
- int rtdm_getpeername (int fd, struct sockaddr *name, socklen_t *namelen)

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*) [read]

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:

rtdm_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 rtdm_dev_context * *context*)

Decrement context reference counter

Parameters:

← ***context*** Device context

Note:

Every successful call to rtdm_context_get() must be matched by a rtdm_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 incomming 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.

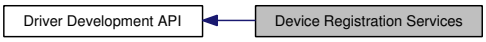
5.6.1.24 ssize_t rtdm_write (int *fd*, const void * *buf*, size_t *nbyte*)

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

Collaboration diagram for Device Registration Services:



Data Structures

- struct rtdm_operations

  Device operations.

- struct rtdm_dev_context
- struct rtdm_device

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, unsigned int request, void __user *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_recvmsg_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.

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_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 4
  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.

Functions

- int rtdm_dev_register (struct rtdm_device *device)
- int rtdm_dev_unregister (struct rtdm_device *device, unsigned int poll_delay)

5.7.1 Define Documentation

5.7.1.1 #define RTDM_CLOSING 1

Set by RTDM when the device is being closed.

5.7.1.2 #define RTDM_CREATED_IN_NRT 0

Set by RTDM if the device instance was created in non-real-time context.

5.7.1.3 #define RTDM_DEVICE_TYPE_MASK 0x00F0

Mask selecting the device type.

5.7.1.4 #define RTDM_EXCLUSIVE 0x0001

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

5.7.1.5 #define RTDM_NAMED_DEVICE 0x0010

If set, the device is addressed via a clear-text name.

5.7.1.6 #define RTDM_PROTOCOL_DEVICE 0x0020

If set, the device is addressed via a combination of protocol ID and socket type.

5.7.2 Typedef Documentation

5.7.2.1 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

5.7.2.2 typedef int(* rtdm_ioctl_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, unsigned int request, void __user *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:

Positiv value on success, otherwise negative error code

See also:

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

5.7.2.3 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

5.7.2.4 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

5.7.2.5 typedef ssize_t(* rtdm_recvmsg_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:

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

5.7.2.6 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

5.7.2.7 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

5.7.2.8 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

5.7.3 Function Documentation

5.7.3.1 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.

5.7.3.2 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:

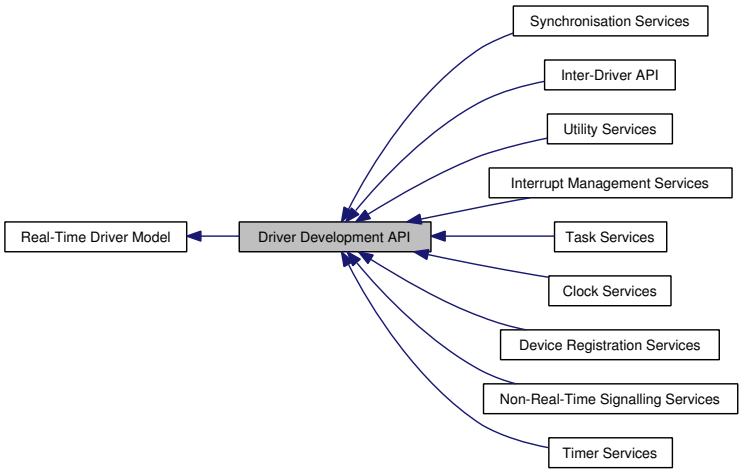
This service can be called from:

- Kernel module initialization/cleanup code

Rescheduling: never.

5.8 Driver Development API

Collaboration diagram for 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 rtdm_driver.h

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

Modules

- Inter-Driver API
- Device Registration Services
- Clock Services
- Task Services
- Timer Services
- Synchronisation Services
- Interrupt Management Services
- Non-Real-Time Signalling Services
- Utility Services

5.9 Clock Services

Collaboration diagram for Clock Services:

Functions

- nanosecs_abs_t rtdm_clock_read (void)
- nanosecs_abs_t rtdm_clock_read_monotonic (void)

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.

5.9.1.2 nanosecs_abs_t rtdm_clock_read_monotonic (void)

Get monotonic time

Returns:

The monotonic 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:

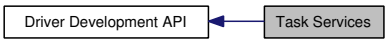
This service can be called from:

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

Rescheduling: never.

5.10 Task Services

Collaboration diagram for 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)
- void rtdm_task_destroy (rtdm_task_t *task)
- void rtdm_task_set_priority (rtdm_task_t *task, int priority)
- int rtdm_task_set_period (rtdm_task_t *task, nanosecs_rel_t period)
- int rtdm_task_wait_period (void)
- int rtdm_task_unblock (rtdm_task_t *task)
- rtdm_task_t * rtdm_task_current (void)
- int rtdm_task_sleep (nanosecs_rel_t delay)
- int rtdm_task_sleep_until (nanosecs_abs_t wakeup_time)
- int rtdm_task_sleep_abs (nanosecs_abs_t wakeup_time, enum rtdm_timer_mode mode)
- void rtdm_task_join_nrt (rtdm_task_t *task, unsigned int poll_delay)
- void rtdm_task_busy_sleep (nanosecs_rel_t delay)

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 nanoseconds 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*** Delay in milliseconds between periodic tests for the state of the real-time task. This parameter is ignored if the termination is internally realised without polling.

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 nanoseconds 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_abs (nanosecs_abs_t *wakeup_time*, enum rtdm_timer_mode *mode*)

Sleep until a specified absolute time

Parameters:

← ***wakeup_time*** Absolute timeout in nanoseconds

← ***mode*** Selects the timer mode, see RTDM_TIMERMODE_xxx for details

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.
- -EINVAL is returned if an invalid parameter was passed.

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_sleep_until (nanosecs_abs_t *wakeup_time*)

Sleep until a specified absolute time

Deprecated

Use rtdm_task_sleep_abs instead!

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.

5.10.2.11 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.

5.10.2.12 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 occured.

5.11 Timer Services

Collaboration diagram for Timer Services:

RTDM_TIMERMODE_xxx

Timer operation modes

- enum rtdm_timer_mode { RTDM_TIMERMODE_RELATIVE = XN_RELATIVE, RTDM_TIMERMODE_ABSOLUTE = XN_ABSOLUTE, RTDM_TIMERMODE_REALTIME = XN_REALTIME }

Typedefs

- typedef void(* rtdm_timer_handler_t)(rtdm_timer_t *timer)
  Timer handler.

Functions

- int rtdm_timer_init (rtdm_timer_t *timer, rtdm_timer_handler_t handler, const char *name)
- void rtdm_timer_destroy (rtdm_timer_t *timer)
- int rtdm_timer_start (rtdm_timer_t *timer, nanosecs_abs_t expiry, nanosecs_rel_t interval, enum rtdm_timer_mode mode)
- void rtdm_timer_stop (rtdm_timer_t *timer)
- int rtdm_timer_start_in_handler (rtdm_timer_t *timer, nanosecs_abs_t expiry, nanosecs_rel_t interval, enum rtdm_timer_mode mode)
- void rtdm_timer_stop_in_handler (rtdm_timer_t *timer)

5.11.1 Typedef Documentation

5.11.1.1 typedef void(* rtdm_timer_handler_t)(rtdm_timer_t *timer)

Timer handler.

Parameters:

← ***timer*** Timer handle as returned by rtdm_timer_init()

5.11.2 Enumeration Type Documentation

5.11.2.1 enum rtdm_timer_mode

Enumerator:

RTDM_TIMERMODE_RELATIVE Monotonic timer with relative timeout.

RTDM_TIMERMODE_ABSOLUTE Monotonic timer with absolute timeout.
RTDM_TIMERMODE_REALTIME Adjustable timer with absolute timeout.

5.11.3 Function Documentation

5.11.3.1 void rtdm_timer_destroy (rtdm_timer_t * *timer*)

Destroy a timer

Parameters:

↔ ***timer*** Timer handle as returned by rtdm_timer_init() Environments: This service can be called from: - Kernel module initialization/cleanup code

- Kernel-based task
- User-space task (RT, non-RT) Rescheduling: never.

5.11.3.2 int rtdm_timer_init (rtdm_timer_t * *timer*, rtdm_timer_handler_t *handler*, const char * *name*)

Initialise a timer

Parameters:

↔ ***timer*** Timer handle
← ***handler*** Handler to be called on timer expiry
← ***name*** Optional timer name

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.

5.11.3.3 int rtdm_timer_start (rtdm_timer_t * *timer*, nanosecs_abs_t *expiry*, nanosecs_rel_t *interval*, enum rtdm_timer_mode *mode*)

Start a timer

Parameters:

↔ ***timer*** Timer handle as returned by rtdm_timer_init()
← ***expiry*** Firing time of the timer, `mode` defines if relative or absolute
← ***interval*** Relative reload value, > 0 if the timer shall work in periodic mode with the specific interval, 0 for one-shot timers
← ***mode*** Defines the operation mode, see RTDM_TIMERMODE_xxx for possible values

Returns:

0 on success, otherwise: - -ETIMEDOUT is returned if `expiry` describes an absolute date in the past.

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.

5.11.3.4 int rtdm_timer_start_in_handler (rtdm_timer_t * *timer*, nanosecs_abs_t *expiry*, nanosecs_rel_t *interval*, enum rtdm_timer_mode *mode*)

Start a timer from inside a timer handler

Parameters:

↔ ***timer*** Timer handle as returned by rtdm_timer_init()

← ***expiry*** Firing time of the timer, `mode` defines if relative or absolute

← ***interval*** Relative reload value, > 0 if the timer shall work in periodic mode with the specific interval, 0 for one-shot timers

← ***mode*** Defines the operation mode, see RTDM_TIMERMODE_xxx for possible values

Returns:

0 on success, otherwise: - -ETIMEDOUT is returned if `expiry` describes an absolute date in the past.

Environments:

This service can be called from:

- Timer handler

Rescheduling: never.

5.11.3.5 void rtdm_timer_stop (rtdm_timer_t * *timer*)

Stop a timer

Parameters:

↔ ***timer*** Timer handle as returned by rtdm_timer_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.

5.11.3.6 void rtdm_timer_stop_in_handler (rtdm_timer_t * *timer*)

Stop a timer from inside a timer handler

Parameters:

↔ ***timer*** Timer handle as returned by rtdm_timer_init() Environments: This service can be called from: - Timer handler Rescheduling: never.

5.12 Synchronisation Services

Collaboration diagram for Synchronisation Services:

Spinlock with Preemption Deactivation

- typedef rthal_spinlock_t rtdm_lock_t

  Lock variable.

- typedef unsigned long rtdm_lockctx_t

  Variable to save the context while holding a lock.

- #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.

Timeout Sequence Management

- void rtdm_toseq_init (rtdm_toseq_t *timeout_seq, nanosecs_rel_t timeout)

Event Services

- void rtdm_event_init (rtdm_event_t *event, unsigned long pending)
- void rtdm_event_destroy (rtdm_event_t *event)
- void rtdm_event_pulse (rtdm_event_t *event)
- void rtdm_event_signal (rtdm_event_t *event)
- int rtdm_event_wait (rtdm_event_t *event)
- int rtdm_event_timedwait (rtdm_event_t *event, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)
- void rtdm_event_clear (rtdm_event_t *event)

Semaphore Services

- void rtdm_sem_init (rtdm_sem_t *sem, unsigned long value)
- void rtdm_sem_destroy (rtdm_sem_t *sem)
- int rtdm_sem_down (rtdm_sem_t *sem)
- int rtdm_sem_timeddown (rtdm_sem_t *sem, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)
- void rtdm_sem_up (rtdm_sem_t *sem)

Mutex Services

- void rtdm_mutex_init (rtdm_mutex_t *mutex)
- void rtdm_mutex_destroy (rtdm_mutex_t *mutex)
- void rtdm_mutex_unlock (rtdm_mutex_t *mutex)
- int rtdm_mutex_lock (rtdm_mutex_t *mutex)
- int rtdm_mutex_timedlock (rtdm_mutex_t *mutex, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)

Global Lock across Scheduler Invocation

- #define RTDM_EXECUTE_ATOMICALLY(code_block)

5.12.1 Define Documentation

5.12.1.1 #define RTDM_EXECUTE_ATOMICALLY(code_block)

Value:

```
{                                       \
        <ENTER_ATOMIC_SECTION>          \
        code_block;                     \
        <LEAVE_ATOMIC_SECTION>          \
}
```

Execute code block atomically Generally, it is illegal to suspend the current task by calling rtdm_task_sleep(), rtdm_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_ATOMICALLY() 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 bock. 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*.

5.12.1.2 #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.

5.12.1.3 #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.

5.12.1.4 #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.

5.12.1.5 #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.

5.12.1.6 #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.

5.12.1.7 #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.

5.12.1.8 #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.

5.12.2 Function Documentation

5.12.2.1 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.

5.12.2.2 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.

5.12.2.3 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.

5.12.2.4 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.

5.12.2.5 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.

5.12.2.6 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 occurence 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 NULL

Returns:

0 on success, otherwise:

- -ETIMEDOUT is returned if the 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.

5.12.2.7 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.

5.12.2.8 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.

5.12.2.9 void rtdm_mutex_init (rtdm_mutex_t * *mutex*)

Initialise a mutex This function initalises 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.

5.12.2.10 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.

5.12.2.11 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 NULL

Returns:

0 on success, otherwise:

- -ETIMEDOUT is returned if the 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.

5.12.2.12 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)

Rescheduling: possible.

5.12.2.13 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.

5.12.2.14 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.

5.12.2.15 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.

5.12.2.16 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 semphore'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 NULL

Returns:

0 on success, otherwise:

- -ETIMEDOUT is returned if the 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.

5.12.2.17 void rtdm_sem_up (rtdm_sem_t * *sem*)

Increment a semaphore This function increments the given semphore'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.

5.12.2.18 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:

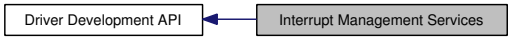
This service can be called from:

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

Rescheduling: never.

5.13 Interrupt Management Services

Collaboration diagram for 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)
- int rtdm_irq_free (rtdm_irq_t *irq_handle)
- int rtdm_irq_enable (rtdm_irq_t *irq_handle)
- int rtdm_irq_disable (rtdm_irq_t *irq_handle)

5.13.1 Define Documentation

5.13.1.1 #define rtdm_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 rtdm_irq_request() is returned, type-casted to the specified *type*.

Environments:

This service can be called from:

- Interrupt service routine

Rescheduling: never.

5.13.2 Typedef Documentation

5.13.2.1 typedef int(* rtdm_irq_handler_t)(rtdm_irq_t *irq_handle)

Interrupt handler.

Parameters:

← ***irq_handle*** IRQ handle as returned by rtdm_irq_request()

Returns:

0 or a combination of RTDM_IRQ_xxx flags

5.13.3 Function Documentation

5.13.3.1 int rtdm_irq_disable (rtdm_irq_t * *irq_handle*)

Disable 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: never.

5.13.3.2 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.

5.13.3.3 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.

5.13.3.4 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 This function registers the provided handler with an IRQ line and enables the line.

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*** Device name to show up in real-time IRQ lists

← ***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.

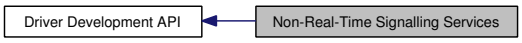
Environments:
This service can be called from:

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

Rescheduling: never.

5.14 Non-Real-Time Signalling Services

Collaboration diagram for Non-Real-Time Signalling Services:



5.14.1 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(* rtdm_nrtsig_handler_t)(rtdm_nrtsig_t nrt_sig, void *arg)
  Non-real-time signal handler.

Functions

- int rtdm_nrtsig_init (rtdm_nrtsig_t *nrt_sig, rtdm_nrtsig_handler_t handler, void *arg)
- void rtdm_nrtsig_destroy (rtdm_nrtsig_t *nrt_sig)
- void rtdm_nrtsig_pend (rtdm_nrtsig_t *nrt_sig)
  Trigger non-real-time signal.

5.14.2 Typedef Documentation

5.14.2.1 typedef void(* rtdm_nrtsig_handler_t)(rtdm_nrtsig_t nrt_sig, void *arg)

Non-real-time signal handler.

Parameters:

← ***nrt_sig*** Signal handle as returned by rtdm_nrtsig_init()

← ***arg*** Argument as passed to rtdm_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.

5.14.3 Function Documentation

5.14.3.1 void rtdm_nrtsig_destroy (rtdm_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.

5.14.3.2 int rtdm_nrtsig_init (rtdm_nrtsig_t * *nrt_sig*, rtdm_nrtsig_handler_t *handler*, void * *arg*)

Register a non-real-time signal handler

Parameters:

↔ ***nrt_sig*** Signal handle

← ***handler*** Non-real-time signal handler

← ***arg*** Custom argument passed to `handler()` on each invocation

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.

5.14.3.3 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.

5.15 Utility Services

Collaboration diagram for 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.

5.15.1 Function Documentation

5.15.1.1 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.

5.15.1.2 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 rtdm_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.

5.15.1.3 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.

5.15.1.4 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.

5.15.1.5 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.

5.15.1.6 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.

5.15.1.7 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 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.

5.15.1.8 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.

5.15.1.9 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.

5.15.1.10 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.

5.15.1.11 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.

5.15.1.12 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.

5.15.1.13 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.

5.15.1.14 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:

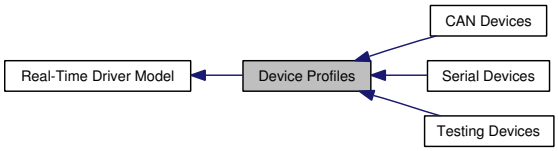
This service can be called from:

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

Rescheduling: never.

5.16 Device Profiles

Collaboration diagram for Device Profiles:



5.16.1 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

Data Structures

- struct rtdm_device_info_t

  Device information.

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 are common to all device profiles.

- #define RTIOC_DEVICE_INFO _IOR(RTIOC_TYPE_COMMON, 0x00, struct rtdm_device_info)

  Retrieve information about a device or socket.

- #define RTIOC_PURGE _IOW(RTIOC_TYPE_COMMON, 0x10, int)

  Purge internal device or socket buffers.

5.16.2 Define Documentation

5.16.2.1 #define RTIOC_DEVICE_INFO _IOR(RTIOC_TYPE_COMMON, 0x00, struct rtdm_device_info)

Retrieve information about a device or socket.

Parameters:

→ ***arg*** Pointer to information buffer (struct rtdm_device_info)

5.16.2.2 #define RTIOC_PURGE _IOW(RTIOC_TYPE_COMMON, 0x10, int)

Purge internal device or socket buffers.

Parameters:

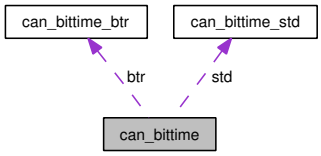
← ***arg*** Purge mask, see RTDM_PURGE_xxx_BUFFER

Chapter 6

Xenomai RTDM skin API Data Structure Documentation

6.1 can_bittime Struct Reference

Collaboration diagram for can_bittime:



6.1.1 Detailed Description

Custom CAN bit-time definition.

Examples:

rtcanconfig.c.

Data Fields

- can_bittime_type_t type
  Type of bit-time definition.
- struct can_bittime_std std
  Standard bit-time.
- struct can_bittime_btr btr
  Hardware-spcific 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

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

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_t Struct Reference

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`. This also includes the CAN_EFF_FLAG and CAN_RTR_FLAG of CAN_-xxx_FLAG. If this comparison is true, the message will be received by the socket. The logic can be inverted with the `can_id` flag CAN_INV_FILTER :

```
if (can_id & CAN_INV_FILTER) {
   if ((received_can_id & can_mask) != (can_id & ~CAN_INV_FILTER))
      accept-message;
} else {
   if ((received_can_id & can_mask) == can_id)
      accept-message;
}
```

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.

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_t::can_id

CAN ID which must match with incoming IDs after passing the mask.

The filter logic can be inverted with the flag CAN_INV_FILTER.

6.4.2.2 uint32_t can_filter_t::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_t Struct Reference

6.5.1 Detailed Description

Raw CAN frame.

Central structure for receiving and sending CAN frames.

Examples:

rtcan_rtt.c, rtcanrecv.c, and rtcansend.c.

Public Member Functions

- uint8_t data[8] __attribute__ ((aligned(8)))
  Payload data bytes.

Data Fields

- can_id_t can_id
  CAN ID of the frame.
- uint8_t can_dlc
  Size of the payload in bytes.

6.5.2 Field Documentation

6.5.2.1 can_id_t can_frame_t::can_id

CAN ID of the frame.

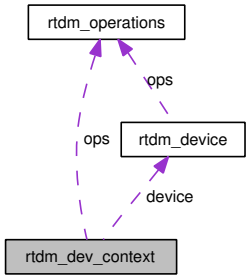
See CAN ID flags for special bits.

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

- include/rtdm/rtcan.h

6.6 rtdm_dev_context Struct Reference

Collaboration diagram for rtdm_dev_context:



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

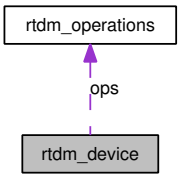
- unsigned long context_flags
  Context flags, see Context Flags for details.
- int fd
  Associated file descriptor.
- atomic_t close_lock_count
  Lock counter of context, held while structure is referenced by an operation handler.
- struct rtdm_operations * ops
  Set of active device operation handlers.
- struct rtdm_device * device
  Reference to owning device.
- struct rtdm_devctx_reserved reserved
  Data stored by RTDM inside a device context (internal use only).
- 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

Collaboration diagram for rtdm_device:



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.

- struct 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.

- int profile_version

  Supported device profile version.

- 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.

- struct proc_dir_entry * proc_entry

  Set to device's /proc root entry after registration, do not modify.

- int device_id

  Driver definable device ID.

- void * device_data

  Driver definable device data.

- struct 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_device_info_t Struct Reference

6.8.1 Detailed Description

Device information.

Data Fields

- int device_flags

  Device flags, see Device Flags for details.

- int device_class

  Device class ID, see RTDM_CLASS_xxx.

- int device_sub_class

  Device sub-class, either RTDM_SUBCLASS_GENERIC or a RTDM_SUBCLASS_xxx definition of the related Device Profile.

- int profile_version

  Supported device profile version.

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

- include/rtdm/rtdm.h

6.9 rtdm_operations Struct Reference

6.9.1 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

6.10 rtser_config_t Struct Reference

6.10.1 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

6.11 rtser_event_t Struct Reference

6.11.1 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

6.12 rtser_status_t Struct Reference

6.12.1 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

6.13 sockaddr_can Struct Reference

6.13.1 Detailed Description

Socket address structure for the CAN address family.

Examples:

rtcan_rtt.c, rtcanrecv.c, and rtcansend.c.

Data Fields

- sa_family_t can_family
  CAN address family, must be `AF_CAN`.
- int can_ifindex
  Interface index of CAN controller.

6.13.2 Field Documentation

6.13.2.1 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/rtcan.h File Reference

7.1.1 Detailed Description

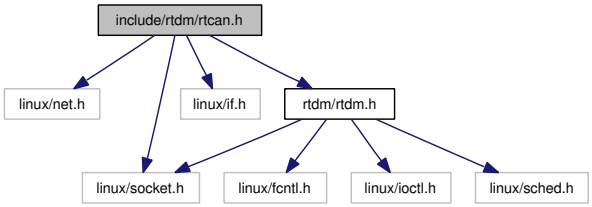
Real-Time Driver Model for RT-Socket-CAN, CAN device profile header.

Note:

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

Include dependency graph for rtcan.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_t
  Filter for reception of CAN messages.
- struct sockaddr_can
  Socket address structure for the CAN address family.
- struct can_frame_t
  Raw CAN frame.

Defines

- #define AF_CAN 29
  CAN address family.
- #define PF_CAN AF_CAN
  CAN protocol family.
- #define SOL_CAN_RAW 103
  CAN socket levels.

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 frame.
- #define CAN_ERR_FLAG 0x20000000
  Error frame (see Errors), not valid in struct can_filter.
- #define CAN_INV_FILTER CAN_ERR_FLAG
  Invert CAN filter definition, only valid in struct can_filter.

Particular CAN protocols

Possible protocols for the PF_CAN protocol family

Currently only the RAW protocol is supported.

- #define CAN_RAW 1
  Raw protocol of `PF_CAN`*, applicable to socket type* `SOCK_RAW`*.*

CAN controller modes

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

Note:

These modes are hardware-dependent. Please consult the hardware manual of the CAN controller for more detailed information.

- #define CAN_CTRLMODE_LISTENONLY 0x1
- #define CAN_CTRLMODE_LOOPBACK 0x2

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_LOOPBACK 0x3
  CAN TX loopback.
- #define CAN_RAW_RECV_OWN_MSGS 0x4
  CAN receive own messages.

IOCTLs

CAN device IOCTLs

- #define SIOCGIFINDEX defined_by_kernel_header_file
  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 custum 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.*

Note: *Error reporting is hardware dependent and most CAN controllers report less detailed error conditions than the SJA1000.*

Note: *In case of a bus-off error condition (CAN_ERR_BUSOFF), the CAN controller is* **not** *restarted automatically. It is the application's responsibility to react appropriately, e.g. calling CAN_MODE_START.*

Note: *Bus error interrupts (CAN_ERR_BUSERROR) are enabled when an application is calling a Recv function on a socket listening on bus errors (using CAN_RAW_ERR_FILTER). After one bus error has occured, the interrupt will be disabled to allow the application time for error processing and to efficiently avoid bus error interrupt flooding.*

- #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

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 occured 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

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.

Enumerations

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

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 }

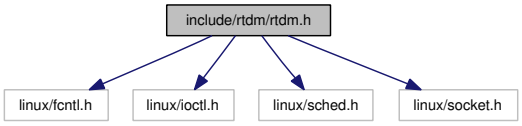
7.2 include/rtdm/rtdm.h File Reference

7.2.1 Detailed Description

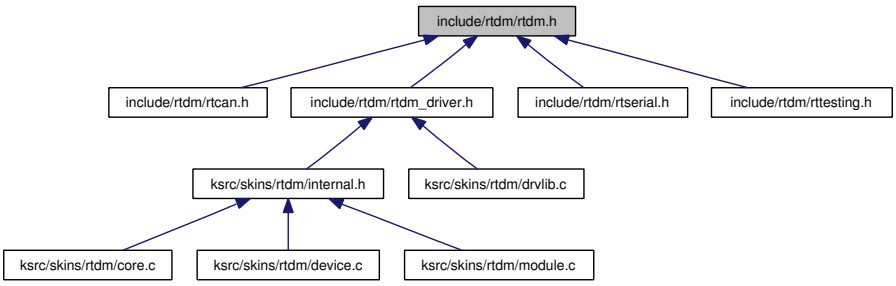
Real-Time Driver Model for Xenomai, user API header.

Note:

Include dependency graph for rtdm.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct rtdm_device_info_t

  Device information.

Defines

API Versioning

- #define RTDM_API_VER 6
  Common user and driver API version.
- #define RTDM_API_MIN_COMPAT_VER 6
  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 are common to all device profiles.

- #define RTIOC_DEVICE_INFO _IOR(RTIOC_TYPE_COMMON, 0x00, struct rtdm_device_info)
  Retrieve information about a device or socket.
- #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.

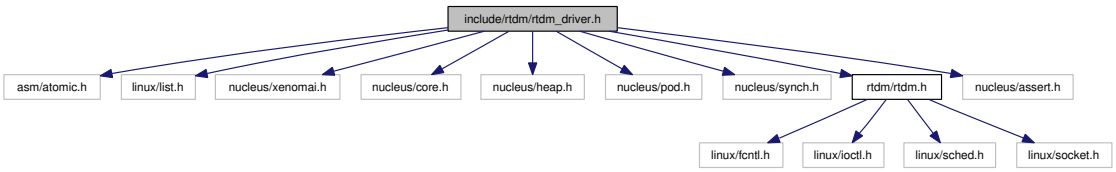
7.3 include/rtdm/rtdm_driver.h File Reference

7.3.1 Detailed Description

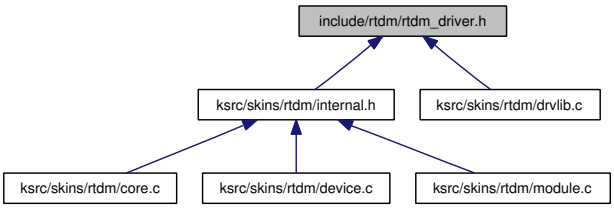
Real-Time Driver Model for Xenomai, driver API header.

Note:

Include dependency graph for rtdm_driver.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct rtdm_operations

  Device operations.

- struct rtdm_dev_context
- struct rtdm_device

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.

Defines

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

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_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 4
  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)

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)

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, void *arg)
  Non-real-time signal handler.
- typedef void(* rtdm_timer_handler_t)(rtdm_timer_t *timer)
  Timer handler.
- typedef void(* rtdm_task_proc_t)(void *arg)
  Real-time task procedure.

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, unsigned int request, void __user *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_recvmsg_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.

Enumerations

RTDM_TIMERMODE_xxx

Timer operation modes

- enum rtdm_timer_mode { RTDM_TIMERMODE_RELATIVE = XN_RELATIVE, RTDM_TIMERMODE_ABSOLUTE = XN_ABSOLUTE, RTDM_TIMERMODE_REALTIME = XN_REALTIME }

Functions

- int rtdm_dev_register (struct rtdm_device *device)
- int rtdm_dev_unregister (struct rtdm_device *device, unsigned int poll_delay)
- struct rtdm_dev_context * rtdm_context_get (int fd)
- 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)
- void rtdm_timer_destroy (rtdm_timer_t *timer)
- int rtdm_timer_start (rtdm_timer_t *timer, nanosecs_abs_t expiry, nanosecs_rel_t interval, enum rtdm_timer_mode mode)
- void rtdm_timer_stop (rtdm_timer_t *timer)
- 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)
- void rtdm_task_busy_sleep (nanosecs_rel_t delay)
- void rtdm_toseq_init (rtdm_toseq_t *timeout_seq, nanosecs_rel_t timeout)
- void rtdm_event_init (rtdm_event_t *event, unsigned long pending)

- int rtdm_event_wait (rtdm_event_t *event)
- int rtdm_event_timedwait (rtdm_event_t *event, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)
- void rtdm_event_signal (rtdm_event_t *event)
- void rtdm_event_clear (rtdm_event_t *event)
- void rtdm_sem_init (rtdm_sem_t *sem, unsigned long value)
- int rtdm_sem_down (rtdm_sem_t *sem)
- int rtdm_sem_timeddown (rtdm_sem_t *sem, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)
- void rtdm_sem_up (rtdm_sem_t *sem)
- void rtdm_mutex_init (rtdm_mutex_t *mutex)
- int rtdm_mutex_lock (rtdm_mutex_t *mutex)
- int rtdm_mutex_timedlock (rtdm_mutex_t *mutex, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)

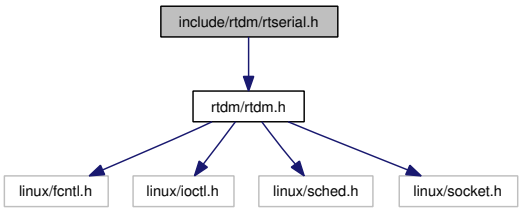
7.4 include/rtdm/rtserial.h File Reference

7.4.1 Detailed Description

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

Note:

Include dependency graph for rtserial.h:



Data Structures

- struct rtser_config_t
  Serial device configuration.
- struct rtser_status_t
  Serial device status.
- struct rtser_event_t
  Additional information about serial device events.

Defines

- #define RTSER_RTIOC_BREAK_CTL _IOR(RTIOC_TYPE_SERIAL, 0x06, int)
  Set or clear break on UART output line.

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_EMTPY** 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

RTSER_BREAK_xxx

Break control

- #define **RTSER_BREAK_CLR** 0x00
- #define **RTSER_BREAK_SET** 0x01
- #define **RTIOC_TYPE_SERIAL** RTDM_CLASS_SERIAL

Sub-Classes of RTDM_CLASS_SERIAL

- #define **RTDM_SUBCLASS_16550A** 0

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 contol register.
- #define RTSER_RTIOC_SET_CONTROL _IOW(RTIOC_TYPE_SERIAL, 0x04, int)
  Set serial device's modem contol register.
- #define RTSER_RTIOC_WAIT_EVENT _IOR(RTIOC_TYPE_SERIAL, 0x05, struct rtser_-event)
  Wait on serial device events according to previously set mask.

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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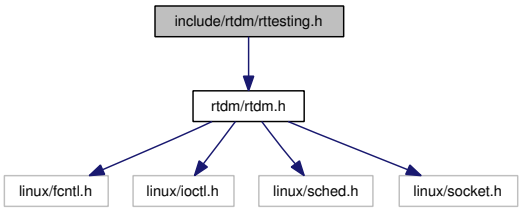
Include dependency graph for rttesting.h:



Defines

Sub-Classes of RTDM_CLASS_TESTING

- #define **RTDM_SUBCLASS_TIMERBENCH** 0
- #define **RTDM_SUBCLASS_IRQBENCH** 1
- #define **RTDM_SUBCLASS_SWITCHTEST** 2

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)

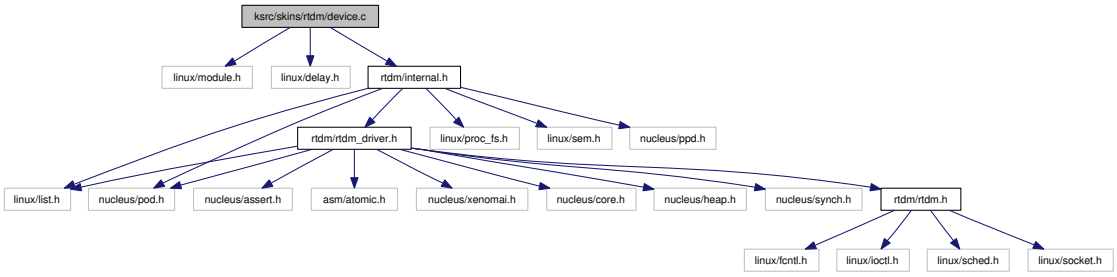
7.6 ksrc/skins/rtdm/device.c File Reference

7.6.1 Detailed Description

Real-Time Driver Model for Xenomai, device management.

Note:

Include dependency graph for device.c:



Functions

- int rtdm_dev_register (struct rtdm_device *device)
- int rtdm_dev_unregister (struct rtdm_device *device, unsigned int poll_delay)

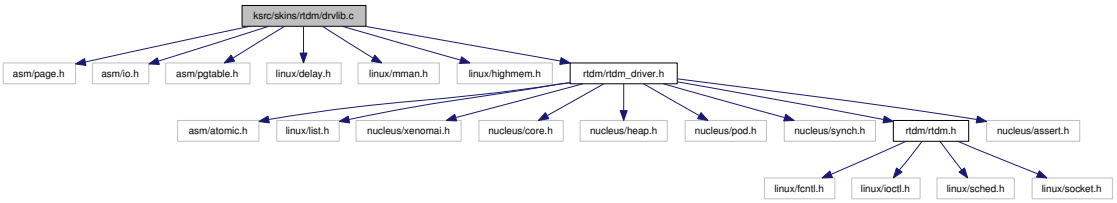
7.7 ksrc/skins/rtdm/drvlib.c File Reference

7.7.1 Detailed Description

Real-Time Driver Model for Xenomai, driver library.

Note:

Include dependency graph for drvlib.c:



Functions

- nanosecs_abs_t rtdm_clock_read (void)
- nanosecs_abs_t rtdm_clock_read_monotonic (void)
- 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)
- void rtdm_task_destroy (rtdm_task_t *task)
- void rtdm_task_set_priority (rtdm_task_t *task, int priority)
- int rtdm_task_set_period (rtdm_task_t *task, nanosecs_rel_t period)
- int rtdm_task_wait_period (void)
- int rtdm_task_unblock (rtdm_task_t *task)
- rtdm_task_t * rtdm_task_current (void)
- int rtdm_task_sleep (nanosecs_rel_t delay)
- int rtdm_task_sleep_until (nanosecs_abs_t wakeup_time)
- int rtdm_task_sleep_abs (nanosecs_abs_t wakeup_time, enum rtdm_timer_mode mode)
- void rtdm_task_join_nrt (rtdm_task_t *task, unsigned int poll_delay)
- void rtdm_task_busy_sleep (nanosecs_rel_t delay)
- int rtdm_timer_init (rtdm_timer_t *timer, rtdm_timer_handler_t handler, const char *name)
- void rtdm_timer_destroy (rtdm_timer_t *timer)

- int rtdm_timer_start (rtdm_timer_t *timer, nanosecs_abs_t expiry, nanosecs_rel_t interval, enum rtdm_timer_mode mode)
- void rtdm_timer_stop (rtdm_timer_t *timer)
- int rtdm_timer_start_in_handler (rtdm_timer_t *timer, nanosecs_abs_t expiry, nanosecs_rel_t interval, enum rtdm_timer_mode mode)
- void rtdm_timer_stop_in_handler (rtdm_timer_t *timer)
- 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)
- int rtdm_irq_free (rtdm_irq_t *irq_handle)
- int rtdm_irq_enable (rtdm_irq_t *irq_handle)
- int rtdm_irq_disable (rtdm_irq_t *irq_handle)
- int rtdm_nrtsig_init (rtdm_nrtsig_t *nrt_sig, rtdm_nrtsig_handler_t handler, void *arg)
- void rtdm_nrtsig_destroy (rtdm_nrtsig_t *nrt_sig)
- void rtdm_nrtsig_pend (rtdm_nrtsig_t *nrt_sig)

  Trigger non-real-time signal.

- 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.

Timeout Sequence Management

- void rtdm_toseq_init (rtdm_toseq_t *timeout_seq, nanosecs_rel_t timeout)

Event Services

- void rtdm_event_init (rtdm_event_t *event, unsigned long pending)
- void rtdm_event_destroy (rtdm_event_t *event)
- void rtdm_event_pulse (rtdm_event_t *event)
- void rtdm_event_signal (rtdm_event_t *event)
- int rtdm_event_wait (rtdm_event_t *event)
- int rtdm_event_timedwait (rtdm_event_t *event, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)
- void rtdm_event_clear (rtdm_event_t *event)

Semaphore Services

- void rtdm_sem_init (rtdm_sem_t *sem, unsigned long value)
- void rtdm_sem_destroy (rtdm_sem_t *sem)
- int rtdm_sem_down (rtdm_sem_t *sem)
- int rtdm_sem_timeddown (rtdm_sem_t *sem, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)
- void rtdm_sem_up (rtdm_sem_t *sem)

Mutex Services

- void rtdm_mutex_init (rtdm_mutex_t *mutex)
- void rtdm_mutex_destroy (rtdm_mutex_t *mutex)
- void rtdm_mutex_unlock (rtdm_mutex_t *mutex)
- int rtdm_mutex_lock (rtdm_mutex_t *mutex)
- int rtdm_mutex_timedlock (rtdm_mutex_t *mutex, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)

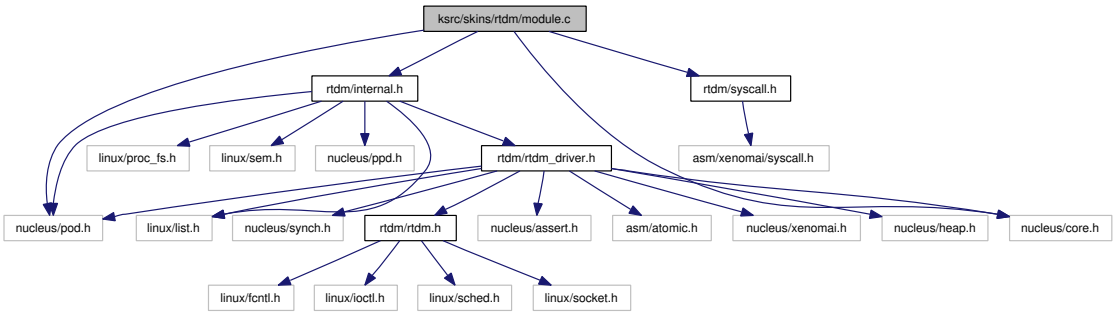
7.8 ksrc/skins/rtdm/module.c File Reference

7.8.1 Detailed Description

Real-Time Driver Model for Xenomai.

Note:

Include dependency graph for module.c:



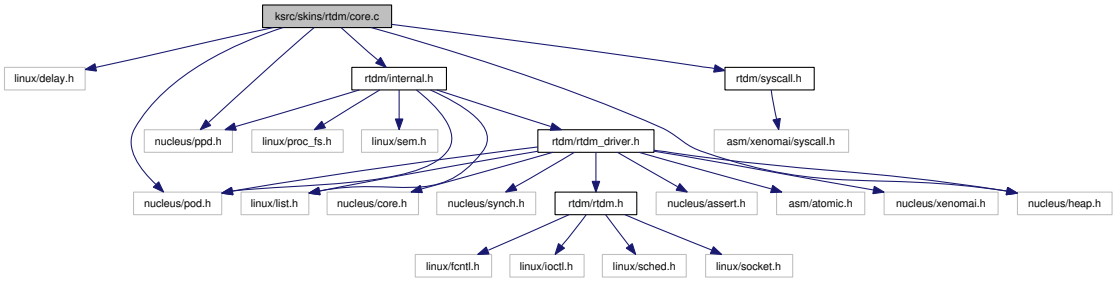
7.9 ksrc/skins/rtdm/core.c File Reference

7.9.1 Detailed Description

Real-Time Driver Model for Xenomai, device operation multiplexing.

Note:

Include dependency graph for core.c:



Functions

- struct rtdm_dev_context * rtdm_context_get (int fd)
- void rtdm_context_lock (struct rtdm_dev_context *context)
- void rtdm_context_unlock (struct rtdm_dev_context *context)
- int rtdm_open (const char *path, int oflag,...)
- int rtdm_socket (int protocol_family, int socket_type, int protocol)
- int rtdm_close (int fd)
- int rtdm_ioctl (int fd, int request,...)
- ssize_t rtdm_read (int fd, void *buf, size_t nbyte)
- ssize_t rtdm_write (int fd, const void *buf, size_t nbyte)
- ssize_t rtdm_recvmsg (int fd, struct msghdr *msg, int flags)
- ssize_t rtdm_recvfrom (int fd, void *buf, size_t len, int flags, struct sockaddr *from, socklen_t *fromlen)
- ssize_t rtdm_recv (int fd, void *buf, size_t len, int flags)
- ssize_t rtdm_sendmsg (int fd, const struct msghdr *msg, int flags)

- ssize_t rtdm_sendto (int fd, const void *buf, size_t len, int flags, const struct sockaddr *to, socklen_t tolen)
- ssize_t rtdm_send (int fd, const void *buf, size_t len, int flags)
- int rtdm_bind (int fd, const struct sockaddr *my_addr, socklen_t addrlen)
- int rtdm_connect (int fd, const struct sockaddr *serv_addr, socklen_t addrlen)
- int rtdm_listen (int fd, int backlog)
- int rtdm_accept (int fd, struct sockaddr *addr, socklen_t *addrlen)
- int rtdm_shutdown (int fd, int how)
- int rtdm_getsockopt (int fd, int level, int optname, void *optval, socklen_t *optlen)
- int rtdm_setsockopt (int fd, int level, int optname, const void *optval, socklen_t optlen)
- int rtdm_getsockname (int fd, struct sockaddr *name, socklen_t *namelen)
- int rtdm_getpeername (int fd, struct sockaddr *name, socklen_t *namelen)
- int rt_dev_open (const char *path, int oflag,...)
- int rt_dev_socket (int protocol_family, int socket_type, int protocol)
- int rt_dev_close (int fd)
- int rt_dev_ioctl (int fd, int request,...)
- ssize_t rt_dev_read (int fd, void *buf, size_t nbyte)
- ssize_t rt_dev_write (int fd, const void *buf, size_t nbyte)
- ssize_t rt_dev_recvmsg (int fd, struct msghdr *msg, int flags)
- ssize_t rt_dev_recvfrom (int fd, void *buf, size_t len, int flags, struct sockaddr *from, socklen_t *fromlen)
- ssize_t rt_dev_recv (int fd, void *buf, size_t len, int flags)
- ssize_t rt_dev_sendmsg (int fd, const struct msghdr *msg, int flags)
- ssize_t rt_dev_sendto (int fd, const void *buf, size_t len, int flags, const struct sockaddr *to, socklen_t tolen)
- ssize_t rt_dev_send (int fd, const void *buf, size_t len, int flags)
- int rt_dev_bind (int fd, const struct sockaddr *my_addr, socklen_t addrlen)
- int rt_dev_connect (int fd, const struct sockaddr *serv_addr, socklen_t addrlen)
- int rt_dev_listen (int fd, int backlog)
- int rt_dev_accept (int fd, struct sockaddr *addr, socklen_t *addrlen)
- int rt_dev_shutdown (int fd, int how)
- int rt_dev_getsockopt (int fd, int level, int optname, void *optval, socklen_t *optlen)
- int rt_dev_setsockopt (int fd, int level, int optname, const void *optval, socklen_t optlen)
- int rt_dev_getsockname (int fd, struct sockaddr *name, socklen_t *namelen)
- int rt_dev_getpeername (int fd, struct sockaddr *name, socklen_t *namelen)

Chapter 8

Xenomai RTDM skin API Example Documentation

8.1 cross-link.c

```
1 /*
2  * cross-link.c
3  *
4  * Userspace test program (Xenomai native skin) for RTDM-based UART drivers
5  * Copyright 2005 by Joerg Langenberg <joergel75@gmx.net>
6  *
7  * Updates by Jan Kiszka <jan.kiszka@web.de>
8  *
9  * This program is free software; you can redistribute it and/or modify
10  * it under the terms of the GNU General Public License as published by
11  * the Free Software Foundation; either version 2 of the License, or
12  * (at your option) any later version.
13  *
14  * This program is distributed in the hope that it will be useful,
15  * but WITHOUT ANY WARRANTY; without even the implied warranty of
16  * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
17  * GNU General Public License for more details.
18  *
19  * You should have received a copy of the GNU General Public License
20  * along with this program; if not, write to the Free Software
21  * Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.
22  */
23 #include <stdio.h>
24 #include <signal.h>
25 #include <unistd.h>
26 #include <sys/mman.h>
27
28 #include <native/task.h>
29 #include <native/timer.h>
30
31 #include <rtdm/rtserial.h>
32
33 #define MAIN_PREFIX   "main : "
34 #define WTASK_PREFIX  "write_task: "
35 #define RTASK_PREFIX  "read_task: "
36
37 #define WRITE_FILE    "rtser0"
38 #define READ_FILE     "rtser1"
39
40 int read_fd  = -1;
```

```
41 int write_fd = -1;
42
43 #define STATE_FILE_OPENED         1
44 #define STATE_TASK_CREATED        2
45
46 unsigned int read_state = 0;
47 unsigned int write_state = 0;
48
49 /*                            --s-ms-us-ns */
50 RTIME write_task_period_ns =    100000000llu;
51 RT_TASK write_task;
52 RT_TASK read_task;
53
54 static const struct rtser_config read_config = {
55         .config_mask       = 0xFFFF,
56         .baud_rate         = 115200,
57         .parity            = RTSER_DEF_PARITY,
58         .data_bits         = RTSER_DEF_BITS,
59         .stop_bits         = RTSER_DEF_STOPB,
60         .handshake         = RTSER_DEF_HAND,
61         .fifo_depth        = RTSER_DEF_FIFO_DEPTH,
62         .rx_timeout        = RTSER_DEF_TIMEOUT,
63         .tx_timeout        = RTSER_DEF_TIMEOUT,
64         .event_timeout     = 1000000000, /* 1 s */
65         .timestamp_history = RTSER_RX_TIMESTAMP_HISTORY,
66         .event_mask        = RTSER_EVENT_RXPEND,
67 };
68
69 static const struct rtser_config write_config = {
70         .config_mask       = RTSER_SET_BAUD | RTSER_SET_TIMESTAMP_HISTORY,
71         .baud_rate         = 115200,
72         .timestamp_history = RTSER_DEF_TIMESTAMP_HISTORY,
73         /* the rest implicitely remains default */
74 };
75
76 static int close_file( int fd, char *name)
77 {
78         int err, i=0;
79
80         do {
81                 i++;
82                 err = rt_dev_close(fd);
83                 switch (err) {
84                 case -EAGAIN:
85                         printf(MAIN_PREFIX "%s -> EAGAIN (%d times)\n",
86                                name, i);
87                         rt_task_sleep(50000); /* wait 50us */
88                         break;
89                 case 0:
90                         printf(MAIN_PREFIX "%s -> closed\n", name);
91                         break;
92                 default:
93                         printf(MAIN_PREFIX "%s -> %s\n", name,
94                                strerror(-err));
95                         break;
96                 }
97         } while (err == -EAGAIN && i < 10);
98
99         return err;
100 }
101
102 void cleanup_all(void)
103 {
104          if (read_state & STATE_FILE_OPENED) {
105                  close_file(read_fd, READ_FILE" (read)");
106                  read_state &= ~STATE_FILE_OPENED;
107          }
```

```
108
109         if (write_state & STATE_FILE_OPENED) {
110                 close_file(write_fd, WRITE_FILE " (write)");
111                 write_state &= ~STATE_FILE_OPENED;
112         }
113
114         if (write_state & STATE_TASK_CREATED) {
115                 printf(MAIN_PREFIX "delete write_task\n");
116                 rt_task_delete(&write_task);
117                 write_state &= ~STATE_TASK_CREATED;
118         }
119
120         if (read_state & STATE_TASK_CREATED) {
121                 printf(MAIN_PREFIX "delete read_task\n");
122                 rt_task_delete(&read_task);
123                 read_state &= ~STATE_TASK_CREATED;
124         }
125 }
126
127 void catch_signal(int sig)
128 {
129         cleanup_all();
130         printf(MAIN_PREFIX "exit\n");
131         return;
132 }
133
134 void write_task_proc(void *arg)
135 {
136         int err;
137         RTIME write_time;
138         ssize_t sz = sizeof(RTIME);
139         ssize_t written = 0;
140
141         err = rt_task_set_periodic(NULL, TM_NOW,
142                                    rt_timer_ns2ticks(write_task_period_ns));
143         if (err) {
144                 printf(WTASK_PREFIX "error on set periodic, %s\n",
145                        strerror(-err));
146                 goto exit_write_task;
147         }
148
149         while (1) {
150                 err = rt_task_wait_period(NULL);
151                 if (err) {
152                         printf(WTASK_PREFIX
153                                "error on rt_task_wait_period, %s\n",
154                                strerror(-err));
155                         break;
156                 }
157
158                 write_time = rt_timer_read();
159
160                 written = rt_dev_write(write_fd, &write_time, sz);
161                 if (written < 0 ) {
162                         printf(WTASK_PREFIX "error on rt_dev_write, %s\n",
163                                strerror(-err));
164                         break;
165                 } else if (written != sz) {
166                         printf(WTASK_PREFIX "only %d / %d byte transmitted\n",
167                                written, sz);
168                         break;
169                 }
170         }
171
172  exit_write_task:
173         if ((write_state & STATE_FILE_OPENED) &&
174             close_file(write_fd, WRITE_FILE " (write)") == 0)
```

```
175                 write_state &= ~STATE_FILE_OPENED;
176
177         printf(WTASK_PREFIX "exit\n");
178 }
179
180 void read_task_proc(void *arg)
181 {
182         int err;
183         int nr = 0;
184         RTIME read_time  = 0;
185         RTIME write_time = 0;
186         RTIME irq_time   = 0;
187         ssize_t sz = sizeof(RTIME);
188         ssize_t read = 0;
189         struct rtser_event rx_event;
190
191         printf(" Nr |   write->irq    |    irq->read    |   write->read   |\n");
192         printf("-----------------------------------------------------------\n");
193
194         /*
195          * We are in secondary mode now due to printf, the next
196          * blocking Xenomai or driver call will switch us back
197          * (here: RTSER_RTIOC_WAIT_EVENT).
198          */
199
200         while (1) {
201                 /* waiting for event */
202                 err = rt_dev_ioctl(read_fd, RTSER_RTIOC_WAIT_EVENT, &rx_event);
203                 if (err) {
204                         printf(RTASK_PREFIX
205                                "error on RTSER_RTIOC_WAIT_EVENT, %s\n",
206                                strerror(-err));
207                         if (err == -ETIMEDOUT)
208                                 continue;
209                         break;
210                 }
211
212                 irq_time = rx_event.rxpend_timestamp;
213                 read = rt_dev_read(read_fd, &write_time, sz);
214                 if (read == sz) {
215                         read_time = rt_timer_read();
216                         printf("%3d |%16llu |%16llu |%16llu\n", nr,
217                                irq_time  - write_time,
218                                read_time - irq_time,
219                                read_time - write_time);
220                         nr++;
221                 } else if (read < 0 ) {
222                         printf(RTASK_PREFIX "error on rt_dev_read, code %s\n",
223                                strerror(-err));
224                         break;
225                 } else {
226                         printf(RTASK_PREFIX "only %d / %d byte received \n",
227                                read, sz);
228                         break;
229                 }
230         }
231
232         if ((read_state & STATE_FILE_OPENED) &&
233             close_file(read_fd, READ_FILE " (read)") == 0)
234                 read_state &= ~STATE_FILE_OPENED;
235
236         printf(RTASK_PREFIX "exit\n");
237 }
238
239 int main(int argc, char* argv[])
240 {
241         int err = 0;
```

```
242
243         signal(SIGTERM, catch_signal);
244         signal(SIGINT, catch_signal);
245
246         /* no memory-swapping for this programm */
247         mlockall(MCL_CURRENT | MCL_FUTURE);
248
249         /* open rtser0 */
250         write_fd = rt_dev_open( WRITE_FILE, 0);
251         if (write_fd < 0) {
252                 printf(MAIN_PREFIX "can't open %s (write), %s\n", WRITE_FILE,
253                        strerror(-write_fd));
254                 goto error;
255         }
256         write_state |= STATE_FILE_OPENED;
257         printf(MAIN_PREFIX "write-file opened\n");
258
259         /* writing write-config */
260         err = rt_dev_ioctl(write_fd, RTSER_RTIOC_SET_CONFIG, &write_config);
261         if (err) {
262                 printf(MAIN_PREFIX "error while RTSER_RTIOC_SET_CONFIG, %s\n",
263                        strerror(-err));
264                 goto error;
265         }
266         printf(MAIN_PREFIX "write-config written\n");
267
268         /* open rtser1 */
269         read_fd = rt_dev_open( READ_FILE, 0 );
270         if (read_fd < 0) {
271                 printf(MAIN_PREFIX "can't open %s (read), %s\n", READ_FILE,
272                        strerror(-read_fd));
273                 goto error;
274         }
275         read_state |= STATE_FILE_OPENED;
276         printf(MAIN_PREFIX "read-file opened\n");
277
278         /* writing read-config */
279         err = rt_dev_ioctl(read_fd, RTSER_RTIOC_SET_CONFIG, &read_config);
280         if (err) {
281                 printf(MAIN_PREFIX "error while rt_dev_ioctl, %s\n",
282                        strerror(-err));
283                 goto error;
284         }
285         printf(MAIN_PREFIX "read-config written\n");
286
287         /* create write_task */
288         err = rt_task_create(&write_task, "write_task", 0, 50, 0);
289         if (err) {
290                 printf(MAIN_PREFIX "failed to create write_task, %s\n",
291                        strerror(-err));
292                 goto error;
293         }
294         write_state |= STATE_TASK_CREATED;
295         printf(MAIN_PREFIX "write-task created\n");
296
297         /* create read_task */
298         err = rt_task_create(&read_task, "read_task", 0, 51, 0);
299         if (err) {
300                 printf(MAIN_PREFIX "failed to create read_task, %s\n",
301                        strerror(-err));
302                 goto error;
303         }
304         read_state |= STATE_TASK_CREATED;
305         printf(MAIN_PREFIX "read-task created\n");
306
307         /* start write_task */
308         printf(MAIN_PREFIX "starting write-task\n");
```

```
309         err = rt_task_start(&write_task, &write_task_proc, NULL);
310         if (err) {
311                 printf(MAIN_PREFIX "failed to start write_task, %s\n",
312                        strerror(-err));
313                 goto error;
314         }
315
316         /* start read_task */
317         printf(MAIN_PREFIX "starting read-task\n");
318         err = rt_task_start(&read_task,&read_task_proc,NULL);
319         if (err) {
320                 printf(MAIN_PREFIX "failed to start read_task, %s\n",
321                        strerror(-err));
322                 goto error;
323         }
324
325         pause();
326         return 0;
327
328  error:
329         cleanup_all();
330         return err;
331 }
```

8.2 rtcan_rtt.c

```
1 /*
2  * Round-Trip-Time Test - sends and receives messages and measures the
3  *                        time in between.
4  *
5  * Copyright (C) 2006 Wolfgang Grandegger <wg@grandegger.com>
6  *
7  * Based on RTnet's examples/xenomai/posix/rtt-sender.c.
8  *
9  * Copyright (C) 2002 Ulrich Marx <marx@kammer.uni-hannover.de>
10 *               2002 Marc Kleine-Budde <kleine-budde@gmx.de>
11 *               2006 Jan Kiszka <jan.kiszka@web.de>
12 *
13 * This program is free software; you can redistribute it and/or modify
14 * it under the terms of the GNU General Public License as published by
15 * the Free Software Foundation; either version 2 of the License, or
16 * (at your option) any later version.
17 *
18 * This program is distributed in the hope that it will be useful,
19 * but WITHOUT ANY WARRANTY; without even the implied warranty of
20 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
21 * GNU General Public License for more details.
22 *
23 * You should have received a copy of the GNU General Public License
24 * along with this program; if not, write to the Free Software
25 * Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.
26 *
27 *
28 * The program sends out CAN messages periodically and copies the current
29 * time-stamp to the payload. At reception, that time-stamp is compared
30 * with the current time to determine the round-trip time. The jitter
31 * values are printer out regularly. Concurrent tests can be carried out
32 * by starting the program with different message identifiers. It is also
33 * possible to use this program on a remote system as simple repeater to
34 * loopback messages.
35 */
36
37 #include <errno.h>
38 #include <mqueue.h>
39 #include <signal.h>
40 #include <pthread.h>
41 #include <stdio.h>
42 #include <stdlib.h>
43 #include <string.h>
44 #include <unistd.h>
45 #include <limits.h>
46 #include <getopt.h>
47 #include <netinet/in.h>
48 #include <sys/mman.h>
49
50 #include <rtdm/rtcan.h>
51
52 #define NSEC_PER_SEC 1000000000
53
54 static unsigned int cycle = 10000; /* 10 ms */
55 static can_id_t can_id = 0x1;
56
57 static pthread_t txthread, rxthread;
58 static int txsock, rxsock;
59 static mqd_t mq;
60 static int txcount, rxcount;
61 static int overruns;
62 static int repeater;
63
64 struct rtt_stat {
65     long long rtt;
```

```
66     long long rtt_min;
67     long long rtt_max;
68     long long rtt_sum;
69     long long rtt_sum_last;
70     int counts_per_sec;
71 };
72
73 static void print_usage(char *prg)
74 {
75     fprintf(stderr,
76             "Usage: %s  [Options] <tx-can-interface> <rx-can-interface>\n"
77             "Options:\n"
78             " -h, --help     This help\n"
79             " -r, --repeater Repeater, send back received messages\n"
80             " -i, --id=ID    CAN Identifier (default = 0x1)\n"
81             " -c, --cycle    Cycle time in us (default = 10000us)\n",
82             prg);
83 }
84
85 void *transmitter(void *arg)
86 {
87     struct sched_param  param = { .sched_priority = 80 };
88     struct timespec next_period;
89     struct timespec time;
90     struct can_frame frame;
91     long long *rtt_time = (long long *)&frame.data;
92
93     /* Pre-fill CAN frame */
94     frame.can_id = can_id;
95     frame.can_dlc = sizeof(*rtt_time);
96
97     pthread_setschedparam(pthread_self(), SCHED_FIFO, &param);
98
99     clock_gettime(CLOCK_MONOTONIC, &next_period);
100
101     while(1) {
102         next_period.tv_nsec += cycle * 1000;
103         while (next_period.tv_nsec >= NSEC_PER_SEC) {
104                 next_period.tv_nsec -= NSEC_PER_SEC;
105                 next_period.tv_sec++;
106         }
107
108         clock_nanosleep(CLOCK_MONOTONIC, TIMER_ABSTIME, &next_period, NULL);
109
110         if (rxcount != txcount) {
111             overruns++;
112             continue;
113         }
114
115         clock_gettime(CLOCK_MONOTONIC, &time);
116         *rtt_time = time.tv_sec * NSEC_PER_SEC + time.tv_nsec;
117
118         /* Transmit the message containing the local time */
119         if (send(txsock, (void *)&frame, sizeof(can_frame_t), 0) < 0) {
120             if (errno == EBADF)
121                 printf("terminating transmitter thread\n");
122             else
123                 perror("send failed");
124             return NULL;
125         }
126         txcount++;
127     }
128 }
129
130
131 void *receiver(void *arg)
132 {
```

```
133     struct sched_param param = { .sched_priority = 82 };
134     struct timespec time;
135     struct can_frame frame;
136     long long *rtt_time = (long long *)frame.data;
137     struct rtt_stat rtt_stat = {0, 10000000000000000000LL, -10000000000000000000LL,
138                                0, 0, 0};
139     pthread_setschedparam(pthread_self(), SCHED_FIFO, &param);
140
141     rtt_stat.counts_per_sec = 1000000 / cycle;
142
143     while (1) {
144         if (recv(rxsock, (void *)&frame, sizeof(can_frame_t), 0) < 0) {
145             if (errno == EBADF)
146                 printf("terminating receiver thread\n");
147             else
148                 perror("recv failed");
149             return NULL;
150         }
151         if (repeater) {
152             /* Transmit the message back as is */
153             if (send(txsock, (void *)&frame, sizeof(can_frame_t), 0) < 0) {
154                 if (errno == EBADF)
155                     printf("terminating transmitter thread\n");
156                 else
157                     perror("send failed");
158                 return NULL;
159             }
160             txcount++;
161         } else {
162             clock_gettime(CLOCK_MONOTONIC, &time);
163             if (rxcount > 0) {
164                 rtt_stat.rtt = (time.tv_sec * 1000000000LL +
165                                 time.tv_nsec - *rtt_time);
166                 rtt_stat.rtt_sum += rtt_stat.rtt;
167                 if (rtt_stat.rtt <  rtt_stat.rtt_min)
168                     rtt_stat.rtt_min = rtt_stat.rtt;
169                 if (rtt_stat.rtt > rtt_stat.rtt_max)
170                     rtt_stat.rtt_max = rtt_stat.rtt;
171             }
172         }
173         rxcount++;
174
175         if ((rxcount % rtt_stat.counts_per_sec) == 0) {
176             mq_send(mq, (char *)&rtt_stat, sizeof(rtt_stat), 0);
177             rtt_stat.rtt_sum_last = rtt_stat.rtt_sum;
178         }
179     }
180 }
181
182 void catch_signal(int sig)
183 {
184     mq_close(mq);
185 }
186
187
188 int main(int argc, char *argv[])
189 {
190     struct sched_param param = { .sched_priority = 1 };
191     pthread_attr_t thattr;
192     struct mq_attr mqattr;
193     struct sockaddr_can rxaddr, txaddr;
194     struct can_filter rxfilter[1];
195     struct rtt_stat rtt_stat;
196     char mqname[32];
197     char *txdev, *rxdev;
198     struct ifreq ifr;
199     int ret, opt;
```

```
200
201     struct option long_options[] = {
202         { "id", required_argument, 0, 'i'},
203         { "cycle", required_argument, 0, 'c'},
204         { "repeater", required_argument, 0, 'r'},
205         { "help", no_argument, 0, 'h'},
206         { 0, 0, 0, 0},
207     };
208
209     while ((opt = getopt_long(argc, argv, "hri:c:",
210                               long_options, NULL)) != -1) {
211         switch (opt) {
212         case 'c':
213             cycle = atoi(optarg);
214             break;
215
216         case 'i':
217             can_id = strtoul(optarg, NULL, 0);
218             break;
219
220         case 'r':
221             repeater = 1;
222             break;
223
224         default:
225             fprintf(stderr, "Unknown option %c\n", opt);
226         case 'h':
227             print_usage(argv[0]);
228             exit(-1);
229         }
230     }
231
232     printf("%d %d\n", optind, argc);
233     if (optind + 2 != argc) {
234         print_usage(argv[0]);
235         exit(0);
236     }
237
238     txdev = argv[optind];
239     rxdev = argv[optind + 1];
240
241     /* Create and configure RX socket */
242     if ((rxsock = socket(PF_CAN, SOCK_RAW, CAN_RAW)) < 0) {
243         perror("RX socket failed");
244         return -1;
245     }
246
247     strncpy(ifr.ifr_name, rxdev, IFNAMSIZ);
248     printf("RX rxsock=%d, ifr_name=%s\n", rxsock, ifr.ifr_name);
249
250     if (ioctl(rxsock, SIOCGIFINDEX, &ifr) < 0) {
251         perror("RX ioctl SIOCGIFINDEX failed");
252         goto failure1;
253     }
254
255     /* We only want to receive our own messages */
256     rxfilter[0].can_id = can_id;
257     rxfilter[0].can_mask = 0x3ff;
258     if (setsockopt(rxsock, SOL_CAN_RAW, CAN_RAW_FILTER,
259                    &rxfilter, sizeof(struct can_filter)) < 0) {
260         perror("RX setsockopt CAN_RAW_FILTER failed");
261         goto failure1;
262     }
263     memset(&rxaddr, 0, sizeof(rxaddr));
264     rxaddr.can_ifindex = ifr.ifr_ifindex;
265     rxaddr.can_family = AF_CAN;
266     if (bind(rxsock, (struct sockaddr *)&rxaddr, sizeof(rxaddr)) < 0) {
```

```
267         perror("RX bind failed\n");
268         goto failure1;
269     }
270
271     /* Create and configure TX socket */
272
273     if (strcmp(rxdev, txdev) == 0) {
274         txsock = rxsock;
275     } else {
276         if ((txsock = socket(PF_CAN, SOCK_RAW, 0)) < 0) {
277             perror("TX socket failed");
278             goto failure1;
279         }
280
281         strncpy(ifr.ifr_name, txdev, IFNAMSIZ);
282         printf("TX txsock=%d, ifr_name=%s\n", txsock, ifr.ifr_name);
283
284         if (ioctl(txsock, SIOCGIFINDEX, &ifr) < 0) {
285             perror("TX ioctl SIOCGIFINDEX failed");
286             goto failure2;
287         }
288
289         /* Suppress definiton of a default receive filter list */
290         if (setsockopt(txsock, SOL_CAN_RAW, CAN_RAW_FILTER, NULL, 0) < 0) {
291             perror("TX setsockopt CAN_RAW_FILTER failed");
292             goto failure2;
293         }
294
295         memset(&txaddr, 0, sizeof(txaddr));
296         txaddr.can_ifindex = ifr.ifr_ifindex;
297         txaddr.can_family = AF_CAN;
298
299         if (bind(txsock, (struct sockaddr *)&txaddr, sizeof(txaddr)) < 0) {
300                 perror("TX bind failed\n");
301                 goto failure2;
302         }
303     }
304
305     signal(SIGTERM, catch_signal);
306     signal(SIGINT, catch_signal);
307     signal(SIGHUP, catch_signal);
308     mlockall(MCL_CURRENT|MCL_FUTURE);
309
310     printf("Round-Trip-Time test %s -> %s with CAN ID 0x%x\n",
311            argv[optind], argv[optind + 1], can_id);
312     printf("Cycle time: %d us\n", cycle);
313     printf("All RTT timing figures are in us.\n");
314
315     /* Create statistics message queue */
316     snprintf(mqname, sizeof(mqname), "/rtcan_rtt-%d", getpid());
317     mqattr.mq_flags   = 0;
318     mqattr.mq_maxmsg  = 100;
319     mqattr.mq_msgsize = sizeof(struct rtt_stat);
320     mq = mq_open(mqname, O_RDWR | O_CREAT | O_EXCL, 0600, &mqattr);
321     if (mq == (mqd_t)-1) {
322         perror("opening mqueue failed");
323         goto failure2;
324     }
325
326     /* Create receiver RT-thread */
327     pthread_attr_init(&thattr);
328     pthread_attr_setdetachstate(&thattr, PTHREAD_CREATE_JOINABLE);
329     pthread_attr_setstacksize(&thattr, PTHREAD_STACK_MIN);
330     ret = pthread_create(&rxthread, &thattr, &receiver, NULL);
331     if (ret) {
332         fprintf(stderr, "%s: pthread_create(receiver) failed\n",
333                 strerror(-ret));
```

```
334         goto failure3;
335     }
336
337     if (!repeater) {
338         /* Create transitter RT-thread */
339         ret = pthread_create(&txthread, &thattr, &transmitter, NULL);
340         if (ret) {
341             fprintf(stderr, "%s: pthread_create(transmitter) failed\n",
342                     strerror(-ret));
343             goto failure4;
344         }
345     }
346
347     pthread_setschedparam(pthread_self(), SCHED_FIFO, &param);
348
349     if (repeater)
350         printf("Messages\n");
351     else
352         printf("Messages RTTlast RTT_avg RTT_min RTT_max Overruns\n");
353
354     while (1) {
355         long long rtt_avg;
356
357         ret = mq_receive(mq, (char *)&rtt_stat, sizeof(rtt_stat), NULL);
358         if (ret != sizeof(rtt_stat)) {
359             if (ret < 0) {
360                 if (errno == EBADF)
361                     printf("terminating mq_receive\n");
362                 else
363                     perror("mq_receive failed");
364             } else
365                 fprintf(stderr,
366                         "mq_receive returned invalid length %d\n", ret);
367             break;
368         }
369
370         if (repeater) {
371             printf("%8d\n", rxcount);
372         } else {
373             rtt_avg = ((rtt_stat.rtt_sum - rtt_stat.rtt_sum_last) /
374                        rtt_stat.counts_per_sec);
375             printf("%8d %7ld %7ld %7ld %7ld %8d\n", rxcount,
376                    (long)(rtt_stat.rtt / 1000), (long)(rtt_avg / 1000),
377                    (long)(rtt_stat.rtt_min / 1000),
378                    (long)(rtt_stat.rtt_max / 1000),
379                    overruns);
380         }
381     }
382
383     /* This call also leaves primary mode, required for socket cleanup. */
384     printf("shutting down\n");
385
386     /* Important: First close the sockets! */
387     while ((close(rxsock) < 0) && (errno == EAGAIN)) {
388         printf("RX socket busy - waiting...\n");
389         sleep(1);
390     }
391     while ((close(txsock) < 0) && (errno == EAGAIN)) {
392         printf("TX socket busy - waiting...\n");
393         sleep(1);
394     }
395
396     pthread_join(txthread, NULL);
397     pthread_kill(rxthread, SIGHUP);
398     pthread_join(rxthread, NULL);
399
400     return 0;
```

```
401
402  failure4:
403     pthread_kill(rxthread, SIGHUP);
404     pthread_join(rxthread, NULL);
405  failure3:
406     mq_close(mq);
407  failure2:
408     close(txsock);
409  failure1:
410     close(rxsock);
411
412     return 1;
413 }
```

8.3 rtcanconfig.c

```
1 /*
2  * Program to configuring the CAN controller
3  *
4  * Copyright (C) 2006 Wolfgang Grandegger <wg@grandegger.com>
5  *
6  * Copyright (C) 2005, 2006 Sebastian Smolorz
7  *                          <Sebastian.Smolorz@stud.uni-hannover.de>
8  *
9  *
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14  *
15  * This program is distributed in the hope that it will be useful,
16  * but WITHOUT ANY WARRANTY; without even the implied warranty of
17  * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18  * GNU General Public License for more details.
19  *
20  * You should have received a copy of the GNU General Public License
21  * along with this program; if not, write to the Free Software
22  * Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.
23  */
24
25 #include <stdio.h>
26 #include <stdlib.h>
27 #include <signal.h>
28 #include <unistd.h>
29 #include <string.h>
30 #include <time.h>
31 #include <errno.h>
32 #include <getopt.h>
33 #include <sys/mman.h>
34
35 #include <rtdm/rtcan.h>
36
37 static void print_usage(char *prg)
38 {
39     fprintf(stderr,
40             "Usage: %s <can-interface> [Options] [up|down|start|stop|sleep]\n"
41             "Options:\n"
42             " -v, --verbose            be verbose\n"
43             " -h, --help               this help\n"
44             " -c, --ctrlmode=CTRLMODE  listenonly, loopback or none\n"
45             " -b, --baudrate=BPS       baudrate in bits/sec\n"
46             " -B, --bittime=BTR0:BTR1  BTR or standard bit-time\n"
47             " -B, --bittime=BRP:PROP_SEG:PHASE_SEG1:PHASE_SEG2:SJW:SAM\n",
48             prg);
49 }
50
51 can_baudrate_t string_to_baudrate(char *str)
52 {
53     can_baudrate_t baudrate;
54     if (sscanf(str, "%i", &baudrate) != 1)
55         return -1;
56     return baudrate;
57 }
58
59 int string_to_mode(char *str)
60 {
61     if ( !strcmp(str, "up") || !strcmp(str, "start") )
62         return CAN_MODE_START;
63     else if ( !strcmp(str, "down") || !strcmp(str, "stop") )
64         return CAN_MODE_STOP;
65     else if ( !strcmp(str, "sleep") )
```

```
66          return CAN_MODE_SLEEP;
67      return -EINVAL;
68  }
69
70  int string_to_ctrlmode(char *str)
71  {
72      if ( !strcmp(str, "listenonly") )
73          return CAN_CTRLMODE_LISTENONLY;
74      else if ( !strcmp(str, "loopback") )
75          return CAN_CTRLMODE_LOOPBACK;
76      else if ( !strcmp(str, "none") )
77          return 0;
78
79      return -1;
80  }
81
82  int main(int argc, char *argv[])
83  {
84      char    ifname[16];
85      int     can_fd = -1;
86      int     new_baudrate = -1;
87      int     new_mode = -1;
88      int     new_ctrlmode = 0, set_ctrlmode = 0;
89      int     verbose = 0;
90      int     bittime_count = 0, bittime_data[6];
91      struct  ifreq ifr;
92      can_baudrate_t *baudrate;
93      can_ctrlmode_t *ctrlmode;
94      can_mode_t *mode;
95      struct can_bittime *bittime;
96      int opt, ret;
97      char* ptr;
98
99      struct option long_options[] = {
100         { "help", no_argument, 0, 'h' },
101         { "verbose", no_argument, 0, 'v'},
102         { "baudrate", required_argument, 0, 'b'},
103         { "bittime", required_argument, 0, 'B'},
104         { "ctrlmode", required_argument, 0, 'c'},
105         { 0, 0, 0, 0},
106     };
107
108     while ((opt = getopt_long(argc, argv, "hvb:B:c:",
109                               long_options, NULL)) != -1) {
110         switch (opt) {
111         case 'h':
112             print_usage(argv[0]);
113             exit(0);
114
115         case 'v':
116             verbose = 1;
117             break;
118
119         case 'b':
120             new_baudrate = string_to_baudrate(optarg);
121             if (new_baudrate == -1) {
122                 print_usage(argv[0]);
123                 exit(0);
124             }
125             break;
126
127         case 'B':
128             ptr = optarg;
129             while (1) {
130                 bittime_data[bittime_count++] = strtoul(ptr, NULL, 0);
131                 if (!(ptr = strchr(ptr, ':')))
132                     break;
```

```
133                 ptr++;
134             }
135             if (bittime_count != 2 && bittime_count != 6) {
136                 print_usage(argv[0]);
137                 exit(0);
138             }
139             break;
140
141         case 'c':
142             ret = string_to_ctrlmode(optarg);
143             if (ret == -1) {
144                 print_usage(argv[0]);
145                 exit(0);
146             }
147             new_ctrlmode |= ret;
148             set_ctrlmode = 1;
149             break;
150
151             break;
152
153         default:
154             fprintf(stderr, "Unknown option %c\n", opt);
155             break;
156         }
157     }
158
159     /* Get CAN interface name */
160     if (optind != argc - 1 && optind != argc - 2) {
161         print_usage(argv[0]);
162         return 0;
163     }
164
165     strncpy(ifname, argv[optind], IFNAMSIZ);
166     strncpy(ifr.ifr_name, ifname, IFNAMSIZ);
167
168     if (optind == argc - 2) {   /* Get mode setting */
169         new_mode = string_to_mode(argv[optind + 1]);
170         if (verbose)
171             printf("mode: %s (%#x)\n", argv[optind + 1], new_mode);
172         if (new_mode < 0) {
173             print_usage(argv[0]);
174             return 0;
175         }
176     }
177
178     can_fd = rt_dev_socket(PF_CAN, SOCK_RAW, CAN_RAW);
179     if (can_fd < 0) {
180         fprintf(stderr, "Cannot open RTDM CAN socket. Maybe driver not loaded? \n");
181         return can_fd;
182     }
183
184     ret = rt_dev_ioctl(can_fd, SIOCGIFINDEX, &ifr);
185     if (ret) {
186         fprintf(stderr,"Can't get interface index for %s, code = %d\n", ifname, ret);
187         return ret;
188     }
189
190
191     if (new_baudrate != -1) {
192         if (verbose)
193             printf("baudrate: %d\n", new_baudrate);
194         baudrate = (can_baudrate_t *)&ifr.ifr_ifru;
195         *baudrate = new_baudrate;
196         ret = rt_dev_ioctl(can_fd, SIOCSCANBAUDRATE, &ifr);
197         if (ret) {
198             goto abort;
199         }
```

```
200     }
201
202     if (bittime_count) {
203         bittime = (struct can_bittime *)&ifr.ifr_ifru;
204         if (bittime_count == 2) {
205             bittime->type = CAN_BITTIME_BTR;
206             bittime->btr.btr0 = bittime_data[0];
207             bittime->btr.btr1 = bittime_data[1];
208             if (verbose)
209                 printf("bit-time: btr0=0x%02x btr1=0x%02x\n",
210                        bittime->btr.btr0, bittime->btr.btr1);
211         } else {
212             bittime->type = CAN_BITTIME_STD;
213             bittime->std.brp = bittime_data[0];
214             bittime->std.prop_seg = bittime_data[1];
215             bittime->std.phase_seg1 = bittime_data[2];
216             bittime->std.phase_seg2 = bittime_data[3];
217             bittime->std.sjw = bittime_data[4];
218             bittime->std.sam = bittime_data[5];
219             if (verbose)
220                 printf("bit-time: brp=%d prop_seg=%d phase_seg1=%d "
221                        "phase_seg2=%d sjw=%d sam=%d\n",
222                        bittime->std.brp,
223                        bittime->std.prop_seg,
224                        bittime->std.phase_seg1,
225                        bittime->std.phase_seg2,
226                        bittime->std.sjw,
227                        bittime->std.sam);
228         }
229
230         ret = rt_dev_ioctl(can_fd, SIOCSCANCUSTOMBITTIME, &ifr);
231         if (ret) {
232             goto abort;
233         }
234
235     }
236
237     if (set_ctrlmode != 0) {
238         ctrlmode = (can_ctrlmode_t *)&ifr.ifr_ifru;
239         *ctrlmode = new_ctrlmode;
240         if (verbose)
241             printf("ctrlmode: %#x\n", new_ctrlmode);
242         ret = rt_dev_ioctl(can_fd, SIOCSCANCTRLMODE, &ifr);
243         if (ret) {
244             goto abort;
245         }
246     }
247
248     if (new_mode != -1) {
249         mode = (can_mode_t *)&ifr.ifr_ifru;
250         *mode = new_mode;
251         ret = rt_dev_ioctl(can_fd, SIOCSCANMODE, &ifr);
252         if (ret) {
253             goto abort;
254         }
255     }
256
257     rt_dev_close(can_fd);
258     return 0;
259
260  abort:
261     rt_dev_close(can_fd);
262     return ret;
263 }
```

8.4 rtcanrecv.c

```
1 #include <stdio.h>
2 #include <stdlib.h>
3 #include <signal.h>
4 #include <unistd.h>
5 #include <time.h>
6 #include <errno.h>
7 #include <getopt.h>
8 #include <sys/mman.h>
9
10 #include <native/task.h>
11 #include <native/pipe.h>
12
13 #include <rtdm/rtcan.h>
14
15 static void print_usage(char *prg)
16 {
17     fprintf(stderr,
18             "Usage: %s [<can-interface>] [Options]\n"
19             "Options:\n"
20             " -f  --filter=id:mask[:id:mask]... apply filter\n"
21             " -e  --error=mask      receive error messages\n"
22             " -t, --timeout=MS      timeout in ms\n"
23             " -T, --timestamp       with absolute timestamp\n"
24             " -R, --timestamp-rel   with relative timestamp\n"
25             " -v, --verbose         be verbose\n"
26             " -p, --print=MODULO    print every MODULO message\n"
27             " -h, --help            this help\n",
28             prg);
29 }
30
31
32 extern int optind, opterr, optopt;
33
34 static int s = -1, verbose = 0, print = 1;
35 static nanosecs_rel_t timeout = 0, with_timestamp = 0, timestamp_rel = 0;
36
37 RT_TASK rt_task_desc;
38
39 #define BUF_SIZ 255
40 #define MAX_FILTER 16
41
42 struct sockaddr_can recv_addr;
43 struct can_filter recv_filter[MAX_FILTER];
44 static int filter_count = 0;
45
46 int add_filter(u_int32_t id, u_int32_t mask)
47 {
48     if (filter_count >= MAX_FILTER)
49         return -1;
50     recv_filter[filter_count].can_id = id;
51     recv_filter[filter_count].can_mask = mask;
52     printf("Filter #%d: id=0x%08x mask=0x%08x\n", filter_count, id, mask);
53     filter_count++;
54     return 0;
55 }
56
57 void cleanup(void)
58 {
59     int ret;
60
61     if (verbose)
62         printf("Cleaning up...\n");
63
64     if (s >= 0) {
65         ret = rt_dev_close(s);
```

```
66          s = -1;
67          if (ret) {
68              fprintf(stderr, "rt_dev_close: %s\n", strerror(-ret));
69          }
70          rt_task_delete(&rt_task_desc);
71      }
72      }
73
74  void cleanup_and_exit(int sig)
75  {
76      if (verbose)
77          printf("Signal %d received\n", sig);
78      cleanup();
79      exit(0);
80  }
81
82  void rt_task(void)
83  {
84      int i, ret, count = 0;
85      struct can_frame frame;
86      struct sockaddr_can addr;
87      socklen_t addrlen = sizeof(addr);
88      struct msghdr msg;
89      struct iovec iov;
90      nanosecs_abs_t timestamp, timestamp_prev = 0;
91
92      if (with_timestamp) {
93          msg.msg_iov = &iov;
94          msg.msg_iovlen = 1;
95          msg.msg_name = (void *)&addr;
96          msg.msg_namelen = sizeof(struct sockaddr_can);
97          msg.msg_control = (void *)&timestamp;
98          msg.msg_controllen = sizeof(nanosecs_abs_t);
99      }
100
101      while (1) {
102          if (with_timestamp) {
103              iov.iov_base = (void *)&frame;
104              iov.iov_len = sizeof(can_frame_t);
105              ret = rt_dev_recvmsg(s, &msg, 0);
106          } else
107              ret = rt_dev_recvfrom(s, (void *)&frame, sizeof(can_frame_t), 0,
108                                    (struct sockaddr *)&addr, &addrlen);
109          if (ret < 0) {
110              switch (ret) {
111              case -ETIMEDOUT:
112                  if (verbose)
113                      printf("rt_dev_recv: timed out");
114                  continue;
115              case -EBADF:
116                  if (verbose)
117                      printf("rt_dev_recv: aborted because socket was closed");
118                  break;
119              default:
120                  fprintf(stderr, "rt_dev_recv: %s\n", strerror(-ret));
121              }
122              break;
123          }
124
125          if (print && (count % print) == 0) {
126              printf("#%d: (%d) ", count, addr.can_ifindex);
127              if (with_timestamp && msg.msg_controllen) {
128                  if (timestamp_rel) {
129                  printf("%llдns ", (long long)(timestamp - timestamp_prev));
130                      timestamp_prev = timestamp;
131                  } else
132                      printf("%llдns ", (long long)timestamp);
```

```
133             }
134             if (frame.can_id & CAN_ERR_FLAG)
135                 printf("!0x%08x!", frame.can_id & CAN_ERR_MASK);
136             else if (frame.can_id & CAN_EFF_FLAG)
137                 printf("<0x%08x>", frame.can_id & CAN_EFF_MASK);
138             else
139                 printf("<0x%03x>", frame.can_id & CAN_SFF_MASK);
140 
141             printf(" [%d]", frame.can_dlc);
142             if (!(frame.can_id & CAN_RTR_FLAG))
143                 for (i = 0; i < frame.can_dlc; i++) {
144                     printf(" %02x", frame.data[i]);
145                 }
146             if (frame.can_id & CAN_ERR_FLAG) {
147                 printf(" ERROR ");
148                 if (frame.can_id & CAN_ERR_BUSOFF)
149                     printf("bus-off");
150                 if (frame.can_id & CAN_ERR_CRTL)
151                     printf("controller problem");
152             } else if (frame.can_id & CAN_RTR_FLAG)
153                 printf(" remote request");
154             printf("\n");
155         }
156         count++;
157     }
158 }
159 
160 int main(int argc, char **argv)
161 {
162     int opt, ret;
163     u_int32_t id, mask;
164     u_int32_t err_mask = 0;
165     struct ifreq ifr;
166     char *ptr;
167     char name[32];
168 
169     struct option long_options[] = {
170         { "help", no_argument, 0, 'h' },
171         { "verbose", no_argument, 0, 'v'},
172         { "filter", required_argument, 0, 'f'},
173         { "error", required_argument, 0, 'e'},
174         { "timeout", required_argument, 0, 't'},
175         { "timestamp", no_argument, 0, 'T'},
176         { "timestamp-rel", no_argument, 0, 'R'},
177         { 0, 0, 0, 0},
178     };
179 
180     mlockall(MCL_CURRENT | MCL_FUTURE);
181 
182     signal(SIGTERM, cleanup_and_exit);
183     signal(SIGINT, cleanup_and_exit);
184 
185     while ((opt = getopt_long(argc, argv, "hve:f:t:p:RT",
186                               long_options, NULL)) != -1) {
187         switch (opt) {
188         case 'h':
189             print_usage(argv[0]);
190             exit(0);
191 
192         case 'p':
193             print = strtoul(optarg, NULL, 0);
194             break;
195 
196         case 'v':
197             verbose = 1;
198             break;
199 
```

```
200         case 'e':
201             err_mask = strtoul(optarg, NULL, 0);
202             break;
203
204         case 'f':
205             ptr = optarg;
206             while (1) {
207                 id = strtoul(ptr, NULL, 0);
208                 ptr = strchr(ptr, ':');
209                 if (!ptr) {
210                     fprintf(stderr, "filter must be applied in the form id:mask[:id:mask]...\n");
211                     exit(1);
212                 }
213                 ptr++;
214                 mask = strtoul(ptr, NULL, 0);
215                 ptr = strchr(ptr, ':');
216                 add_filter(id, mask);
217                 if (!ptr)
218                     break;
219                 ptr++;
220             }
221             break;
222
223         case 't':
224             timeout = (nanosecs_rel_t)strtoul(optarg, NULL, 0) * 1000000;
225             break;
226
227         case 'R':
228             timestamp_rel = 1;
229         case 'T':
230             with_timestamp = 1;
231             break;
232
233         default:
234             fprintf(stderr, "Unknown option %c\n", opt);
235             break;
236         }
237     }
238
239     ret = rt_dev_socket(PF_CAN, SOCK_RAW, CAN_RAW);
240     if (ret < 0) {
241         fprintf(stderr, "rt_dev_socket: %s\n", strerror(-ret));
242         return -1;
243     }
244     s = ret;
245
246     if (argv[optind] == NULL) {
247         if (verbose)
248             printf("interface all\n");
249
250         ifr.ifr_ifindex = 0;
251     } else {
252         if (verbose)
253             printf("interface %s\n", argv[optind]);
254
255         strncpy(ifr.ifr_name, argv[optind], IFNAMSIZ);
256         if (verbose)
257             printf("s=%d, ifr_name=%s\n", s, ifr.ifr_name);
258
259         ret = rt_dev_ioctl(s, SIOCGIFINDEX, &ifr);
260         if (ret < 0) {
261             fprintf(stderr, "rt_dev_ioctl GET_IFINDEX: %s\n", strerror(-ret));
262             goto failure;
263         }
264     }
265
266     if (err_mask) {
```

```
267         ret = rt_dev_setsockopt(s, SOL_CAN_RAW, CAN_RAW_ERR_FILTER,
268                                 &err_mask, sizeof(err_mask));
269         if (ret < 0) {
270             fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
271             goto failure;
272         }
273         if (verbose)
274             printf("Using err_mask=%#x\n", err_mask);
275     }
276
277     if (filter_count) {
278         ret = rt_dev_setsockopt(s, SOL_CAN_RAW, CAN_RAW_FILTER,
279                                 &recv_filter, filter_count *
280                                 sizeof(struct can_filter));
281         if (ret < 0) {
282             fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
283             goto failure;
284         }
285     }
286
287     recv_addr.can_family = AF_CAN;
288     recv_addr.can_ifindex = ifr.ifr_ifindex;
289     ret = rt_dev_bind(s, (struct sockaddr *)&recv_addr,
290                       sizeof(struct sockaddr_can));
291     if (ret < 0) {
292         fprintf(stderr, "rt_dev_bind: %s\n", strerror(-ret));
293         goto failure;
294     }
295
296     if (timeout) {
297         if (verbose)
298             printf("Timeout: %lld ns\n", (long long)timeout);
299         ret = rt_dev_ioctl(s, RTCAN_RTIOC_RCV_TIMEOUT, &timeout);
300         if (ret) {
301             fprintf(stderr, "rt_dev_ioctl RCV_TIMEOUT: %s\n", strerror(-ret));
302             goto failure;
303         }
304     }
305
306     if (with_timestamp) {
307         ret = rt_dev_ioctl(s, RTCAN_RTIOC_TAKE_TIMESTAMP, RTCAN_TAKE_TIMESTAMPS);
308         if (ret) {
309             fprintf(stderr, "rt_dev_ioctl TAKE_TIMESTAMP: %s\n", strerror(-ret));
310             goto failure;
311         }
312     }
313
314     snprintf(name, sizeof(name), "rtcanrecv-%d", getpid());
315     ret = rt_task_shadow(&rt_task_desc, name, 0, 0);
316     if (ret) {
317         fprintf(stderr, "rt_task_shadow: %s\n", strerror(-ret));
318         goto failure;
319     }
320
321     rt_task();
322     /* never returns */
323
324  failure:
325     cleanup();
326     return -1;
327 }
```

8.5 rtcansend.c

```
1 #include <stdio.h>
2 #include <stdlib.h>
3 #include <signal.h>
4 #include <unistd.h>
5 #include <time.h>
6 #include <errno.h>
7 #include <getopt.h>
8 #include <sys/mman.h>
9
10 #include <native/task.h>
11 #include <native/timer.h>
12 #include <native/pipe.h>
13
14 #include <rtdm/rtcan.h>
15
16 extern int optind, opterr, optopt;
17
18 static void print_usage(char *prg)
19 {
20     fprintf(stderr,
21             "Usage: %s <can-interface> [Options] <can-msg>\n"
22             "<can-msg> can consist of up to 8 bytes given as a space separated list\n"
23             "Options:\n"
24             " -i, --identifier=ID   CAN Identifier (default = 1)\n"
25             " -r  --rtr             send remote request\n"
26             " -e  --extended        send extended frame\n"
27             " -l  --loop=COUNT      send message COUNT times\n"
28             " -c, --count           message count in data[0-3]\n"
29             " -d, --delay=MS        delay in ms (default = 1ms)\n"
30             " -s, --send            use send instead of sendto\n"
31             " -t, --timeout=MS      timeout in ms\n"
32             " -L, --loopback=0|1    switch local loopback off or on\n"
33             " -v, --verbose         be verbose\n"
34             " -p, --print=MODULO    print every MODULO message\n"
35             " -h, --help            this help\n",
36             prg);
37 }
38
39
40 RT_TASK rt_task_desc;
41
42 static int s=-1, dlc=0, rtr=0, extended=0, verbose=0, loops=1;
43 static SRTIME delay=1000000;
44 static int count=0, print=1, use_send=0, loopback=-1;
45 static nanosecs_rel_t timeout = 0;
46 static struct can_frame frame;
47 static struct sockaddr_can to_addr;
48
49
50 void cleanup(void)
51 {
52     int ret;
53
54     if (verbose)
55         printf("Cleaning up...\n");
56
57     usleep(100000);
58
59     if (s >= 0) {
60         ret = rt_dev_close(s);
61         s = -1;
62         if (ret) {
63             fprintf(stderr, "rt_dev_close: %s\n", strerror(-ret));
64         }
65         rt_task_delete(&rt_task_desc);
```

```
66     }
67 }
68
69 void cleanup_and_exit(int sig)
70 {
71     if (verbose)
72         printf("Signal %d received\n", sig);
73     cleanup();
74     exit(0);
75 }
76
77 void rt_task(void)
78 {
79     int i, j, ret;
80
81     for (i = 0; i < loops; i++) {
82         rt_task_sleep(rt_timer_ns2ticks(delay));
83         if (count)
84             memcpy(&frame.data[0], &i, sizeof(i));
85         /* Note: sendto avoids the definiton of a receive filter list */
86         if (use_send)
87             ret = rt_dev_send(s, (void *)&frame, sizeof(can_frame_t), 0);
88         else
89             ret = rt_dev_sendto(s, (void *)&frame, sizeof(can_frame_t), 0,
90                                 (struct sockaddr *)&to_addr, sizeof(to_addr));
91         if (ret < 0) {
92             switch (ret) {
93             case -ETIMEDOUT:
94                 if (verbose)
95                     printf("rt_dev_send(to): timed out");
96                 break;
97             case -EBADF:
98                 if (verbose)
99                     printf("rt_dev_send(to): aborted because socket was closed");
100                break;
101            default:
102                fprintf(stderr, "rt_dev_send: %s\n", strerror(-ret));
103                break;
104            }
105            i = loops;          /* abort */
106            break;
107        }
108        if (verbose && (i % print) == 0) {
109            if (frame.can_id & CAN_EFF_FLAG)
110                printf("<0x%08x>", frame.can_id & CAN_EFF_MASK);
111            else
112                printf("<0x%03x>", frame.can_id & CAN_SFF_MASK);
113            printf(" [%d]", frame.can_dlc);
114            for (j = 0; j < frame.can_dlc; j++) {
115                printf(" %02x", frame.data[j]);
116            }
117            printf("\n");
118        }
119    }
120 }
121
122 int main(int argc, char **argv)
123 {
124     int i, opt, ret;
125     struct ifreq ifr;
126     char name[32];
127
128     struct option long_options[] = {
129         { "help", no_argument, 0, 'h' },
130         { "identifier", required_argument, 0, 'i'},
131         { "rtr", no_argument, 0, 'r'},
132         { "extended", no_argument, 0, 'e'},
```

```
133         { "verbose", no_argument, 0, 'v'},
134         { "count", no_argument, 0, 'c'},
135         { "print", required_argument, 0, 'p'},
136         { "loop", required_argument, 0, 'l'},
137         { "delay", required_argument, 0, 'd'},
138         { "send", no_argument, 0, 's'},
139         { "timeout", required_argument, 0, 't'},
140         { "loopback", required_argument, 0, 'L'},
141         { 0, 0, 0, 0},
142     };
143 
144     mlockall(MCL_CURRENT | MCL_FUTURE);
145 
146     signal(SIGTERM, cleanup_and_exit);
147     signal(SIGINT, cleanup_and_exit);
148 
149     frame.can_id = 1;
150 
151     while ((opt = getopt_long(argc, argv, "hvi:l:red:t:cp:sL:",
152                               long_options, NULL)) != -1) {
153         switch (opt) {
154         case 'h':
155             print_usage(argv[0]);
156             exit(0);
157 
158         case 'p':
159             print = strtoul(optarg, NULL, 0);
160 
161         case 'v':
162             verbose = 1;
163             break;
164 
165         case 'c':
166             count = 1;
167             break;
168 
169         case 'l':
170             loops = strtoul(optarg, NULL, 0);
171             break;
172 
173         case 'i':
174             frame.can_id = strtoul(optarg, NULL, 0);
175             break;
176 
177         case 'r':
178             rtr = 1;
179             break;
180 
181         case 'e':
182             extended = 1;
183             break;
184 
185         case 'd':
186             delay = strtoul(optarg, NULL, 0) * 1000000LL;
187             break;
188 
189         case 's':
190             use_send = 1;
191             break;
192 
193         case 't':
194             timeout = strtoul(optarg, NULL, 0) * 1000000LL;
195             break;
196 
197         case 'L':
198             loopback = strtoul(optarg, NULL, 0);
199             break;
```

```
200
201         default:
202             fprintf(stderr, "Unknown option %c\n", opt);
203             break;
204         }
205     }
206
207     if (optind == argc) {
208         print_usage(argv[0]);
209         exit(0);
210     }
211
212     if (argv[optind] == NULL) {
213         fprintf(stderr, "No Interface supplied\n");
214         exit(-1);
215     }
216
217     if (verbose)
218         printf("interface %s\n", argv[optind]);
219
220     ret = rt_dev_socket(PF_CAN, SOCK_RAW, CAN_RAW);
221     if (ret < 0) {
222         fprintf(stderr, "rt_dev_socket: %s\n", strerror(-ret));
223         return -1;
224     }
225     s = ret;
226
227     if (loopback >= 0) {
228         ret = rt_dev_setsockopt(s, SOL_CAN_RAW, CAN_RAW_LOOPBACK,
229                                 &loopback, sizeof(loopback));
230         if (ret < 0) {
231             fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
232             goto failure;
233         }
234         if (verbose)
235             printf("Using loopback=%d\n", loopback);
236     }
237
238     strncpy(ifr.ifr_name, argv[optind], IFNAMSIZ);
239     if (verbose)
240         printf("s=%d, ifr_name=%s\n", s, ifr.ifr_name);
241
242     ret = rt_dev_ioctl(s, SIOCGIFINDEX, &ifr);
243     if (ret < 0) {
244         fprintf(stderr, "rt_dev_ioctl: %s\n", strerror(-ret));
245         goto failure;
246     }
247
248     memset(&to_addr, 0, sizeof(to_addr));
249     to_addr.can_ifindex = ifr.ifr_ifindex;
250     to_addr.can_family = AF_CAN;
251     if (use_send) {
252         /* Suppress definiton of a default receive filter list */
253         ret = rt_dev_setsockopt(s, SOL_CAN_RAW, CAN_RAW_FILTER, NULL, 0);
254         if (ret < 0) {
255             fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
256             goto failure;
257         }
258
259         ret = rt_dev_bind(s, (struct sockaddr *)&to_addr, sizeof(to_addr));
260         if (ret < 0) {
261             fprintf(stderr, "rt_dev_bind: %s\n", strerror(-ret));
262             goto failure;
263         }
264     }
265
266     if (count)
```

```
267         frame.can_dlc = sizeof(int);
268     else {
269         for (i = optind + 1; i < argc; i++) {
270             frame.data[dlc] = strtoul(argv[i], NULL, 0);
271             dlc++;
272             if( dlc == 8 )
273                 break;
274         }
275         frame.can_dlc = dlc;
276     }
277 
278     if (rtr)
279         frame.can_id |= CAN_RTR_FLAG;
280 
281     if (extended)
282         frame.can_id |= CAN_EFF_FLAG;
283 
284     if (timeout) {
285         if (verbose)
286             printf("Timeout: %lld ns\n", (long long)timeout);
287         ret = rt_dev_ioctl(s, RTCAN_RTIOC_SND_TIMEOUT, &timeout);
288         if (ret) {
289             fprintf(stderr, "rt_dev_ioctl SND_TIMEOUT: %s\n", strerror(-ret));
290             goto failure;
291         }
292     }
293 
294     snprintf(name, sizeof(name), "rtcansend-%d", getpid());
295     ret = rt_task_shadow(&rt_task_desc, name, 1, 0);
296     if (ret) {
297         fprintf(stderr, "rt_task_shadow: %s\n", strerror(-ret));
298         goto failure;
299     }
300 
301     rt_task();
302 
303     cleanup();
304     return 0;
305 
306  failure:
307     cleanup();
308     return -1;
309 }
```

Chapter 9

Xenomai RTDM skin API Page Documentation

9.1 Deprecated List

Global rtdm_task_sleep_until Use rtdm_task_sleep_abs instead!

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