

# **Linux/RT-Linux CAN Driver (LinCAN)**

## **Linux/RT-Linux CAN Driver (LinCAN)**

by Pavel Pisa

Published June 2005

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# Preface

LinCAN is a Linux kernel module that implements a CAN driver capable of working with multiple cards, even with different chips and IO methods. Each communication object can be accessed from multiple applications concurrently. It supports RT-Linux, 2.2, 2.4, and 2.6 with fully implemented select, poll, fasync, O\_NONBLOCK, and O\_SYNC semantics and multithreaded read/write capabilities. It works with the common Intel i82527, Philips 82c200, and Philips SJA1000 (in standard and PeliCAN mode) CAN controllers. It is part of a set of CAN/CANopen related components developed as part of OCERA framework.

# Chapter 1. Linux/RT-Linux CAN Driver (LinCAN)

The LINCAN is an implementation of the Linux device driver supporting more CAN controller chips and many CAN interface boards. Its implementation has long history already. The OCERA version of the driver adds new features, continuous enhancements and reimplementations of structure of the driver. Most important feature is that driver supports multiple open of one communication object from more Linux and even RT-Linux applications and threads. The usage of the driver is tightly coupled to the virtual CAN API interface component which hides driver low level interface to the application programmers.

## 1.1. LinCAN Summary

### 1.1.1. Summary

Name of the component

Linux CAN Driver (LINCAN)

Author

Pavel Pisa

Arnaud Westenberg

Tomasz Motylewski

Maintainer

Pavel Pisa

LinCAN Internet resources

<http://www.ocera.org> OCERA project home page

<http://sourceforge.net/projects/ocera> OCERA SourceForge project page. The OCERA CVS relative path to LinCAN driver sources is

`ocera/components/comm/can/lincan.`

<http://cmp.felk.cvut.cz/~pisa/can> local testing directory

Reviewer

The previous driver versions were tested by more users. The actual version has been tested at CTU by more OCERA developers, by Unicontrols and by BFAD GmbH, which use pre-OCERA and current version of the driver in their products.

**List of the cards tested with latest version of the driver:**

- PC104 Advantech PCM3680 dual channel board on 2.4 RT-Linux enabled kernel
- PiKRON ISA card on 2.4 and 2.6 Linux kernels
- BfaD DIMM PC card on 2.4 RT-Linux enabled kernel
- KVASER pcican-q on 2.6 Linux kernel and on 2.4 RT-Linux enabled kernel
- virtual board tested on all systems as well

Supported layers

- High-level available  
Linux device interface available for soft real-time Linux only and for mixed-mode RT-Linux/Linux driver compilation
- Low-level available



RT-Linux device is registered only for mixed-mode RT-Linux/Linux driver compilation. The driver messages transmission and reception runs in hard real-time threads in such case.

Version

lincan-0.3

Status

Beta

Dependencies

The driver requires CAN interface hardware for access to real CAN bus.

Driver can be used even without hardware if a virtual board is configured. This setup is useful for testing of interworking of other CAN components.

Linux kernels from 2.2.x, 2.4.x and 2.6.x series are fully supported.

The RT-Linux version 3.2 or OCERA RT-Linux enabled system is required for hard real-time use.

The RT-Linux version requires RT-Linux `malloc`, which is part of OCERA RT-Linux version and can be downloaded for older RT-Linux versions .

The use of VCA API library is suggested for seamless application transitions between driver kinds and versions.

Supported hardware (some not tested)

- Advantech PC-104 PCM3680 dual channel board
- PiKRON ISA card
- BfaD DIMM PC card
- KVASER PCican-Q, PCican-D, PCican-S
- KVASER PCcan-Q, PCcan-D, PCcan-S, PCcan-F
- MPL AG PIP5, PIP6, PIP7, PIP8
- NSI PC-104 board CAN104
- Contemporary Controls PC-104 board CAN104
- Arcom Control Systems PC-104 board AIM104CAN
- IXXAT ISA board PC-I03
- SECO PC-104 board M436
- Board support template sources for yet unsupported hardware
- Virtual board

Release date

February 2004

## 1.2. LinCAN Driver Description

### 1.2.1. Introduction

The LinCAN driver is the loadable module for the Linux kernel which implements CAN driver. The driver communicates and controls one or more CAN controllers chips. Each chip/CAN interface is represented to the applications as one or more CAN message objects accessible as character devices. The application can open the character device and use `read/write` system calls for CAN messages transmission or reception through the connected message object. The parameters of the message object can be modified by the `IOCTL` system call. The closing of the character device releases resources allocated by

the application. The present version of the driver supports three most common CAN controllers:

- Intel i82527 chips
- Philips 82c200 chips
- Philips SJA1000 chips in standard and PeliCAN mode

The intelligent CAN/CANopen cards should be supported by in the near future. One of such cards is P-CAN series of cards produced by Unicontrols. The driver contains support for more than ten CAN cards basic types with different combinations of the above mentioned chips. Not all card types are held by OCERA members, but CTU has and tested more SJA1000 type cards and will test some i82527 cards in near future.

## 1.3. LinCAN Driver System Level API

### 1.3.1. Device Files and Message Structure

Each driver is a subsystem which has no direct application level API. The operating system is responsible for user space calls transformation into driver functions calls or dispatch routines invocations. The CAN driver is implemented as a character device with the standard device node names `/dev/can0`, `/dev/can1`, etc. The application program communicates with the driver through the standard system low level input/output primitives (`open`, `close`, `read`, `write`, `select` and `ioctl`). The CAN driver convention of usage of these functions is described in the next subsection.

The `read` and `write` functions need to transfer one or more CAN messages. The structure `canmsg_t` is defined for this purpose and is defined in include file `can/can.h`. The `canmsg_t` structure has next fields:

```
struct canmsg_t {
    int flags;
    int cob;
    unsigned long id;
    canmsg_tstamp_t timestamp;
    unsigned short length;
    unsigned char data[CAN_MSG_LENGTH];
} PACKED;
```

#### flags

The `flags` field holds information about message type. The bit `MSG_RTR` marks remote transmission request messages. Writing of such message into the CAN message object handle results in transmission of the RTR message. The RTR message can be received by the `read` call if no buffer with corresponding ID is pre-filled in the driver. The bit `MSG_EXT` indicates that the message with extended (bit 29 set) ID will be send or was received. The bit `MSG_OVR` is intended for fast indication of the reception message queue overflow. The transmitted messages could be distributed back to the local clients after transmission to the CAN bus. Such messages are marked by `MSG_LOCAL` bit.

#### cob

The field reserved for a holding message communication object number. It could be used for serialization of received messages from more message object into one message queue in the future.

#### id

CAN message ID.

#### timestamp

The field intended for storing of the message reception time.

#### length

The number of the data bytes send or received in the CAN message. The number of data load bytes is from 0 to 8.

data

The byte array holding message data.

As was mentioned above, direct communication with the driver through system calls is not encouraged because this interface is partially system dependent and cannot be ported to all environments. The suggested alternative is to use OCERA provided VCA library which defines the portable and clean interface to the CAN driver implementation.

The other issue is addition of the support for new CAN interface boards and CAN controller chips. The subsection Board Support Functions describes template functions, which needs to be implemented for newly supported board. The template of board support can be found in the file `src/template.c`.

The other task for more brave souls is addition of the support for the unsupported chip type. The source supporting the SJA1000 chip in the PeliCAN mode can serve as an example. The full source of this chip support is stored in the file `src/sja1000p.c`. The subsection Chip Support Functions describes basic functions necessary for the new chip support.

## 1.3.2. CAN Driver File Operations

### open

#### Name

`open` — message communication object open system call

#### Synopsis

```
int open (const char * pathname, int flags);
```

#### Arguments

*pathname*

The path to driver device node is specified there. The conventional device names for Linux CAN driver are `/dev/can0`, `/dev/can1`, etc.

*flags*

flags modifying style of open call. The standard `O_RDWR` mode should be used for CAN device. The mode `O_NOBLOCK` can be used with driver as well. This mode results in immediate return of read and write.

#### Description

Returns negative number in the case of error. Returns the file descriptor for named CAN message object in other cases.

### close

#### Name

`close` — message communication object close system call

**Synopsis**

```
int close (int fd);
```

**Arguments**

*fd*

file descriptor to opened can message communication object

**Description**

Returns negative number in the case of error.

**read****Name**

read — reads received CAN messages from message object

**Synopsis**

```
ssize_t read(int fd, void * buf, size_t count);
```

**Arguments**

*fd*

file descriptor to opened can message communication object

*buf*

pointer to array of `canmsg_t` structures.

*count*

size of message array buffer in number of bytes

**Description**

Returns negative value in the case of error else returns number of read bytes which is multiple of `canmsg_t` structure size.

**write****Name**

write — writes CAN messages to message object for transmission

**Synopsis**

```
ssize_t write(int fd, const void * buf, size_t count);
```

**Arguments**

*fd*

file descriptor to opened can message communication object

*buf*

pointer to array of `canmsg_t` structures.

*count*

size of message array buffer in number of bytes. The parameter informs driver about number of messages prepared for transmission and should be multiple of `canmsg_t` structure size.

## Description

Returns negative value in the case of error else returns number of bytes successfully stored into message object transmission queue. The positive returned number is multiple of `canmsg_t` structure size.

# struct canfilt\_t

## Name

`struct canfilt_t` — structure for acceptance filter setup

## Synopsis

```
struct canfilt_t {
    int flags;
    int queid;
    int cob;
    unsigned long id;
    unsigned long mask;
};
```

## Members

`flags`

message flags

`MSG_RTR` .. message is Remote Transmission Request,

`MSG_EXT` .. message with extended ID,

`MSG_OVR` .. indication of queue overflow condition,

`MSG_LOCAL` .. message originates from this node.

there are corresponding mask bits `MSG_RTR_MASK`, `MSG_EXT_MASK`, `MSG_LOCAL_MASK`.

`MSG_PROCESSLOCAL` enables local messages processing in the combination with global setting

`queid`

CAN queue identification in the case of the multiple queues per one user (open instance)

`cob`

communication object number (not used)

`id`

selected required value of cared ID id bits

`mask`

select bits significant for the comparison;

1 .. take care about corresponding ID bit,

0 .. don't care

## IOCTL CANQUE\_FILTER

### Name

IOCTL CANQUE\_FILTER — Sets acceptance filter for CAN queue connected to client state

### Synopsis

```
int ioctl(int fd, int command = CANQUE_FILTER, struct canfilt_t * filt);
```

### Arguments

*fd*

file descriptor to opened can message communication object

*command*

Denotes CAN queue filter command, CANQUE\_FILTER

*filt*

pointer to the canfilt\_t structure.

### Description

The CANQUE\_FILTER IOCTL invocation sets acceptance mask of associated canqueue to specified parameters. Actual version of the driver changes filter of the default reception queue. The filed `queid` should be initialized to zero to support compatibility with future driver versions.

The call returns negative value in the case of error.

## IOCTL CANQUE\_FLUSH

### Name

IOCTL CANQUE\_FLUSH — Flushes messages from reception CAN queue

### Synopsis

```
int ioctl(int fd, int command = CANQUE_FLUSH, int queid);
```

### Arguments

*fd*

file descriptor to opened can message communication object

*command*

Denotes CAN queue flush command, CANQUE\_FLUSH

*queid*

Should be initialized to zero to support compatibility with future driver versions

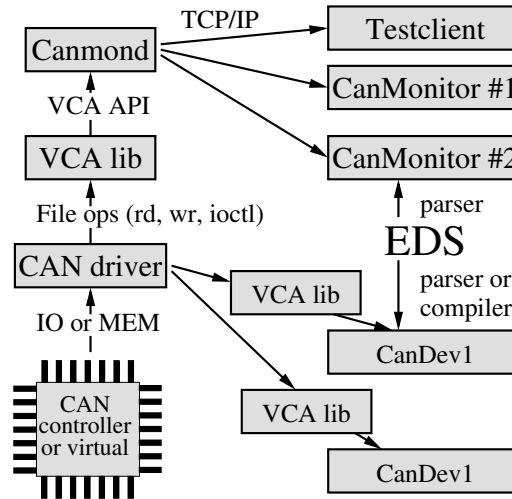
### Description

The call flushes all messages from the CAN queue.

The call returns negative value in the case of error.

## 1.4. LinCAN Driver Architecture

The LinCAN provides simultaneous queued communication for more concurrent running applications.



**Figure 1-1. LinCAN architecture**

Even each of communication object can be used by one or more applications, which connects to the communication object internal representation by means of CAN FIFO queues. This enables to build complex systems based even on card and chips, which provides only one communication objects (for example SJA1000).

The driver can be configured to provide virtual CAN board (software emulated message object) to test CAN components on the Linux system without hardware required to connect to the real CAN bus. The example configuration of the CAN network components connected to one real or virtual communication object of LinCAN driver is shown in figure Figure 1-1. The communication object is used by the CAN monitor daemon and two CANopen devices implemented by OCERA CanDev component. The actual system dependent driver API is hidden to applications under VCA library. The CAN monitor daemon translates CAN messages to TCP/IP network for Java based platform independent CAN monitor and C based test client.

Each communication object is represented as character device file. The devices can be opened and closed by applications in blocking or non-blocking mode. LinCAN client application state, chip and object configurations are controlled by IOCTL system call. One or more CAN messages can be sent or received through write/read system calls. The data read from or written to the driver are formed from sequence of fixed size structures representing CAN messages.

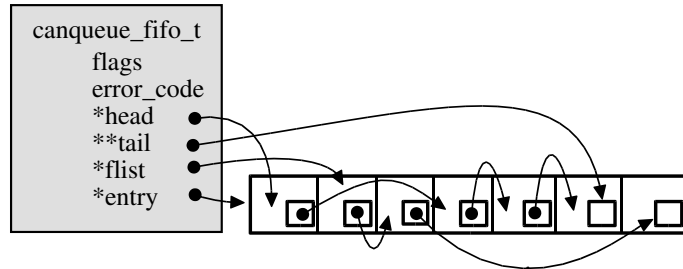
```

struct canmsg_t {
    int    flags;
    int    cob;
    unsigned long    id;
    canmsg_tstamp_t timestamp;
    unsigned short    length;
    unsigned char    data[CAN_MSG_LENGTH];
};

```

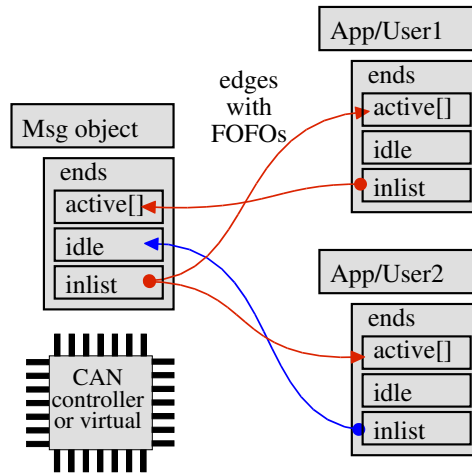
The LinCAN driver version 0.2 has rewritten infrastructure based on message FIFOs organized into oriented edges between chip drivers (structure `chip_t`) message objects representations (structure `msgobj_t`) and open device file instances state (structure `canuser_t`). The complete relationship between CAN hardware representation and open instances is illustrated in the figure Figure 1-4.

The message FIFO (structure `canque_fifo_t`) initialization code allocates configurable number of slots capable to hold one message.



**Figure 1-2. LinCAN message FIFO implementation**

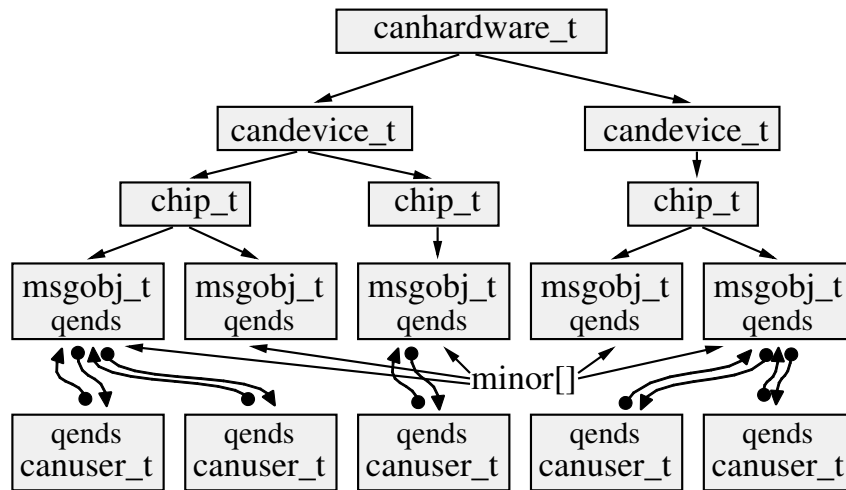
The all slots are linked to the free list after initialization. The slot can be requested by FIFO input side by function `canque_fifo_get_inslot`. The slot is filled by message data and is linked into FIFO queue by function `canque_fifo_put_inslot`. If previously requested slot is not successfully filled by data, it can be released by `canque_fifo_abort_inslot`. The output side of the FIFO tests presence of ready slots by function `canque_fifo_test_outslot`. If the slot is returned by this function, it is processed and released by function `canque_fifo_free_outslot`. The processing can be postponed in the case of bus error or higher priority message processing request by `canque_fifo_again_outslot` function. All these functions are optimized to be fast and short, which enables to synchronize them by spin-lock semaphores and guarantee atomic nature of them. The FIFO implementation is illustrated in the figure Figure 1-2.



**Figure 1-3. LinCAN driver message flow graph edges**

The low level message FIFOs are wrapped by CAN edges structures (`canque_edge_t`), which are used for message passing between all components of the driver. The actual version of LinCAN driver uses oriented edges to connect Linux and RT-Linux clients/users with chips and communication objects. Each entity, which is able to hold edge ends, has to be equipped by `canque_ends_t` structure. The input ends of edges/FIFOs are held on `inlist`. The inactive/empty out ends of the edges are held on a `idle` list and active out ends are held on a `active` list corresponding to the edge priority. The `canque_fifo_test_outslot` function can determine by examination of active lists if there is message to accept/process. This concept makes possible to use same type of edges for outgoing and incoming directions. The concept of edges can be even used for message filtering by priority or acceptance masks. It is prepared for future targeting messages to predefined message objects according to their priority or type and for redundant and fault tolerant message distribution into more CAN buses. Message concentration, virtual nodes and other special processing can be implemented above this concept as well. The example of interconnection of one communication object with two users/open instances is illustrated in the picture Figure 1-3. Three edges/FIFOs are in the active state and one edge/FIFO is empty in the shown example.





**Figure 1-4. CAN hardware model in the LinCAN driver**

The figure Figure 1-4 is example of object inside LinCAN driver representing system with two boards, three chips and more communication objects. Some of these objects are used by one or more applications. The object open instances are represented as `canuser_t` structures.

## 1.5. Driver History and Implementation Issues

The development of the CAN drivers for Linux has long history. We have been faced before two basic alternatives, start new project from scratch or use some other project as basis of our development. The first approach could lead faster to more simple and clean internal architecture but it would mean to introduce new driver with probably incompatible interface unusable for already existing applications. The support of many types of cards is thing which takes long time as well. More existing projects aimed to development of a Linux CAN driver has been analyzed:

### Original LDDK CAN driver project

The driver project aborted on the kernel evolution and LDDK concept. The LDDK tried to prepare infrastructure for development of the kernel version independent character device drivers written in meta code. The goal was top-ranking, but it proves, that well written "C" language driver can be more portable than the LDDK complex infrastructure.

### can4linux-0.9 by PORT GmbH

This is version of the above LDDK driver maintained by Port GmbH. The card type is hard compiled into the driver by selected defines and only Philips 82c200 chips are supported.

### CanFestival

The big advantage of this driver is an integrated support for the RT-Linux, but driver implementation is highly coupled to one card. Some concepts of the driver are interesting but the driver has the hard-coded number of message queues.

### can-0.7.1 by Arnaud Westenberg

This driver has its roots in the LDDK project as well. The original LDDK concept has been eliminated in the driver source and necessary adaptation of the driver for the different Linux kernel versions is achieved by the controllable number of defines and conditional compilation. There is more independent contributors. The main advantages of the driver are support of many cards working in parallel, IO and memory space chip connection support and more cards of different types can be selected at module load time. There exist more users and applications compatible with the driver interface. Disadvantages of the original version of this driver

are non-optimal infrastructure, non-portable make system and lack of the select support.

The responsible OCERA developers selected the **can-0.7.1** driver as a base of their development for next reasons:

- Best support for more cards in system
- Supports for many types of cards
- The internal abstraction of the peripheral access method and the chip support

The most important features added by OCERA development team are:

- Added the select system call support
- The support for our memory mapped ISA card added, which proved simplicity of addition of the support for new type of CAN cards
- Added devfs support
- Revised and bug-fixed the IRQ support in the first phase
- Added support for 2.6.x kernels
- Rebuilt the make system to compile options fully follow the running kernel options, cross-compilation still possible when the kernel location and compiler is specified. The driver checked with more 2.2.x, 2.4.x and 2.6.x kernels and hardware configurations.
- Cleaned-up synchronization required to support 2.6.x SMP kernels and enhanced 2.4.x kernels performance
- The deeper rebuilt of the driver infrastructure to enable porting to more systems (most important RT-Linux). The naive FIFO implementation has been replaced by robust CAN queues, edges and ends framework. The big advantage of continuous development is ability to keep compatibility with many cards and applications
- The infrastructure rewrite enabled to support multiple opening of the single minor device
- Support for individual queues message acceptance filters added
- The driver setup functions modified to enable PCI and USB hardware hot-swapping and PnP recognition in the future
- Added support for KVASER PCI cards family
- Added support for virtual can board for more CAN/CANopen components interworking testing on single computer without real CAN hardware.
- The conditional compilation mode for Linux/RT-Linux support has been added. The driver manipulates with chips and boards from RT-Linux hard real-time worker threads in that compilation mode. The POSIX device file interface is provided for RT-Linux threads in parallel to the standard Linux device interface.
- Work on support for first of intelligent CAN/CANopen cards has been started

The possible future enhancements

- Cleanup and enhance RTR processing. Add some support for emulated RTR processing for SJA1000 chips
- Enhance clients API to gain full advantages of possibility to connect more CAN queues with different priorities to the one user state structure
- Add support for more CAN cards and chips (82C900 comes to mind)
- Add support for XILINX FPGA based board in development at CTU. There already exists VHDL source for the chip core, connect it to PC-104 bus and LinCAN driver
- Do next steps in the PCI cards support cleanup and add Linux 2.6.x sysfs support

## 1.6. LinCAN Driver Internals

### 1.6.1. Basic Driver Data Structures

#### struct canhardware\_t

##### Name

struct canhardware\_t — structure representing pointers to all CAN boards

##### Synopsis

```
struct canhardware_t {
    int nr_boards;
    struct rtr_id * rtr_queue;
    can_spinlock_t rtr_lock;
    struct candevice_t * candevice[MAX_HW_CARDS];
};
```

##### Members

nr\_boards

number of present boards

rtr\_queue

RTR - remote transmission request queue (expect some changes there)

rtr\_lock

locking for RTR queue

candevice[MAX\_HW\_CARDS]

array of pointers to CAN devices/boards

#### struct candevice\_t

##### Name

struct candevice\_t — CAN device/board structure

##### Synopsis

```
struct candevice_t {
    char * hwname;
    int candev_idx;
    unsigned long io_addr;
    unsigned long res_addr;
    unsigned long dev_base_addr;
    unsigned int flags;
    int nr_all_chips;
    int nr_82527_chips;
    int nr_sja1000_chips;
    struct canchip_t * chip[MAX_HW_CHIPS];
    struct hwspecops_t * hwspecops;
    struct canhardware_t * hosthardware_p;
    union sysdevptr;
};
```

##### Members

hwname

text string with board type

**candev\_idx**  
 board index in `canhardware_t.candevicel[]`  
**io\_addr**  
 IO/physical MEM address  
**res\_addr**  
 optional reset register port  
**dev\_base\_addr**  
 CPU translated IO/virtual MEM address  
**flags**  
 board flags: `PROGRAMMABLE_IRQ` .. interrupt number can be programmed into board  
**nr\_all\_chips**  
 number of chips present on the board  
**nr\_82527\_chips**  
 number of Intel 8257 chips  
**nr\_sja1000\_chips**  
 number of Philips SJA100 chips  
**chip[MAX\_HW\_CHIPS]**  
 array of pointers to the chip structures  
**hwspecops**  
 pointer to board specific operations  
**hosthardware\_p**  
 pointer to the root hardware structure  
**sysdevptr**  
 union reserved for pointer to bus specific device structure (case `pcidev` is used for PCI devices)

## Description

The structure represent configuration and state of associated board. The driver infrastructure prepares this structure and calls board type specific `board_register` function. The board support provided register function fills right function pointers in `hwspecops` structure. Then driver setup calls functions `init_hw_data`, `init_chip_data`, `init_obj_data` and `program_irq`. Function `init_hw_data` and `init_chip_data` have to specify number and types of connected chips or objects respectively. The use of `nr_all_chips` is preferred over use of fields `nr_82527_chips` and `nr_sja1000_chips` in the board non-specific functions. The `io_addr` and `dev_base_addr` is filled from module parameters to the same value. The `request_io` function can fix-up `dev_base_addr` field if virtual address is different than bus address.

## struct canchip\_t

### Name

`struct canchip_t` — CAN chip state and type information

### Synopsis

```

struct canchip_t {
    char * chip_type;
    int chip_idx;
    int chip_irq;
}
  
```

```

unsigned long chip_base_addr;
unsigned int flags;
long clock;
long baudrate;
void (* write_register) (unsigned data,unsigned long address);
unsigned (* read_register) (unsigned long address);
void * chip_data;
unsigned short sja_cdr_reg;
unsigned short sja_ocr_reg;
unsigned short int_cpu_reg;
unsigned short int_clk_reg;
unsigned short int_bus_reg;
struct msgobj_t * msgobj[MAX_MSGOBS];
struct chipspecops_t * chipspecops;
struct candevice_t * hostdevice;
int max_objects;
can_spinlock_t chip_lock;
#ifdef CAN_WITH_RTL
pthread_t worker_thread;
unsigned long pend_flags;
#endif
};

```

## Members

### chip\_type

text string describing chip type

### chip\_idx

index of the chip in candevice\_t.chip[] array

### chip\_irq

chip interrupt number if any

### chip\_base\_addr

chip base address in the CPU IO or virtual memory space

### flags

chip flags: CHIP\_CONFIGURED .. chip is configured, CHIP\_SEGMENTED .. access to the chip is segmented (mainly for i82527 chips)

### clock

chip base clock frequency in Hz

### baudrate

selected chip baudrate in Hz

### write\_register

write chip register function copy

### read\_register

read chip register function copy

### chip\_data

pointer for optional chip specific data extension

### sja\_cdr\_reg

SJA specific register - holds hardware specific options for the Clock Divider register. Options defined in the sja1000.h file: CDR\_CLKOUT\_MASK, CDR\_CLK\_OFF, CDR\_RXINPEN, CDR\_CBP, CDR\_PELICAN

### sja\_ocr\_reg

SJA specific register - hold hardware specific options for the Output Control register. Options defined in the sja1000.h file: OCR\_MODE\_BIPHASE, OCR\_MODE\_TEST, OCR\_MODE\_NORMAL, OCR\_MODE\_CLOCK, OCR\_TX0\_LH, OCR\_TX1\_ZZ.

### int\_cpu\_reg

Intel specific register - holds hardware specific options for the CPU Interface register. Options defined in the i82527.h file: iCPU\_CEN, iCPU\_MUX, iCPU\_SLP, iCPU\_PWD, iCPU\_DMC, iCPU\_DSC, iCPU\_RST.

**int\_clk\_reg**

Intel specific register - holds hardware specific options for the Clock Out register. Options defined in the `i82527.h` file: `iCLK_CD0`, `iCLK_CD1`, `iCLK_CD2`, `iCLK_CD3`, `iCLK_SL0`, `iCLK_SL1`.

**int\_bus\_reg**

Intel specific register - holds hardware specific options for the Bus Configuration register. Options defined in the `i82527.h` file: `iBUS_DR0`, `iBUS_DR1`, `iBUS_DT1`, `iBUS_POL`, `iBUS_CBY`.

**msgobj[MAX\_MSGOBS]**

array of pointers to individual communication objects

**chipspecops**

pointer to the set of chip specific object filled by `init_chip_data` function

**hostdevice**

pointer to chip hosting board

**max\_objects**

maximal number of communication objects connected to this chip

**chip\_lock**

reserved for synchronization of the chip supporting routines (not used in the current driver version)

**worker\_thread**

chip worker thread ID (RT-Linux specific field)

**pend\_flags**

holds information about pending interrupt and `tx_wake` operations (RT-Linux specific field). Masks values: `MSGOBJ_TX_REQUEST` .. some of the message objects requires `tx_wake` call, `MSGOBJ_IRQ_REQUEST` .. chip interrupt processing required `MSGOBJ_WORKER_WAKE` .. marks, that worker thread should be waked for some of above reasons

**Description**

The fields `write_register` and `read_register` are copied from corresponding fields from `hwspecops` structure (`chip->hostdevice->hwspecops->write_register` and `chip->hostdevice->hwspecops->read_register`) to `speedup can_write_reg` and `can_read_reg` functions.

## struct msgobj\_t

**Name**

`struct msgobj_t` — structure holding communication object state

**Synopsis**

```
struct msgobj_t {
    unsigned long obj_base_addr;
    unsigned int minor;
    unsigned int object;
    unsigned long obj_flags;
    int ret;
    struct canque_ends_t * qends;
    struct canque_edge_t * tx_qedge;
    struct canque_slot_t * tx_slot;
    int tx_retry_cnt;
    struct timer_list tx_timeout;
    struct canmsg_t rx_msg;
    struct canchip_t * hostchip;
};
```

```

    unsigned long rx_preconfig_id;
    atomic_t obj_used;
    struct list_head obj_users;
};

```

## Members

`obj_base_addr`

`minor`

associated device minor number

`object`

object number in `canchip_t` structure +1

`obj_flags`

message object specific flags. Masks values: `MSGOBJ_TX_REQUEST` .. the message object requests TX activation `MSGOBJ_TX_LOCK` .. some IRQ routine or callback on some CPU is running inside TX activation processing code

`ret`

field holding status of the last Tx operation

`qends`

pointer to message object corresponding ends structure

`tx_qedge`

edge corresponding to transmitted message

`tx_slot`

slot holding transmitted message, slot is taken from `canque_test_outslot` call and is freed by `canque_free_outslot` or rescheduled `canque_again_outslot`

`tx_retry_cnt`

transmission attempt counter

`tx_timeout`

can be used by chip driver to check for the transmission timeout

`rx_msg`

temporary storage to hold received messages before calling to `canque_filter_msg2edges`

`hostchip`

pointer to the `&canchip_t` structure this object belongs to

`rx_preconfig_id`

place to store RX message identifier for some chip types that reuse same object for TX

`obj_used`

counter of users (associated file structures for Linux userspace clients) of this object

`obj_users`

list of user structures of type `&canuser_t`.

## struct canuser\_t

### Name

`struct canuser_t` — structure holding CAN user/client state

## Synopsis

```

struct canuser_t {
    unsigned long flags;
    struct list_head peers;
    struct canque_ends_t * qends;
    struct msgobj_t * msgobj;
    struct canque_edge_t * rx_edge0;
    union {} userinfo;
    int magic;
};

```

## Members

### flags

used to distinguish Linux/RT-Linux type

### peers

for connection into list of object users

### qends

pointer to the ends structure corresponding for this user

### msgobj

communication object the user is connected to

### rx\_edge0

default receive queue for filter IOCTL

### userinfo

stores user context specific information. The field *fileinfo*.file holds pointer to open device file state structure for the Linux user-space client applications

### magic

magic number to check consistency when pointer is retrieved from file private field

## struct hwspecops\_t

### Name

struct hwspecops\_t — hardware/board specific operations

### Synopsis

```

struct hwspecops_t {
    int (* request_io) (struct candevice_t *candev);
    int (* release_io) (struct candevice_t *candev);
    int (* reset) (struct candevice_t *candev);
    int (* init_hw_data) (struct candevice_t *candev);
    int (* init_chip_data) (struct candevice_t *candev, int chipnr);
    int (* init_obj_data) (struct canchip_t *chip, int objnr);
    int (* program_irq) (struct candevice_t *candev);
    void (* write_register) (unsigned data, unsigned long address);
    unsigned (* read_register) (unsigned long address);
};

```

### Members

#### request\_io

reserve io or memory range for can board

#### release\_io

free reserved io memory range

#### reset

hardware reset routine



**init\_hw\_data**

called to initialize `&candevicet` structure, mainly `res_add`, `nr_all_chips`, `nr_82527_chips`, `nr_sja1000_chips` and `flags` fields

**init\_chip\_data**

called initialize each `&canchipt` structure, mainly `chip_type`, `chip_base_addr`, `clock` and chip specific registers. It is responsible to setup `&canchipt->chipspecops` functions for non-standard chip types (type other than “i82527”, “sja1000” or “sja1000p”)

**init\_obj\_data**

called initialize each `&msgobjt` structure, mainly `obj_base_addr` field.

**program\_irq**

program interrupt generation hardware of the board if flag `PROGRAMMABLE_IRQ` is present for specified device/board

**write\_register**

low level write register routine

**read\_register**

low level read register routine

## struct chipspecops\_t

### Name

struct chipspecops\_t — can controller chip specific operations

### Synopsis

```
struct chipspecops_t {
    int (* chip_config) (struct canchip_t *chip);
    int (* baud_rate) (struct canchip_t *chip, int rate, int clock, int sjw, int sampl_pt, int flags);
    int (* standard_mask) (struct canchip_t *chip, unsigned short code, unsigned short mask);
    int (* extended_mask) (struct canchip_t *chip, unsigned long code, unsigned long mask);
    int (* message15_mask) (struct canchip_t *chip, unsigned long code, unsigned long mask);
    int (* clear_objects) (struct canchip_t *chip);
    int (* config_irqs) (struct canchip_t *chip, short irqs);
    int (* pre_read_config) (struct canchip_t *chip, struct msgobj_t *obj);
    int (* pre_write_config) (struct canchip_t *chip, struct msgobj_t *obj, struct canmsg_t *msg);
    int (* send_msg) (struct canchip_t *chip, struct msgobj_t *obj, struct canmsg_t *msg);
    int (* remote_request) (struct canchip_t *chip, struct msgobj_t *obj);
    int (* check_tx_stat) (struct canchip_t *chip);
    int (* wakeup_tx) (struct canchip_t *chip, struct msgobj_t *obj);
    int (* filtch_rq) (struct canchip_t *chip, struct msgobj_t *obj);
    int (* enable_configuration) (struct canchip_t *chip);
    int (* disable_configuration) (struct canchip_t *chip);
    int (* set_btrregs) (struct canchip_t *chip, unsigned short btr0, unsigned short btr1);
    int (* attach_to_chip) (struct canchip_t *chip);
    int (* release_chip) (struct canchip_t *chip);
    int (* start_chip) (struct canchip_t *chip);
    int (* stop_chip) (struct canchip_t *chip);
    int (* irq_handler) (int irq, struct canchip_t *chip);
    int (* irq_accept) (int irq, struct canchip_t *chip);
};
```

### Members

**chip\_config**

CAN chip configuration

**baud\_rate**

set communication parameters

**standard\_mask**  
 setup of mask for message filtering

**extended\_mask**  
 setup of extended mask for message filtering

**message15\_mask**  
 set mask of i82527 message object 15

**clear\_objects**  
 clears state of all message object residing in chip

**config\_irqs**  
 tunes chip hardware interrupt delivery

**pre\_read\_config**  
 prepares message object for message reception

**pre\_write\_config**  
 prepares message object for message transmission

**send\_msg**  
 initiate message transmission

**remote\_request**  
 configures message object and asks for RTR message

**check\_tx\_stat**  
 checks state of transmission engine

**wakeup\_tx**  
 wakeup TX processing

**filth\_rq**  
 optional routine for propagation of outgoing edges filters to HW

**enable\_configuration**  
 enable chip configuration mode

**disable\_configuration**  
 disable chip configuration mode

**set\_btregs**  
 configures bitrate registers

**attach\_to\_chip**  
 attaches to the chip, setups registers and possibly state informations

**release\_chip**  
 called before chip structure removal if CHIP\_ATTACHED is set

**start\_chip**  
 starts chip message processing

**stop\_chip**  
 stops chip message processing

**irq\_handler**  
 interrupt service routine

**irq\_accept**  
 optional fast irq accept routine responsible for blocking further interrupts

## 1.6.2. Board Support Functions

The functions, which should be implemented for each supported board, are described in the next section. The functions are prefixed by boardname. The prefix *template* has been selected for next description.

## template\_request\_io

### Name

template\_request\_io — reserve io or memory range for can board

### Synopsis

```
int template_request_io (struct candevice_t * candev);
```

### Arguments

*candev*

pointer to candevice/board which asks for io. Field *io\_addr* of *candev* is used in most cases to define start of the range

### Description

The function `template_request_io` is used to reserve the io-memory. If your hardware uses a dedicated memory range as hardware control registers you will have to add the code to reserve this memory as well. `IO_RANGE` is the io-memory range that gets reserved, please adjust according your hardware. Example: `#define IO_RANGE 0x100` for i82527 chips or `#define IO_RANGE 0x20` for sja1000 chips in basic CAN mode.

### Return Value

The function returns zero on success or `-ENODEV` on failure

### File

src/template.c

## template\_release\_io

### Name

template\_release\_io — free reserved io memory range

### Synopsis

```
int template_release_io (struct candevice_t * candev);
```

### Arguments

*candev*

pointer to candevice/board which releases io

### Description

The function `template_release_io` is used to free reserved io-memory. In case you have reserved more io memory, don't forget to free it here. `IO_RANGE` is the io-memory range that gets released, please adjust according your hardware. Example: `#define IO_RANGE 0x100` for i82527 chips or `#define IO_RANGE 0x20` for sja1000 chips in basic CAN mode.

**Return Value**

The function always returns zero

**File**

src/template.c

## template\_reset

**Name**

template\_reset — hardware reset routine

**Synopsis**

```
int template_reset (struct candevice_t * candev);
```

**Arguments**

*candev*

Pointer to candevice/board structure

**Description**

The function `template_reset` is used to give a hardware reset. This is rather hardware specific so I haven't included example code. Don't forget to check the reset status of the chip before returning.

**Return Value**

The function returns zero on success or `-ENODEV` on failure

**File**

src/template.c

## template\_init\_hw\_data

**Name**

template\_init\_hw\_data — Initialize hardware cards

**Synopsis**

```
int template_init_hw_data (struct candevice_t * candev);
```

**Arguments**

*candev*

Pointer to candevice/board structure

## Description

The function `template_init_hw_data` is used to initialize the hardware structure containing information about the installed CAN-board. `RESET_ADDR` represents the io-address of the hardware reset register. `NR_82527` represents the number of Intel 82527 chips on the board. `NR_SJA1000` represents the number of Philips sja1000 chips on the board. The flags entry can currently only be `CANDEV_PROGRAMMABLE_IRQ` to indicate that the hardware uses programmable interrupts.

## Return Value

The function always returns zero

## File

`src/template.c`

# template\_init\_chip\_data

## Name

`template_init_chip_data` — Initialize chips

## Synopsis

```
int template_init_chip_data (struct candevice_t * candev, int chipnr);
```

## Arguments

*candev*

Pointer to candevice/board structure

*chipnr*

Number of the CAN chip on the hardware card

## Description

The function `template_init_chip_data` is used to initialize the hardware structure containing information about the CAN chips. `CHIP_TYPE` represents the type of CAN chip. `CHIP_TYPE` can be “i82527” or “sja1000”. The `chip_base_addr` entry represents the start of the ‘official’ memory map of the installed chip. It’s likely that this is the same as the `io_addr` argument supplied at module loading time. The `clock` entry holds the chip clock value in Hz. The entry `sja_cdr_reg` holds hardware specific options for the Clock Divider register. Options defined in the `sja1000.h` file: `sjaCDR_CLKOUT_MASK`, `sjaCDR_CLK_OFF`, `sjaCDR_RXINPEN`, `sjaCDR_CBP`, `sjaCDR_PELICAN`. The entry `sja_ocr_reg` holds hardware specific options for the Output Control register. Options defined in the `sja1000.h` file: `sjaOCR_MODE_BIPHASE`, `sjaOCR_MODE_TEST`, `sjaOCR_MODE_NORMAL`, `sjaOCR_MODE_CLOCK`, `sjaOCR_TX0_LH`, `sjaOCR_TX1_ZZ`. The entry `int_clk_reg` holds hardware specific options for the Clock Out register. Options defined in the `i82527.h` file: `iCLK_CD0`, `iCLK_CD1`, `iCLK_CD2`, `iCLK_CD3`, `iCLK_SL0`, `iCLK_SL1`. The entry `int_bus_reg` holds hardware specific options for the Bus Configuration register. Options defined in the `i82527.h` file: `iBUS_DR0`, `iBUS_DR1`, `iBUS_DT1`, `iBUS_POL`, `iBUS_CBY`. The entry `int_cpu_reg` holds hardware specific options for the cpu interface register. Options defined in the `i82527.h` file: `iCPU_CEN`, `iCPU_MUX`, `iCPU_SLP`, `iCPU_PWD`, `iCPU_DMC`, `iCPU_DSC`, `iCPU_RST`.

**Return Value**

The function always returns zero

**File**

src/template.c

## template\_init\_obj\_data

**Name**

template\_init\_obj\_data — Initialize message buffers

**Synopsis**

```
int template_init_obj_data (struct canchip_t * chip, int objnr);
```

**Arguments**

*chip*

Pointer to chip specific structure

*objnr*

Number of the message buffer

**Description**

The function `template_init_obj_data` is used to initialize the hardware structure containing information about the different message objects on the CAN chip. In case of the `sja1000` there's only one message object but on the `i82527` chip there are 15. The code below is for a `i82527` chip and initializes the object base addresses. The entry `obj_base_addr` represents the first memory address of the message object. In case of the `sja1000` `obj_base_addr` is taken the same as the chips base address. Unless the hardware uses a segmented memory map, flags can be set zero.

**Return Value**

The function always returns zero

**File**

src/template.c

## template\_program\_irq

**Name**

template\_program\_irq — program interrupts

**Synopsis**

```
int template_program_irq (struct candev_t * candev);
```

**Arguments***candev*

Pointer to candevice/board structure

**Description**

The function `template_program_irq` is used for hardware that uses programmable interrupts. If your hardware doesn't use programmable interrupts you should not set the `candevices_t->flags` entry to `CANDEV_PROGRAMMABLE_IRQ` and leave this function unedited. Again this function is hardware specific so there's no example code.

**Return value**The function returns zero on success or `-ENODEV` on failure**File**`src/template.c`

## template\_write\_register

**Name**`template_write_register` — Low level write register routine**Synopsis**

```
void template_write_register (unsigned data, unsigned long address);
```

**Arguments***data*

data to be written

*address*

memory address to write to

**Description**

The function `template_write_register` is used to write to hardware registers on the CAN chip. You should only have to edit this function if your hardware uses some specific write process.

**Return Value**

The function does not return a value

**File**`src/template.c`

## template\_read\_register

**Name**`template_read_register` — Low level read register routine

## Synopsis

```
unsigned template_read_register (unsigned long address);
```

## Arguments

*address*

memory address to read from

## Description

The function `template_read_register` is used to read from hardware registers on the CAN chip. You should only have to edit this function if your hardware uses some specific read process.

## Return Value

The function returns the value stored in *address*

## File

`src/template.c`

## 1.6.3. Chip Support Functions

The controller chip specific functions are described in the next section. The functions should be prefixed by chip type. Because documentation of chip functions has been retrieved from the actual SJA1000 PeliCAN support, the function prefix is *sjal1000p*.

## sjal1000p\_enable\_configuration

### Name

`sjal1000p_enable_configuration` — enable chip configuration mode

### Synopsis

```
int sjal1000p_enable_configuration (struct canchip_t * chip);
```

### Arguments

*chip*

pointer to chip state structure

## sjal1000p\_disable\_configuration

### Name

`sjal1000p_disable_configuration` — disable chip configuration mode

### Synopsis

```
int sjal1000p_disable_configuration (struct canchip_t * chip);
```



**Arguments**

*chip*  
pointer to chip state structure

**sja1000p\_chip\_config****Name**

sja1000p\_chip\_config — can chip configuration

**Synopsis**

```
int sja1000p_chip_config (struct canchip_t * chip);
```

**Arguments**

*chip*  
pointer to chip state structure

**Description**

This function configures chip and prepares it for message transmission and reception. The function resets chip, resets mask for acceptance of all messages by call to sja1000p\_extended\_mask function and then computes and sets baudrate with use of function sja1000p\_baud\_rate.

**Return Value**

negative value reports error.

**File**

src/sja1000p.c

**sja1000p\_extended\_mask****Name**

sja1000p\_extended\_mask — setup of extended mask for message filtering

**Synopsis**

```
int sja1000p_extended_mask (struct canchip_t * chip, unsigned long code, unsigned long mask);
```

**Arguments**

*chip*  
pointer to chip state structure  
*code*  
can message acceptance code  
*mask*  
can message acceptance mask

**Return Value**

negative value reports error.

**File**

src/sja1000p.c

## sja1000p\_baud\_rate

**Name**

sja1000p\_baud\_rate — set communication parameters.

**Synopsis**

```
int sja1000p_baud_rate (struct canchip_t * chip, int rate, int clock, int sjw, int sampl_pt,
int flags);
```

**Arguments**

*chip*

pointer to chip state structure

*rate*

baud rate in Hz

*clock*

frequency of sja1000 clock in Hz (ISA osc is 14318000)

*sjw*

synchronization jump width (0-3) prescaled clock cycles

*sampl\_pt*

sample point in % (0-100) sets (TSEG1+1)/(TSEG1+TSEG2+2) ratio

*flags*

fields BTR1\_SAM, OCMODE, OCPOL, OCTP, OCTN, CLK\_OFF, CBP

**Return Value**

negative value reports error.

**File**

src/sja1000p.c

## sja1000p\_read

**Name**

sja1000p\_read — reads and distributes one or more received messages

**Synopsis**

```
void sja1000p_read (struct canchip_t * chip, struct msgobj_t * obj);
```

**Arguments**

*chip*  
pointer to chip state structure

*obj*  
pinter to CAN message queue information

**File**

src/sja1000p.c

**sja1000p\_pre\_read\_config****Name**

sja1000p\_pre\_read\_config — prepares message object for message reception

**Synopsis**

```
int sja1000p_pre_read_config (struct canchip_t * chip, struct msgobj_t * obj);
```

**Arguments**

*chip*  
pointer to chip state structure

*obj*  
pointer to message object state structure

**Return Value**

negative value reports error. Positive value indicates immediate reception of message.

**File**

src/sja1000p.c

**sja1000p\_pre\_write\_config****Name**

sja1000p\_pre\_write\_config — prepares message object for message transmission

**Synopsis**

```
int sja1000p_pre_write_config (struct canchip_t * chip, struct msgobj_t * obj, struct canmsg_t * msg);
```

**Arguments**

*chip*  
pointer to chip state structure

*obj*  
pointer to message object state structure

*msg*

pointer to CAN message

**Description**

This function prepares selected message object for future initiation of message transmission by `sja1000p_send_msg` function. The CAN message data and message ID are transferred from *msg* slot into chip buffer in this function.

**Return Value**

negative value reports error.

**File**

src/sja1000p.c

## sja1000p\_send\_msg

**Name**`sja1000p_send_msg` — initiate message transmission**Synopsis**

```
int sja1000p_send_msg (struct canchip_t * chip, struct msgobj_t * obj, struct canmsg_t * msg);
```

**Arguments***chip*

pointer to chip state structure

*obj*

pointer to message object state structure

*msg*

pointer to CAN message

**Description**

This function is called after `sja1000p_pre_write_config` function, which prepares data in chip buffer.

**Return Value**

negative value reports error.

**File**

src/sja1000p.c

## sja1000p\_check\_tx\_stat

**Name**`sja1000p_check_tx_stat` — checks state of transmission engine

## Synopsis

```
int sja1000p_check_tx_stat (struct canchip_t * chip);
```

## Arguments

*chip*

pointer to chip state structure

## Return Value

negative value reports error. Positive return value indicates transmission under way status. Zero value indicates finishing of all issued transmission requests.

## File

src/sja1000p.c

# sja1000p\_set\_btregs

## Name

sja1000p\_set\_btregs — configures bitrate registers

## Synopsis

```
int sja1000p_set_btregs (struct canchip_t * chip, unsigned short btr0, unsigned short btr1);
```

## Arguments

*chip*

pointer to chip state structure

*btr0*

bitrate register 0

*btr1*

bitrate register 1

## Return Value

negative value reports error.

## File

src/sja1000p.c

# sja1000p\_start\_chip

## Name

sja1000p\_start\_chip — starts chip message processing

## Synopsis

```
int sja1000p_start_chip (struct canchip_t * chip);
```

## Arguments

*chip*  
pointer to chip state structure

## Return Value

negative value reports error.

## File

src/sja1000p.c

# sja1000p\_stop\_chip

## Name

sja1000p\_stop\_chip — stops chip message processing

## Synopsis

```
int sja1000p_stop_chip (struct canchip_t * chip);
```

## Arguments

*chip*  
pointer to chip state structure

## Return Value

negative value reports error.

## File

src/sja1000p.c

# sja1000p\_attach\_to\_chip

## Name

sja1000p\_attach\_to\_chip — attaches to the chip, setups registers and state

## Synopsis

```
int sja1000p_attach_to_chip (struct canchip_t * chip);
```

## Arguments

*chip*  
pointer to chip state structure

## Return Value

negative value reports error.

**File**

src/sja1000p.c

## sja1000p\_release\_chip

**Name**

sja1000p\_release\_chip — called before chip structure removal if CHIP\_ATTACHED is set

**Synopsis**

```
int sja1000p_release_chip (struct canchip_t * chip);
```

**Arguments***chip*

pointer to chip state structure

**Return Value**

negative value reports error.

**File**

src/sja1000p.c

## sja1000p\_remote\_request

**Name**

sja1000p\_remote\_request — configures message object and asks for RTR message

**Synopsis**

```
int sja1000p_remote_request (struct canchip_t * chip, struct msgobj_t * obj);
```

**Arguments***chip*

pointer to chip state structure

*obj*

pointer to message object structure

**Return Value**

negative value reports error.

**File**

src/sja1000p.c

## sjal000p\_standard\_mask

### Name

`sjal000p_standard_mask` — setup of mask for message filtering

### Synopsis

```
int sjal000p_standard_mask (struct canchip_t * chip, unsigned short code, unsigned short mask);
```

### Arguments

*chip*

pointer to chip state structure

*code*

can message acceptance code

*mask*

can message acceptance mask

### Return Value

negative value reports error.

### File

`src/sjal000p.c`

## sjal000p\_clear\_objects

### Name

`sjal000p_clear_objects` — clears state of all message object residing in chip

### Synopsis

```
int sjal000p_clear_objects (struct canchip_t * chip);
```

### Arguments

*chip*

pointer to chip state structure

### Return Value

negative value reports error.

### File

`src/sjal000p.c`



## sjal000p\_config\_irqs

### Name

`sjal000p_config_irqs` — tunes chip hardware interrupt delivery

### Synopsis

```
int sjal000p_config_irqs (struct canchip_t * chip, short irqs);
```

### Arguments

*chip*

pointer to chip state structure

*irqs*

requested chip IRQ configuration

### Return Value

negative value reports error.

### File

`src/sjal000p.c`

## sjal000p\_irq\_write\_handler

### Name

`sjal000p_irq_write_handler` — part of ISR code responsible for transmit events

### Synopsis

```
void sjal000p_irq_write_handler (struct canchip_t * chip, struct msgobj_t * obj);
```

### Arguments

*chip*

pointer to chip state structure

*obj*

pointer to attached queue description

### Description

The main purpose of this function is to read message from attached queues and transfer message contents into CAN controller chip. This subroutine is called by `sjal000p_irq_write_handler` for transmit events.

### File

`src/sjal000p.c`

## sjal000p\_irq\_handler

### Name

`sjal000p_irq_handler` — interrupt service routine

### Synopsis

```
int sjal000p_irq_handler (int irq, struct canchip_t * chip);
```

### Arguments

*irq*

interrupt vector number, this value is system specific

*chip*

pointer to chip state structure

### Description

Interrupt handler is activated when state of CAN controller chip changes, there is message to be read or there is more space for new messages or error occurs. The receive events results in reading of the message from CAN controller chip and distribution of message through attached message queues.

### File

`src/sjal000p.c`

## sjal000p\_wakeup\_tx

### Name

`sjal000p_wakeup_tx` — wakeups TX processing

### Synopsis

```
int sjal000p_wakeup_tx (struct canchip_t * chip, struct msgobj_t * obj);
```

### Arguments

*chip*

pointer to chip state structure

*obj*

pointer to message object structure

### Description

Function is responsible for initiating message transmission. It is responsible for clearing of object TX\_REQUEST flag

### Return Value

negative value reports error.

**File**

src/sja1000p.c

## sja1000p\_fill\_chipspecops

**Name**

sja1000p\_fill\_chipspecops — fills chip specific operations

**Synopsis**

```
int sja1000p_fill_chipspecops (struct canchip_t * chip);
```

**Arguments***chip*

pointer to chip representation structure

**Description**

The function fills chip specific operations for sja1000 (PeliCAN) chip.

**Return Value**

returns negative number in the case of fail

### 1.6.4. CAN Queues Common Structures and Functions

This part of the driver implements basic CAN queues infrastructure. It is written as much generic as possible and then specialization for each category of CAN queues clients is implemented in separate subsystem. The only synchronization mechanism required from target system are spin-lock synchronization and atomic bit manipulation. Locked sections are narrowed to the short operations. Even can message 8 bytes movement is excluded from the locked sections of the code.

## struct canque\_slot\_t

**Name**

struct canque\_slot\_t — one CAN message slot in the CAN FIFO queue

**Synopsis**

```
struct canque_slot_t {
    struct canque_slot_t * next;
    unsigned long slot_flags;
    struct canmsg_t msg;
};
```

**Members***next*

pointer to the next/younger slot

*slot\_flags*

space for flags and optional command describing action associated with slot data

msg  
space for one CAN message

## Description

This structure is used to store CAN messages in the CAN FIFO queue.

# struct canque\_fifo\_t

## Name

struct canque\_fifo\_t — CAN FIFO queue representation

## Synopsis

```
struct canque_fifo_t {
    unsigned long fifo_flags;
    unsigned long error_code;
    struct canque_slot_t * head;
    struct canque_slot_t ** tail;
    struct canque_slot_t * flist;
    struct canque_slot_t * entry;
    can_spinlock_t fifo_lock;
    int slotsnr;
};
```

## Members

### fifo\_flags

this field holds global flags describing state of the FIFO. CAN\_FIFOF\_ERROR is set when some error condition occurs. CAN\_FIFOF\_ERR2BLOCK defines, that error should lead to the FIFO block state. CAN\_FIFOF\_BLOCK state blocks insertion of the next messages. CAN\_FIFOF\_OVERRUN attempt to acquire new slot, when FIFO is full. CAN\_FIFOF\_FULL indicates FIFO full state. CAN\_FIFOF\_EMPTY indicates no allocated slot in the FIFO. CAN\_FIFOF\_DEAD condition indication. Used when FIFO is being destroyed.

### error\_code

further description of error condition

### head

pointer to the FIFO head, oldest slot

### tail

pointer to the location, where pointer to newly inserted slot should be added

### flist

pointer to list of the free slots associated with queue

### entry

pointer to the memory allocated for the list slots.

### fifo\_lock

the lock to ensure atomicity of slot manipulation operations.

### slotsnr

number of allocated slots

## Description

This structure represents CAN FIFO queue. It is implemented as a single linked list of slots prepared for processing. The empty slots are stored in single linked list (*flist*).

## canque\_fifo\_get\_inslot

### Name

`canque_fifo_get_inslot` — allocate slot for the input of one CAN message

### Synopsis

```
int canque_fifo_get_inslot (struct canque_fifo_t * fifo, struct canque_slot_t ** slotp, int cmd);
```

### Arguments

*fifo*

pointer to the FIFO structure

*slotp*

pointer to location to store pointer to the allocated slot.

*cmd*

optional command associated with allocated slot.

### Return Value

The function returns negative value if there is no free slot in the FIFO queue.

## canque\_fifo\_put\_inslot

### Name

`canque_fifo_put_inslot` — releases slot to further processing

### Synopsis

```
int canque_fifo_put_inslot (struct canque_fifo_t * fifo, struct canque_slot_t * slot);
```

### Arguments

*fifo*

pointer to the FIFO structure

*slot*

pointer to the slot previously acquired by `canque_fifo_get_inslot`.

### Return Value

The nonzero return value indicates, that the queue was empty before call to the function. The caller should wake-up output side of the queue.

## canque\_fifo\_abort\_inslot

### Name

`canque_fifo_abort_inslot` — release and abort slot

## Synopsis

```
int canque_fifo_abort_inslot (struct canque_fifo_t * fifo, struct canque_slot_t * slot);
```

## Arguments

*fifo*

pointer to the FIFO structure

*slot*

pointer to the slot previously acquired by `canque_fifo_get_inslot`.

## Return Value

The nonzero value indicates, that fifo was full

# canque\_fifo\_test\_outslot

## Name

`canque_fifo_test_outslot` — test and get ready slot from the FIFO

## Synopsis

```
int canque_fifo_test_outslot (struct canque_fifo_t * fifo, struct canque_slot_t ** slotp);
```

## Arguments

*fifo*

pointer to the FIFO structure

*slotp*

pointer to location to store pointer to the oldest slot from the FIFO.

## Return Value

The negative value indicates, that queue is empty. The positive or zero value represents command stored into slot by the call to the function `canque_fifo_get_inslot`. The successfully acquired FIFO output slot has to be released by the call `canque_fifo_free_outslot` or `canque_fifo_again_outslot`.

# canque\_fifo\_free\_outslot

## Name

`canque_fifo_free_outslot` — free processed FIFO slot

## Synopsis

```
int canque_fifo_free_outslot (struct canque_fifo_t * fifo, struct canque_slot_t * slot);
```

## Arguments

*fifo*

pointer to the FIFO structure

*slot*

pointer to the slot previously acquired by `canque_fifo_test_outslot`.

### Return Value

The returned value informs about FIFO state change. The mask `CAN_FIFO_F_FULL` indicates, that the FIFO was full before the function call. The mask `CAN_FIFO_F_EMPTY` informs, that last ready slot has been processed.

## canque\_fifo\_again\_outslot

### Name

`canque_fifo_again_outslot` — interrupt and postpone processing of the slot

### Synopsis

```
int canque_fifo_again_outslot (struct canque_fifo_t * fifo, struct canque_slot_t * slot);
```

### Arguments

*fifo*

pointer to the FIFO structure

*slot*

pointer to the slot previously acquired by `canque_fifo_test_outslot`.

### Return Value

The function cannot fail..

## struct canque\_edge\_t

### Name

`struct canque_edge_t` — CAN message delivery subsystem graph edge

### Synopsis

```
struct canque_edge_t {
    struct canque_fifo_t fifo;
    unsigned long filtid;
    unsigned long filtmask;
    struct list_head inpeers;
    struct list_head outpeers;
    struct list_head activepeers;
    struct canque_ends_t * inends;
    struct canque_ends_t * outends;
    atomic_t edge_used;
    int edge_prio;
    int edge_num;
#ifdef CAN_WITH_RTL
    struct list_head pending_peers;
    unsigned long pending_inops;
    unsigned long pending_outops;
#endif
};
```

## Members

`fifo`

place where primitive `struct canque_fifo_t` FIFO is located.

`filtid`

the possible CAN message identifiers filter.

`filtmask`

the filter mask, the comparison considers only `filtid` bits corresponding to set bits in the `filtmask` field.

`inpeers`

the lists of all peers FIFOs connected by their input side (`inends`) to the same terminal (`struct canque_ends_t`).

`outpeers`

the lists of all peers FIFOs connected by their output side (`outends`) to the same terminal (`struct canque_ends_t`).

`activepeers`

the lists of peers FIFOs connected by their output side (`outends`) to the same terminal (`struct canque_ends_t`) with same priority and active state.

`inends`

the pointer to the FIFO input side terminal (`struct canque_ends_t`).

`outends`

the pointer to the FIFO output side terminal (`struct canque_ends_t`).

`edge_used`

the atomic usage counter, mainly used for safe destruction of the edge.

`edge_prio`

the assigned queue priority from the range 0 to `CANQUEUE_PRIO_NR-1`

`edge_num`

edge sequential number intended for debugging purposes only

`pending_peers`

edges with pending delayed events (RTL->Linux calls)

`pending_inops`

bitmask of pending operations

`pending_outops`

bitmask of pending operations

## Description

This structure represents one direction connection from messages source (`inends`) to message consumer (`outends`) fifo ends hub. The edge contains `&struct canque_fifo_t` for message fifo implementation.

# struct canque\_ends\_t

## Name

`struct canque_ends_t` — CAN message delivery subsystem graph vertex (FIFO ends)



## Synopsis

```

struct canque_ends_t {
    unsigned long ends_flags;
    struct list_head active[CANQUEUE_PRIO_NR];
    struct list_head idle;
    struct list_head inlist;
    struct list_head outlist;
    can_spinlock_t ends_lock;
    void (* notify) (struct canque_ends_t *qends, struct canque_edge_t *qedge, int what);
    void * context;
    union {} endinfo;
    struct list_head dead_peers;
};

```

## Members

### ends\_flags

this field holds flags describing state of the ENDS structure.

### active[CANQUEUE\_PRIO\_NR]

the array of the lists of active edges directed to the ends structure with ready messages. The array is indexed by the edges priorities.

### idle

the list of the edges directed to the ends structure with empty FIFOs.

### inlist

the list of outgoing edges input sides.

### outlist

the list of all incoming edges output sides. Each of there edges is listed on one of *active* or *idle* lists.

### ends\_lock

the lock synchronizing operations between threads accessing same ends structure.

### notify

pointer to notify procedure. The next state changes are notified. CANQUEUE\_NOTIFY\_EMPTY (out->in call) - all slots are processed by FIFO out side. CANQUEUE\_NOTIFY\_SPACE (out->in call) - full state negated => there is space for new message. CANQUEUE\_NOTIFY\_PROC (in->out call) - empty state negated => out side is requested to process slots. CANQUEUE\_NOTIFY\_NOUSR (both) - notify, that the last user has released the edge usage called with some lock to prevent edge disappear. CANQUEUE\_NOTIFY\_DEAD (both) - edge is in progress of deletion. CANQUEUE\_NOTIFY\_ATTACH (both) - new edge has been attached to end. CANQUEUE\_NOTIFY\_FILTCH (out->in call) - edge filter rules changed. CANQUEUE\_NOTIFY\_ERROR (out->in call) - error in messages processing.

### context

space to store ends user specific information

### endinfo

space to store some other ends usage specific informations mainly for waking-up by the notify calls.

### dead\_peers

used to chain ends wanting for postponed destruction

## Description

Structure represents place to connect edges to for CAN communication entity. The zero, one or more incoming and outgoing edges can be connected to this structure.

## canque\_notify\_inends

### Name

`canque_notify_inends` — request to send notification to the input ends

### Synopsis

```
void canque_notify_inends (struct canque_edge_t * qedge, int what);
```

### Arguments

*qedge*

pointer to the edge structure

*what*

notification type

## canque\_notify\_outends

### Name

`canque_notify_outends` — request to send notification to the output ends

### Synopsis

```
void canque_notify_outends (struct canque_edge_t * qedge, int what);
```

### Arguments

*qedge*

pointer to the edge structure

*what*

notification type

## canque\_notify\_bothends

### Name

`canque_notify_bothends` — request to send notification to the both ends

### Synopsis

```
void canque_notify_bothends (struct canque_edge_t * qedge, int what);
```

### Arguments

*qedge*

pointer to the edge structure

*what*

notification type

## canque\_activate\_edge

### Name

`canque_activate_edge` — mark output end of the edge as active

### Synopsis

```
void canque_activate_edge (struct canque_ends_t * inends, struct canque_edge_t * qedge);
```

### Arguments

*inends*

input side of the edge

*qedge*

pointer to the edge structure

### Description

Function call moves output side of the edge from idle onto active edges list. This function has to be called with edge reference count held. that is same as for most of other edge functions.

## canque\_filtid2internal

### Name

`canque_filtid2internal` — converts message ID and filter flags into internal format

### Synopsis

```
unsigned int canque_filtid2internal (unsigned long id, int filtflags);
```

### Arguments

*id*

CAN message 11 or 29 bit identifier

*filtflags*

CAN message flags

### Description

This function maps message ID and MSG\_RTR, MSG\_EXT and MSG\_LOCAL into one 32 bit number

## canque\_edge\_incref

### Name

`canque_edge_incref` — increments edge reference count

## Synopsis

```
void canque_edge_incref (struct canque_edge_t * edge);
```

## Arguments

*edge*  
pointer to the edge structure

# canque\_edge\_decref

## Name

canque\_edge\_decref — decrements edge reference count

## Synopsis

```
void canque_edge_decref (struct canque_edge_t * edge);
```

## Arguments

*edge*  
pointer to the edge structure

## Description

This function has to be called without lock held for both ends of edge. If reference count drops to 0, function canque\_edge\_do\_dead is called.

# canque\_fifo\_flush\_slots

## Name

canque\_fifo\_flush\_slots — free all ready slots from the FIFO

## Synopsis

```
int canque_fifo_flush_slots (struct canque_fifo_t * fifo);
```

## Arguments

*fifo*  
pointer to the FIFO structure

## Description

The caller should be prepared to handle situations, when some slots are held by input or output side slots processing. These slots cannot be flushed or their processing interrupted.

## Return Value

The nonzero value indicates, that queue has not been empty before the function call.

## canque\_fifo\_init\_slots

### Name

`canque_fifo_init_slots` — initializes slot chain of one CAN FIFO

### Synopsis

```
int canque_fifo_init_slots (struct canque_fifo_t * fifo);
```

### Arguments

*fifo*

pointer to the FIFO structure

### Return Value

The negative value indicates, that there is no memory to allocate space for the requested number of the slots.

## canque\_get\_inslot

### Name

`canque_get_inslot` — finds one outgoing edge and allocates slot from it

### Synopsis

```
int canque_get_inslot (struct canque_ends_t * qends, struct canque_edge_t ** qedgep, struct canque_slot_t ** slotp, int cmd);
```

### Arguments

*qends*

ends structure belonging to calling communication object

*qedgep*

place to store pointer to found edge

*slotp*

place to store pointer to allocated slot

*cmd*

command type for slot

### Description

Function looks for the first non-blocked outgoing edge in *qends* structure and tries to allocate slot from it.

### Return Value

If there is no usable edge or there is no free slot in edge negative value is returned.

## canque\_get\_inslot4id

### Name

`canque_get_inslot4id` — finds best outgoing edge and slot for given ID

### Synopsis

```
int canque_get_inslot4id (struct canque_ends_t * qends, struct canque_edge_t ** qedgep,
struct canque_slot_t ** slotp, int cmd, unsigned long id, int prio);
```

### Arguments

*qends*

ends structure belonging to calling communication object

*qedgep*

place to store pointer to found edge

*slotp*

place to store pointer to allocated slot

*cmd*

command type for slot

*id*

communication ID of message to send into edge

*prio*

optional priority of message

### Description

Function looks for the non-blocked outgoing edge accepting messages with given ID. If edge is found, slot is allocated from that edge. The edges with non-zero mask are preferred over edges open to all messages. If more edges with mask accepts given message ID, the edge with highest priority below or equal to required priority is selected.

### Return Value

If there is no usable edge or there is no free slot in edge negative value is returned.

## canque\_put\_inslot

### Name

`canque_put_inslot` — schedules filled slot for processing

### Synopsis

```
int canque_put_inslot (struct canque_ends_t * qends, struct canque_edge_t * qedge, struct
canque_slot_t * slot);
```

### Arguments

*qends*

ends structure belonging to calling communication object

*qedge*

edge slot belong to

*slot*

pointer to the prepared slot

### Description

Puts slot previously acquired by `canque_get_inslot` or `canque_get_inslot4id` function call into FIFO queue and activates edge processing if needed.

### Return Value

Positive value informs, that activation of output end has been necessary

## canque\_abort\_inslot

### Name

`canque_abort_inslot` — aborts preparation of the message in the slot

### Synopsis

```
int canque_abort_inslot (struct canque_ends_t * qends, struct canque_edge_t * qedge, struct
canque_slot_t * slot);
```

### Arguments

*qends*

ends structure belonging to calling communication object

*qedge*

edge slot belong to

*slot*

pointer to the previously allocated slot

### Description

Frees slot previously acquired by `canque_get_inslot` or `canque_get_inslot4id` function call. Used when message copying into slot fails.

### Return Value

Positive value informs, that queue full state has been negated.

## canque\_filter\_msg2edges

### Name

`canque_filter_msg2edges` — sends message into all edges which accept its ID

### Synopsis

```
int canque_filter_msg2edges (struct canque_ends_t * qends, struct canmsg_t * msg);
```

**Arguments***qends*

ends structure belonging to calling communication object

*msg*

pointer to CAN message

**Description**

Sends message to all outgoing edges connected to the given ends, which accepts message communication ID.

**Return Value**

Returns number of edges message has been send to

## canque\_test\_outslot

**Name**

canque\_test\_outslot — test and retrieve ready slot for given ends

**Synopsis**

```
int canque_test_outslot (struct canque_ends_t * qends, struct canque_edge_t ** qedgep, struct
canque_slot_t ** slotp);
```

**Arguments***qends*

ends structure belonging to calling communication object

*qedgep*

place to store pointer to found edge

*slotp*

place to store pointer to received slot

**Description**

Function takes highest priority active incoming edge and retrieves oldest ready slot from it.

**Return Value**

Negative value informs, that there is no ready output slot for given ends. Positive value is equal to the command slot has been allocated by the input side.

## canque\_free\_outslot

**Name**

canque\_free\_outslot — frees processed output slot



## Synopsis

```
int canque_free_outslot (struct canque_ends_t * qends, struct canque_edge_t * qedge, struct
canque_slot_t * slot);
```

## Arguments

*qends*

ends structure belonging to calling communication object

*qedge*

edge slot belong to

*slot*

pointer to the processed slot

## Description

Function releases processed slot previously acquired by `canque_test_outslot` function call.

## Return Value

Return value informs if input side has been notified to know about change of edge state

# canque\_again\_outslot

## Name

`canque_again_outslot` — reschedule output slot to process it again later

## Synopsis

```
int canque_again_outslot (struct canque_ends_t * qends, struct canque_edge_t * qedge, struct
canque_slot_t * slot);
```

## Arguments

*qends*

ends structure belonging to calling communication object

*qedge*

edge slot belong to

*slot*

pointer to the slot for re-processing

## Description

Function reschedules slot previously acquired by `canque_test_outslot` function call for second time processing.

## Return Value

Function cannot fail.

## canque\_set\_filt

### Name

`canque_set_filt` — sets filter for specified edge

### Synopsis

```
int canque_set_filt (struct canque_edge_t * qedge, unsigned long filtid, unsigned long
filtmask, int filtflags);
```

### Arguments

*qedge*

pointer to the edge

*filtid*

ID to set for the edge

*filtmask*

mask used for ID match check

*filtflags*

required filter flags

### Return Value

Negative value is returned if edge is in the process of delete.

## canque\_flush

### Name

`canque_flush` — flush all ready slots in the edge

### Synopsis

```
int canque_flush (struct canque_edge_t * qedge);
```

### Arguments

*qedge*

pointer to the edge

### Description

Tries to flush all allocated slots from the edge, but there could exist some slots associated to edge which are processed by input or output side and cannot be flushed at this moment.

### Return Value

The nonzero value indicates, that queue has not been empty before the function call.

## canqueue\_ends\_init\_gen

### Name

`canqueue_ends_init_gen` — subsystem independent routine to initialize ends state

### Synopsis

```
int canqueue_ends_init_gen (struct canque_ends_t * qends);
```

### Arguments

*qends*

pointer to the ends structure

### Return Value

Cannot fail.

## canqueue\_connect\_edge

### Name

`canqueue_connect_edge` — connect edge between two communication entities

### Synopsis

```
int canqueue_connect_edge (struct canque_edge_t * qedge, struct canque_ends_t * inends,
struct canque_ends_t * outends);
```

### Arguments

*qedge*

pointer to edge

*inends*

pointer to ends the input of the edge should be connected to

*outends*

pointer to ends the output of the edge should be connected to

### Return Value

Negative value informs about failed operation.

## canqueue\_disconnect\_edge

### Name

`canqueue_disconnect_edge` — disconnect edge from communicating entities

### Synopsis

```
int canqueue_disconnect_edge (struct canque_edge_t * qedge);
```

**Arguments**

*qedge*  
pointer to edge

**Return Value**

Negative value means, that edge is used by somebody other and cannot be disconnected.  
Operation has to be delayed.

**canqueue\_block\_inlist****Name**

`canqueue_block_inlist` — block slot allocation of all outgoing edges of specified ends

**Synopsis**

```
void canqueue_block_inlist (struct canque_ends_t * qends);
```

**Arguments**

*qends*  
pointer to ends structure

**canqueue\_block\_outlist****Name**

`canqueue_block_outlist` — block slot allocation of all incoming edges of specified ends

**Synopsis**

```
void canqueue_block_outlist (struct canque_ends_t * qends);
```

**Arguments**

*qends*  
pointer to ends structure

**canqueue\_ends\_kill\_inlist****Name**

`canqueue_ends_kill_inlist` — sends request to die to all outgoing edges

**Synopsis**

```
int canqueue_ends_kill_inlist (struct canque_ends_t * qends, int send_rest);
```

**Arguments***qends*

pointer to ends structure

*send\_rest*

select, whether already allocated slots should be processed by FIFO output side

**Return Value**

Non-zero value means, that not all edges could be immediately disconnected and that ends structure memory release has to be delayed

**canqueue\_ends\_kill\_outlist****Name**

`canqueue_ends_kill_outlist` — sends request to die to all incoming edges

**Synopsis**

```
int canqueue_ends_kill_outlist (struct canque_ends_t * qends);
```

**Arguments***qends*

pointer to ends structure

**Return Value**

Non-zero value means, that not all edges could be immediately disconnected and that ends structure memory release has to be delayed

**canqueue\_ends\_filt\_conjunction****Name**

`canqueue_ends_filt_conjunction` — computes conjunction of incoming edges filters

**Synopsis**

```
int canqueue_ends_filt_conjunction (struct canque_ends_t * qends, struct canfilt_t * filt);
```

**Arguments***qends*

pointer to ends structure

*filt*

pointer the filter structure filled by computed filters conjunction

**Return Value**

Number of incoming edges

## canqueue\_ends\_flush\_inlist

### Name

`canqueue_ends_flush_inlist` — flushes all messages in incoming edges

### Synopsis

```
int canqueue_ends_flush_inlist (struct canque_ends_t * qends);
```

### Arguments

*qends*

pointer to ends structure

### Return Value

Negative value informs about unsuccessful result

## canqueue\_ends\_flush\_outlist

### Name

`canqueue_ends_flush_outlist` — flushes all messages in outgoing edges

### Synopsis

```
int canqueue_ends_flush_outlist (struct canque_ends_t * qends);
```

### Arguments

*qends*

pointer to ends structure

### Return Value

Negative value informs about unsuccessful result

## 1.6.5. CAN Queues Kernel Specific Functions

### canqueue\_notify\_kern

#### Name

`canqueue_notify_kern` — notification callback handler for Linux userspace clients

#### Synopsis

```
void canqueue_notify_kern (struct canque_ends_t * qends, struct canque_edge_t * qedge, int what);
```

## Arguments

*qends*

pointer to the callback side ends structure

*qedge*

edge which invoked notification

*what*

notification type

## Description

The notification event is handled directly by call of this function except case, when called from RT-Linux context in mixed mode Linux/RT-Linux compilation. It is not possible to directly call Linux kernel synchronization primitives in such case. The notification request is postponed and signaled by *pending\_inops* flags by call `canqueue_rtl2lin_check_and_pend` function. The edge reference count is increased until until all pending notifications are processed.

# canqueue\_ends\_init\_kern

## Name

`canqueue_ends_init_kern` — Linux userspace clients specific ends initialization

## Synopsis

```
int canqueue_ends_init_kern (struct canque_ends_t * qends);
```

## Arguments

*qends*

pointer to the callback side ends structure

# canque\_get\_inslot4id\_wait\_kern

## Name

`canque_get_inslot4id_wait_kern` — find or wait for best outgoing edge and slot for given ID

## Synopsis

```
int canque_get_inslot4id_wait_kern (struct canque_ends_t * qends, struct canque_edge_t ** qedgep, struct canque_slot_t ** slotp, int cmd, unsigned long id, int prio);
```

## Arguments

*qends*

ends structure belonging to calling communication object

*qedgep*

place to store pointer to found edge

*slotp*  
place to store pointer to allocated slot

*cmd*  
command type for slot

*id*  
communication ID of message to send into edge

*prio*  
optional priority of message

### Description

Same as `canque_get_inslot4id`, except, that it waits for free slot in case, that queue is full. Function is specific for Linux userspace clients.

### Return Value

If there is no usable edge negative value is returned.

## canque\_get\_outslot\_wait\_kern

### Name

`canque_get_outslot_wait_kern` — receive or wait for ready slot for given ends

### Synopsis

```
int canque_get_outslot_wait_kern (struct canque_ends_t * qends, struct canque_edge_t **
qedgep, struct canque_slot_t ** slotp);
```

### Arguments

*qends*  
ends structure belonging to calling communication object

*qedgep*  
place to store pointer to found edge

*slotp*  
place to store pointer to received slot

### Description

The same as `canque_test_outslot`, except it waits in the case, that there is no ready slot for given ends. Function is specific for Linux userspace clients.

### Return Value

Negative value informs, that there is no ready output slot for given ends. Positive value is equal to the command slot has been allocated by the input side.

## canque\_sync\_wait\_kern

### Name

`canque_sync_wait_kern` — wait for all slots processing



## Synopsis

```
int canque_sync_wait_kern (struct canque_ends_t * qends, struct canque_edge_t * qedge);
```

## Arguments

*qends*

ends structure belonging to calling communication object

*qedge*

pointer to edge

## Description

Functions waits for ends transition into empty state.

## Return Value

Positive value indicates, that edge empty state has been reached. Negative or zero value informs about interrupted wait or other problem.

# canque\_fifo\_init\_kern

## Name

`canque_fifo_init_kern` — initialize one CAN FIFO

## Synopsis

```
int canque_fifo_init_kern (struct canque_fifo_t * fifo, int slotsnr);
```

## Arguments

*fifo*

pointer to the FIFO structure

*slotsnr*

number of requested slots

## Return Value

The negative value indicates, that there is no memory to allocate space for the requested number of the slots.

# canque\_fifo\_done\_kern

## Name

`canque_fifo_done_kern` — frees slots allocated for CAN FIFO

## Synopsis

```
int canque_fifo_done_kern (struct canque_fifo_t * fifo);
```

**Arguments***fifo*

pointer to the FIFO structure

**canque\_new\_edge\_kern****Name**

canque\_new\_edge\_kern — allocate new edge structure in the Linux kernel context

**Synopsis**

```
struct canque_edge_t * canque_new_edge_kern (int slotsnr);
```

**Arguments***slotsnr*

required number of slots in the newly allocated edge structure

**Return Value**

Returns pointer to allocated slot structure or NULL if there is not enough memory to process operation.

**canqueue\_ends\_dispose\_kern****Name**

canqueue\_ends\_dispose\_kern — finalizing of the ends structure for Linux kernel clients

**Synopsis**

```
int canqueue_ends_dispose_kern (struct canque_ends_t * qends, int sync);
```

**Arguments***qends*

pointer to ends structure

*sync*

flag indicating, that user wants to wait for processing of all remaining messages

**Return Value**

Function should be designed such way to not fail.

## 1.6.6. CAN Queues RT-Linux Specific Functions

### canqueue\_rtl2lin\_check\_and\_pend

#### Name

`canqueue_rtl2lin_check_and_pend` — postpones edge notification if called from RT-Linux

#### Synopsis

```
int canqueue_rtl2lin_check_and_pend (struct canque_ends_t * qends, struct canque_edge_t *
qedge, int what);
```

#### Arguments

*qends*

notification target ends

*qedge*

edge delivering notification

*what*

notification type

#### Return Value

if called from Linux context, returns 0 and lefts notification processing on caller responsibility. If called from RT-Linux contexts, schedules postponed event delivery and returns 1

### canque\_get\_inslot4id\_wait\_rtl

#### Name

`canque_get_inslot4id_wait_rtl` — find or wait for best outgoing edge and slot for given ID

#### Synopsis

```
int canque_get_inslot4id_wait_rtl (struct canque_ends_t * qends, struct canque_edge_t **
qedgep, struct canque_slot_t ** slotp, int cmd, unsigned long id, int prio);
```

#### Arguments

*qends*

ends structure belonging to calling communication object

*qedgep*

place to store pointer to found edge

*slotp*

place to store pointer to allocated slot

*cmd*

command type for slot

*id*

communication ID of message to send into edge

*prio*

optional priority of message

### Description

Same as `canque_get_inslot4id`, except, that it waits for free slot in case, that queue is full. Function is specific for Linux userspace clients.

### Return Value

If there is no usable edge negative value is returned.

## canque\_get\_outslot\_wait\_rtl

### Name

`canque_get_outslot_wait_rtl` — receive or wait for ready slot for given ends

### Synopsis

```
int canque_get_outslot_wait_rtl (struct canque_ends_t * qends, struct canque_edge_t **
qedgep, struct canque_slot_t ** slotp);
```

### Arguments

*qends*

ends structure belonging to calling communication object

*qedgep*

place to store pointer to found edge

*slotp*

place to store pointer to received slot

### Description

The same as `canque_test_outslot`, except it waits in the case, that there is no ready slot for given ends. Function is specific for Linux userspace clients.

### Return Value

Negative value informs, that there is no ready output slot for given ends. Positive value is equal to the command slot has been allocated by the input side.

## canque\_sync\_wait\_rtl

### Name

`canque_sync_wait_rtl` — wait for all slots processing

### Synopsis

```
int canque_sync_wait_rtl (struct canque_ends_t * qends, struct canque_edge_t * qedge);
```

**Arguments***qends*

ends structure belonging to calling communication object

*qedge*

pointer to edge

**Description**

Functions waits for ends transition into empty state.

**Return Value**

Positive value indicates, that edge empty state has been reached. Negative or zero value informs about interrupted wait or other problem.

## canque\_fifo\_init\_rtl

**Name**

canque\_fifo\_init\_rtl — initialize one CAN FIFO

**Synopsis**

```
int canque_fifo_init_rtl (struct canque_fifo_t * fifo, int slotsnr);
```

**Arguments***fifo*

pointer to the FIFO structure

*slotsnr*

number of requested slots

**Return Value**

The negative value indicates, that there is no memory to allocate space for the requested number of the slots.

## canque\_fifo\_done\_rtl

**Name**

canque\_fifo\_done\_rtl — frees slots allocated for CAN FIFO

**Synopsis**

```
int canque_fifo_done_rtl (struct canque_fifo_t * fifo);
```

**Arguments***fifo*

pointer to the FIFO structure

## canque\_new\_edge\_rtl

### Name

`canque_new_edge_rtl` — allocate new edge structure in the RT-Linux context

### Synopsis

```
struct canque_edge_t * canque_new_edge_rtl (int slotsnr);
```

### Arguments

*slotsnr*

required number of slots in the newly allocated edge structure

### Return Value

Returns pointer to allocated slot structure or NULL if there is not enough memory to process operation.

## canqueue\_notify\_rtl

### Name

`canqueue_notify_rtl` — notification callback handler for Linux userspace clients

### Synopsis

```
void canqueue_notify_rtl (struct canque_ends_t * qends, struct canque_edge_t * qedge, int what);
```

### Arguments

*qends*

pointer to the callback side ends structure

*qedge*

edge which invoked notification

*what*

notification type

## canqueue\_ends\_init\_rtl

### Name

`canqueue_ends_init_rtl` — RT-Linux clients specific ends initialization

### Synopsis

```
int canqueue_ends_init_rtl (struct canque_ends_t * qends);
```

**Arguments***qends*

pointer to the callback side ends structure

**canqueue\_ends\_dispose\_rtl****Name**

canqueue\_ends\_dispose\_rtl — finalizing of the ends structure for Linux kernel clients

**Synopsis**

```
int canqueue_ends_dispose_rtl (struct canque_ends_t * qends, int sync);
```

**Arguments***qends*

pointer to ends structure

*sync*

flag indicating, that user wants to wait for processing of all remaining messages

**Return Value**

Function should be designed such way to not fail.

**canqueue\_rtl\_initialize****Name**

canqueue\_rtl\_initialize — initialization of global RT-Linux specific features

**Synopsis**

```
void canqueue_rtl_initialize ( void);
```

**Arguments***void*

no arguments

**canqueue\_rtl\_done****Name**

canqueue\_rtl\_done — finalization of global RT-Linux specific features

**Synopsis**

```
void canqueue_rtl_done ( void);
```

**Arguments**

*void*

no arguments

**1.6.7. CAN Queues CAN Chips Specific Functions****canqueue\_notify\_chip****Name**

`canqueue_notify_chip` — notification callback handler for CAN chips ends of queues

**Synopsis**

```
void canqueue_notify_chip (struct canque_ends_t * qends, struct canque_edge_t * qedge, int what);
```

**Arguments**

*qends*

pointer to the callback side ends structure

*qedge*

edge which invoked notification

*what*

notification type

**Description**

This function has to deal with more possible cases. It can be called from the kernel or interrupt context for Linux only compilation of driver. The function can be called from kernel context or RT-Linux thread context for mixed mode Linux/RT-Linux compilation.

**canqueue\_ends\_init\_chip****Name**

`canqueue_ends_init_chip` — CAN chip specific ends initialization

**Synopsis**

```
int canqueue_ends_init_chip (struct canque_ends_t * qends, struct canchip_t * chip, struct msgobj_t * obj);
```

**Arguments**

*qends*

pointer to the ends structure



*chip*

pointer to the corresponding CAN chip structure

*obj*

pointer to the corresponding message object structure

## canqueue\_ends\_done\_chip

### Name

canqueue\_ends\_done\_chip — finalizing of the ends structure for CAN chips

### Synopsis

```
int canqueue_ends_done_chip (struct canque_ends_t * qends);
```

### Arguments

*qends*

pointer to ends structure

### Return Value

Function should be designed such way to not fail.

## 1.6.8. CAN Boards and Chip Setup specific Functions

### can\_checked\_malloc

#### Name

can\_checked\_malloc — memory allocation with registering of requested blocks

#### Synopsis

```
void * can_checked_malloc (size_t size);
```

#### Arguments

*size*

size of the requested block

#### Description

The function is used in the driver initialization phase to catch possible memory leaks for future driver finalization or case, that driver initialization fail.

#### Return Value

pointer to the allocated memory or NULL in the case of fail

## can\_checked\_free

### Name

`can_checked_free` — free memory allocated by `can_checked_malloc`

### Synopsis

```
int can_checked_free (void * address_p);
```

### Arguments

*address\_p*

pointer to the memory block

## can\_del\_mem\_list

### Name

`can_del_mem_list` — check for stale memory allocations at driver finalization

### Synopsis

```
int can_del_mem_list ( void);
```

### Arguments

*void*

no arguments

### Description

Checks, if there are still some memory blocks allocated and releases memory occupied by such blocks back to the system

## can\_request\_io\_region

### Name

`can_request_io_region` — request IO space region

### Synopsis

```
int can_request_io_region (unsigned long start, unsigned long n, const char * name);
```

### Arguments

*start*

the first IO port address

*n*

number of the consecutive IO port addresses

*name*

name/label for the requested region

### Description

The function hides system specific implementation of the feature.

### Return Value

returns positive value (1) in the case, that region could be reserved for the driver. Returns zero (0) if there is collision with other driver or region cannot be taken for some other reason.

## can\_release\_io\_region

### Name

`can_release_io_region` — release IO space region

### Synopsis

```
void can_release_io_region (unsigned long start, unsigned long n);
```

### Arguments

*start*

the first IO port address

*n*

number of the consecutive IO port addresses

## can\_request\_mem\_region

### Name

`can_request_mem_region` — request memory space region

### Synopsis

```
int can_request_mem_region (unsigned long start, unsigned long n, const char * name);
```

### Arguments

*start*

the first memory port physical address

*n*

number of the consecutive memory port addresses

*name*

name/label for the requested region

### Description

The function hides system specific implementation of the feature.

**Return Value**

returns positive value (1) in the case, that region could be reserved for the driver. Returns zero (0) if there is collision with other driver or region cannot be taken for some other reason.

**can\_release\_mem\_region****Name**

`can_release_mem_region` — release memory space region

**Synopsis**

```
void can_release_mem_region (unsigned long start, unsigned long n);
```

**Arguments**

*start*

the first memory port physical address

*n*

number of the consecutive memory port addresses

**can\_base\_addr\_fixup****Name**

`can_base_addr_fixup` — relocates board physical memory addresses to the CPU accessible ones

**Synopsis**

```
int can_base_addr_fixup (struct candevice_t * candev, unsigned long new_base);
```

**Arguments**

*candev*

pointer to the previously filled device/board, chips and message objects structures

*new\_base*

*candev* new base address

**Description**

This function adapts base addresses of all structures of one board to the new board base address. It is required for translation between physical and virtual address mappings. This function is prepared to simplify board specific `xxx_request_io` function for memory mapped devices.

## can\_check\_dev\_taken

### Name

`can_check_dev_taken` — checks if bus device description is already taken by driver

### Synopsis

```
int can_check_dev_taken (void * anydev);
```

### Arguments

*anydev*

pointer to bus specific Linux device description

### Returns

Returns 1 if device is already used by LinCAN driver, 0 otherwise.

## register\_obj\_struct

### Name

`register_obj_struct` — registers message object into global array

### Synopsis

```
int register_obj_struct (struct msgobj_t * obj, int minorbase);
```

### Arguments

*obj*

the initialized message object being registered

*minorbase*

wanted minor number, if (-1) automatically selected

### Return Value

returns negative number in the case of fail

## register\_chip\_struct

### Name

`register_chip_struct` — registers chip into global array

### Synopsis

```
int register_chip_struct (struct canchip_t * chip, int minorbase);
```

**Arguments***chip*

the initialized chip structure being registered

*minorbase*

wanted minor number base, if (-1) automatically selected

**Return Value**

returns negative number in the case of fail

## init\_hw\_struct

**Name**`init_hw_struct` — initializes driver hardware description structures**Synopsis**

```
int init_hw_struct ( void );
```

**Arguments***void*

no arguments

**Description**The function `init_hw_struct` is used to initialize the hardware structure.**Return Value**

returns negative number in the case of fail

## init\_device\_struct

**Name**`init_device_struct` — initializes single CAN device/board**Synopsis**

```
int init_device_struct ( int card, int * chan_param_idx_p, int * irq_param_idx_p );
```

**Arguments***card*index into `hardware_p` HW description*chan\_param\_idx\_p*

pointer to the index into arrays of the CAN channel parameters

*irq\_param\_idx\_p*

pointer to the index into arrays of the per CAN channel IRQ parameters

## Description

The function builds representation of the one board from parameters provided

### in the module parameters arrays

*hw*[card] .. hardware type, *io*[card] .. base IO address, *baudrate*[chan\_param\_idx] .. per channel baudrate, *minor*[chan\_param\_idx] .. optional specification of requested channel minor base, *irq*[irq\_param\_idx] .. one or more board/chips IRQ parameters. The indexes are advanced after consumed parameters if the registration is successful.

The hardware specific operations of the device/board are initialized by call to `init_hwspecops` function. Then board data are initialized by board specific `init_hw_data` function. Then chips and objects representation is build by `init_chip_struct` function. If all above steps are successful, chips and message objects are registered into global arrays.

## Return Value

returns negative number in the case of fail

# init\_chip\_struct

## Name

`init_chip_struct` — initializes one CAN chip structure

## Synopsis

```
int init_chip_struct (struct candevice_t * candev, int chipnr, int irq, long baudrate);
```

## Arguments

*candev*

pointer to the corresponding CAN device/board

*chipnr*

index of the chip in the corresponding device/board structure

*irq*

chip IRQ number or (-1) if not appropriate

*baudrate*

baudrate in the units of 1Bd

## Description

Chip structure is allocated and chip specific operations are filled by call to board specific `init_chip_data` which calls chip specific `fill_chipspecops`. The message objects are generated by calls to `init_obj_struct` function.

## Return Value

returns negative number in the case of fail

## init\_obj\_struct

### Name

`init_obj_struct` — initializes one CAN message object structure

### Synopsis

```
int init_obj_struct (struct candevice_t * candev, struct canchip_t * hostchip, int objnr);
```

### Arguments

*candev*

pointer to the corresponding CAN device/board

*hostchip*

pointer to the chip containing this object

*objnr*

index of the builded object in the chip structure

### Description

The function initializes message object structure and allocates and initializes CAN queue chip ends structure.

### Return Value

returns negative number in the case of fail

## init\_hwspecops

### Name

`init_hwspecops` — finds and initializes board/device specific operations

### Synopsis

```
int init_hwspecops (struct candevice_t * candev, int * irqnum_p);
```

### Arguments

*candev*

pointer to the corresponding CAN device/board

*irqnum\_p*

optional pointer to the number of interrupts required by board

### Description

The function searches board *hwname* in the list of supported boards types. The board type specific `board_register` function is used to initialize *hwspecops* operations.

### Return Value

returns negative number in the case of fail



## can\_default\_irq\_dispatch

### Name

`can_default_irq_dispatch` — the first level interrupt dispatch handler

### Synopsis

```
can_irqreturn_t can_default_irq_dispatch (int irq, void * dev_id, struct pt_regs * regs);
```

### Arguments

*irq*

interrupt vector number, this value is system specific

*dev\_id*

driver private pointer registered at time of `request_irq` call. The CAN driver uses this pointer to store relationship of interrupt to chip state structure - `struct canchip_t`

*regs*

system dependent value pointing to registers stored in exception frame

### File

`src/setup.c`

## can\_chip\_setup\_irq

### Name

`can_chip_setup_irq` — attaches chip to the system interrupt processing

### Synopsis

```
int can_chip_setup_irq (struct canchip_t * chip);
```

### Arguments

*chip*

pointer to CAN chip structure

### Return Value

returns negative number in the case of fail

## can\_chip\_free\_irq

### Name

`can_chip_free_irq` — unregisters chip interrupt handler from the system

**Synopsis**

```
void can_chip_free_irq (struct canchip_t * chip);
```

**Arguments**

*chip*

pointer to CAN chip structure

**1.6.9. CAN Boards and Chip Finalization Functions****msgobj\_done****Name**

msgobj\_done — destroys one CAN message object

**Synopsis**

```
void msgobj_done (struct msgobj_t * obj);
```

**Arguments**

*obj*

pointer to CAN message object structure

**canchip\_done****Name**

canchip\_done — destroys one CAN chip representation

**Synopsis**

```
void canchip_done (struct canchip_t * chip);
```

**Arguments**

*chip*

pointer to CAN chip structure

**candevicedone****Name**

candevicedone — destroys representation of one CAN device/board

## Synopsis

```
void candevice_done (struct candevice_t * candev);
```

## Arguments

*candev*

pointer to CAN device/board structure

# canhardware\_done

## Name

canhardware\_done — destroys representation of all CAN devices/boards

## Synopsis

```
void canhardware_done (struct canhardware_t * canhw);
```

## Arguments

*canhw*

pointer to the root of all CAN hardware representation

## 1.7. LinCAN Usage Information

### 1.7.1. Installation Prerequisites

The next basic conditions are necessary for the LinCAN driver usage

- some of supported types of CAN interface boards (high or low speed). Not required for *virtual* board setup.
- cables and at least one device compatible with the board or the second computer with an another CAN interface board. Not required for *virtual* board setup. Even more clients can communicate each with another if *process local* is enabled for real chip driver.
- working Linux system with any recent 2.6.x, 2.4.x or 2.2.x kernel (successfully tested on 2.4.18, 2.4.22, 2.2.19, 2.2.20, 2.2.22, 2.6.0 kernels) or working setup for kernel cross-compilation
- installed native and or target specific development tools (GCC and binutils) and pre-configured kernel sources corresponding to the running kernel or intended target for cross-compilation

Every non-archaic Linux distribution should provide good starting point for the LinCAN driver installation.

If mixed mode compilation for Linux/RT-Linux is required, additional conditions has to be fulfilled:

- RT-Linux version 3.2 or higher is required and RT-Linux enabled Linux kernel sources and configuration has to be prepared. The recommended is use of OCERA Linux/RT-Linux release (<http://www.ocera.org>).

- RT-Linux real-time `malloc` support. It is already included in the OCERA release. It can be downloaded from OCERA web site for older RT-Linux releases as well (<http://www.ocera.org/download/components/index.html>).

The RT-Linux specific Makefiles infrastructure is not distributed with the current standard LinCAN distribution yet. Please, download full OCERA-CAN package or retrieve sources from CVS by next command:

```
cvsv -d:pserver:anonymous@cvs.ocera.sourceforge.net:/cvsroot/ocera login
cvsv -z3 -d:pserver:anonymous@cvs.ocera.sourceforge.net:/cvsroot/ocera co ocera/components/comm/can
```

## 1.7.2. Quick Installation Instructions

Change current directory into the LinCAN driver source root directory

```
cd lincan-dir
```

invoke make utility. Just type '**make**' at the command line and driver should compile without errors

```
make
```

If there is problem with compilation, look at first lines produced by 'make' command or store make output in file. More about possible problems and more complex compilation examples is in the next subsection.

Install built LinCAN driver object file (`can.o`) into Linux kernel loadable module directory (`/lib/modules/2.x.y/kernel/drivers/char`). This and next commands needs root privileges to proceed successfully.

```
make install
```

If device filesystem (`devfs`) is not used on the computer, device nodes have to be created manually.

```
mkknod -m666 /dev/can0 c 91 0
mkknod -m666 /dev/can1 c 91 1
...
mkknod -m666 /dev/can7 c 97 7
```

The parameters, IO address and interrupt line of inserted CAN interface card need to be determined and configured. The manual driver load can be invoked from the command line with parameters similar to example below

```
insmod can.o hw=pip5 irq=4 io=0x8000
```

This commands loads module with selected one card support for PIP5 board type with IO port base address `0x8000` and interrupt line 4. The full description of module parameters is in the next subsection. If module starts correctly utilities from `utils` subdirectory can be used to test CAN message interchange with device or another computer. The parameters should be written into file `/etc/modules.conf` for subsequent module startup by `modprobe` command.

Line added to file `/etc/modules.conf` follows

```
options can hw=pip5 irq=4 io=0x8000
```

The module dependencies should be updated by command

```
depmod -a
```

The driver can be now stopped and started by simple **modprobe** command

```
modprobe -r can modprobe can
```

### 1.7.3. Installation instructions

The LinCAN make solutions tries to fully automate native kernel out of tree module compilation. Make system recurses through kernel `Makefile` to achieve selection of right preprocessor, compiler and linker directives. The description of make targets after make invocation in driver top directory follows

`lincan-drv/Makefile` (all)

LinCAN driver top makefile

`lincan-drv/src/Makefile` (default or all -> `make_this_module`)

Needs to resolve target system kernel sources location. This can be selected manually by uncommenting the `Makefile` definition **`KERNEL_LOCATION=/usr/src/linux-2.2.22`**. The default behavior is to find the running kernel version and look for path to sources of found kernel version in `/lib/modules/2.x.y/build` directory. If no such directory exists, older version of kernel is assumed and makefile tries the `/usr/src/linux` directory.

`lib/modules/2.x.y/build/Makefile` `SUBDIRS=.../lincan-drv/src` (modules)

The kernel supplied `Makefile` is responsible for defining of right defines for pre-processor, compiler and linker. If the Linux kernel is cross-compiled, Linux kernel sources root `Makefile` needs be edited before Linux kernel compilation. The variable `CROSS_COMPILE` should contain development tool-chain prefix, for example **`arm-linux-`**. The Linux kernel make process recurses back into LinCAN driver `src/Makefile`.

`lincan-drv/src/Makefile` (modules)

This pass starts real LinCAN driver build actions.

If there is problem with automatic build process, the next commands can help to diagnose the problem.

```
make clean make >make.out 2>&1
```

The first lines of file `make.out` indicates auto-detected values and can help with resolving of possible problems.

```
make -C src default ;
make -C utils default ;
make[1]: /scripts/pathdown.sh: Command not found
make[1]: Entering directory `/usr/src/can-0.7.1-pi3.4/src'
echo >.supported_cards.h echo \#define ENABLE_CARD_pip 1 >>.supported_cards.h ; ...
Linux kernel version 2.4.19
echo Linux kernel sources /lib/modules/2.4.19/build
Linux kernel sources /lib/modules/2.4.19/build
echo Module target can.o
Module target can.o
echo Module objects proc.o pip.o pccan.o smartcan.o nsi.o ...
make[2]: Entering directory `/usr/src/linux-2.4.19'
```

The driver size can be decreased by restricting of number of supported types of boards. This can be done by editing of definition for `SUPPORTED_CARDS` variable.

There is complete description of driver supported parameters.

```
insmod can.o hw='your hardware' irq='irq number' io='io address' <more options>
```

The more values can be specified for `hw`, `irq` and `io` parameters if more cards is used. Values are separated by commas in such case. The `hw` argument can be one of:

- `pip5`, for the PIP5 computer by MPL AG
- `pip6`, for the PIP6 computer by MPL AG
- `pip7`, for the PIP7 computer by MPL AG
- `pip8`, for the PIP8 computer by MPL AG
- `pccan-q`, for the PCcan-Q ISA card by KVASER
- `pccan-f`, for the PCcan-F ISA card by KVASER

- `pccan-s`, for the PCcan-S ISA card by KVASER
- `pccan-d`, for the PCcan-D ISA card by KVASER
- `pcican-q`, for the PCican-Q PCI card by KVASER (4x SJA1000)
- `pcican-d`, for the PCican-D PCI card by KVASER (2x SJA1000)
- `pcican-s`, for the PCican-S PCI card by KVASER (1x SJA1000)
- `nsican`, for the CAN104 PC/104 card by NSI
- `cc104`, for the CAN104 PC/104 card by Contemporary Controls
- `aim104`, for the AIM104CAN PC/104 card by Arcom Control Systems
- `pc-i03`, for the PC-I03 ISA card by IXXAT
- `pcm3680`, for the PCM-3680 PC/104 card by Advantech
- `m437`, for the M436 PC/104 card by SECO
- `bfadcan` for sja1000 CAN embedded card made by BFAD GmbH
- `pikronisa` for ISA memory mapped sja1000 CAN card made by PiKRON Ltd.
- `template`, for yet unsupported hardware (you need to edit `src/template.c`)
- `virtual`, virtual/dummy board support for testing of driver and software devices and applications

The lists of values for board hardware type (*hw*) and board base IO address (*io*) parameters have to contain same number of values. If the value of *io* has no meaning for specified hardware type (`virtual` or PCI board), it has to be substituted by 0.

The number of required *irq* values per board is variable. The `virtual` and PCI board demands no value, most of the other boards requires one *irq* value per each chip/channel.

The `<more options>` can be one or more of:

- `major=<nr>`, major specifies the major number of the driver. Default value is 91
- `minor=<nr>`, you can specify which base minor number the driver should use for each can channel/chip. Consecutive numbers are taken in the case, that chip supports more communication objects. The values for channels are separated by comas
- `extended=[1/0]`, enables automatic switching to extended format if ID>2047, selects extended frames reception for i82527
- `pelican=[1/0]`, unused parameter, PeliCAN used by default for sja1000p chips now
- `baudrate=<nr>`, baudrate for each channel in step of 1kBd
- `clock_freq=<nr>`, the frequency of the CAN quartz for BfaD board
- `stdmask=<nr>`, default standard mask for some (i82527) chips
- `extmask=<nr>`, default extended mask for some (i82527) chips
- `mo15mask=<nr>`, sets the mask for message object 15 (i82527 only)
- `processlocal=<nr>`, select post-processing/loop-back of transmitted messages
  - 0 .. disabled
  - 1 .. can be enabled by application by FIFO filter setup
  - 2 .. enabled by default
- `can_rtl_priority=<nr>`, select priority of chip worker thread for driver compiled with RT-Linux support

Actual list of supported CAN module parameters and short description can be reached by invocation of the command

```
modinfo can
```

.

## 1.7.4. Simple Utilities

The simple test utilities can be found in the `utils` subdirectory of the LinCAN driver source subtree. These utilities can be used as base for user programs directly communicating with the LinCAN driver. We do not suggest to build applications directly dependent on the driver operating system specific interface. We suggest to use the VCA API library for communication with the driver which brings higher level of system interface abstraction and ensures compatibility with the future versions of LinCAN driver and RT-Linux driver clone versions. The actual low level RT-Linux API to LinCAN driver closely matches `open/close`, `read/write` and `ioctl` interface. Only `select` cannot be provided directly by RT-Linux API.

The basic utilities provided with LinCAN driver are:

`rxtx`

the simple utility to receive or send message which guides user through operation, the message type, the message ID and the message contents by simple prompts

`send`

even more simplistic message sending program

`readburst`

the utility for continuous messages reception and printing of the message contents. This utility can be used as an example of the `select` system call usage.

`sendburst`

the periodic message generator. Each message is filled by the constant pattern and the message sequence number. This utility can be used for throughput and message drops tests.

`can-proxy`

the simple TCP/IP to CAN proxy. The proxy receives simple commands from IP datagrams and processes command sending and state manipulations. Received messages are packed into IP datagrams and send back to the client.

## readburst

### Name

`readburst` — the utility for continuous messages reception and printing of the message contents

### Synopsis

```
readburst [-d candev] [-m mask] [-i id] [-f flags] [-w sec] [-p prefix] [-V] [-h]
```

### Description

The utility **readburst** can be used to monitor or log CAN messages received by one CAN message communication object. Even outgoing transmitted messages can be logged if *process local* is globally or explicitly enabled.

### OPTIONS

`-d --device`

This options selects **readburst** target CAN device. If the option is not specified, default device name `/dev/can0` is used.

`-m --mask`

This option enables to change default mask accepting all messages to the specified CAN message id mask. The hexadecimal value has to be prefixed by prefix `0x`. Numeric value without any prefix is considered as decimal one.

`-i --id`

This option specifies CAN message identifier in the acceptance mask. The accepted CAN messages are then printed by **readburst** command. Only bits corresponding to the non-zero bits of acceptance mask are compared. Hexadecimal value has to be prefixed by any prefix `0x`. Numeric value without prefix is considered as decimal one.

`-f --flags`

Specification of modifiers flags of reception CAN queue. Hexadecimal value has to be prefixed by prefix `0x`. Numeric value without any prefix is considered as decimal one.

Bit name	Bit number	Mask	Description
MSG_RTR	0	0x1	Receive RTR or non-RTR messages
MSG_EXT	2	0x4	Receive extended/standard messages
MSG_LOCAL	3	0x8	Receive local or external messages
MSG_RTR_MASK	8	0x100	Take care about MSG_RTR bit else RTR and non-RTR messages are accepted
MSG_EXT_MASK	10	0x400	Take care about MSG_EXT bit else extended and standard messages are accepted
MSG_LOCAL_MASK	11	0x800	Take care about MSG_LOCAL bit else both local and external messages are accepted
MSG_PROCESSLOCAL	9	0x200	Enable processing of the local messages if not explicitly enabled globally or disabled globally.

`-w --wait`

The number of second the **readburst** waits in the select call.

`-p --prefix`

The *prefix* string can be added at beginning of each printed line. The format specifies `%s` could be used to add device name into prefix.

`-V --version`

Print command version.

`-h --help`

Print command usage information

## sendburst

### Name

**sendburst** — the utility for continuous messages reception and printing of the message contents

### Synopsis

**sendburst** `[-d candev] [-i id] [-s] [-f flags] [-w sec] [-b blocksize] [-c count] [-p prefix] [-V] [-h]`



## Description

The utility **sendburst** generates blocks of messages with specified CAN message ID. The burst block of *blocksize* messages is generated and pushed into can device. If *count* is specified, the command stops and exits after *count* of message blocks send.

## OPTIONS

-d --device

This options selects **sendburst** target CAN device. If the option is not specified, default device name `/dev/can0` is used.

-i --id

This option specifies which CAN message ID is used for transmitted blocks of messages. Hexadecimal value has to be prefixed by prefix `0x`. Numeric value without any prefix is considered as decimal one.

-f --flags

Specification of modifiers flags of the send message. Hexadecimal value has to be prefixed by prefix `0x`. Numeric value without prefix is considered as decimal one.

Bit name	Bit number	Mask	Description
MSG_RTR	0	0x1	Generate RTR messages if specified
MSG_EXT	2	0x4	Use extended messages identifiers if specified

-s --sync

Open device in the synchronous mode. The `send` and `close` blocks until message is sent to to CAN bus.

-w --wait

The number of second the **sendburst** waits between sending burst blocks.

-b --block

The number of messages in the one burst block. Default value is 10.

-c --count

The number of block send after command invocation. If specified, command finishes and returns after specified number of blocks. If unspecified, the **sendburst** runs for infinite time.

-p --prefix

The *prefix* string can is added at beginning of each printed line. The format specifies `%s` could be used to add device name into prefix.

-V --version

Print command version.

-h --help

Print command usage information