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# **Linux Networking Documentation**

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**The kernel development community**

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## Z8530 PROGRAMMING GUIDE

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### 1.1 Introduction

The Z85x30 family synchronous/asynchronous controller chips are used on a large number of cheap network interface cards. The kernel provides a core interface layer that is designed to make it easy to provide WAN services using this chip.

The current driver only support synchronous operation. Merging the asynchronous driver support into this code to allow any Z85x30 device to be used as both a tty interface and as a synchronous controller is a project for Linux post the 2.4 release

### 1.2 Driver Modes

The Z85230 driver layer can drive Z8530, Z85C30 and Z85230 devices in three different modes. Each mode can be applied to an individual channel on the chip (each chip has two channels).

The PIO synchronous mode supports the most common Z8530 wiring. Here the chip is interface to the I/O and interrupt facilities of the host machine but not to the DMA subsystem. When running PIO the Z8530 has extremely tight timing requirements. Doing high speeds, even with a Z85230 will be tricky. Typically you should expect to achieve at best 9600 baud with a Z8C530 and 64Kbits with a Z85230.

The DMA mode supports the chip when it is configured to use dual DMA channels on an ISA bus. The better cards tend to support this mode of operation for a single channel. With DMA running the Z85230 tops out when it starts to hit ISA DMA constraints at about 512Kbits. It is worth noting here that many PC machines hang or crash when the chip is driven fast enough to hold the ISA bus solid.

Transmit DMA mode uses a single DMA channel. The DMA channel is used for transmission as the transmit FIFO is smaller than the receive FIFO. it gives better performance than pure PIO mode but is nowhere near as ideal as pure DMA mode.

### 1.3 Using the Z85230 driver

The Z85230 driver provides the back end interface to your board. To configure a Z8530 interface you need to detect the board and to identify its ports and interrupt resources. It is also your problem to verify the resources are available.

Having identified the chip you need to fill in a struct `z8530_dev`, which describes each chip. This object must exist until you finally shutdown the board. Firstly zero the active field. This ensures nothing goes off without you intending it. The `irq` field should be set to the interrupt number of the chip. (Each chip has a single interrupt source rather than each channel). You are responsible for allocating the interrupt line. The interrupt handler should be set to `z8530_interrupt()`. The device id should be set to the

`z8530_dev` structure pointer. Whether the interrupt can be shared or not is board dependent, and up to you to initialise.

The structure holds two channel structures. Initialise `chanA.ctrlrio` and `chanA.dataio` with the address of the control and data ports. You can or this with `Z8530_PORT_SLEEP` to indicate your interface needs the 5uS delay for chip settling done in software. The `PORT_SLEEP` option is architecture specific. Other flags may become available on future platforms, eg for MMIO. Initialise the `chanA.irqs` to `&z8530_nop` to start the chip up as disabled and discarding interrupt events. This ensures that stray interrupts will be mopped up and not hang the bus. Set `chanA.dev` to point to the device structure itself. The private and name field you may use as you wish. The private field is unused by the Z85230 layer. The name is used for error reporting and it may thus make sense to make it match the network name.

Repeat the same operation with the B channel if your chip has both channels wired to something useful. This isn't always the case. If it is not wired then the I/O values do not matter, but you must initialise `chanB.dev`.

If your board has DMA facilities then initialise the `txdma` and `rxdma` fields for the relevant channels. You must also allocate the ISA DMA channels and do any necessary board level initialisation to configure them. The low level driver will do the Z8530 and DMA controller programming but not board specific magic.

Having initialised the device you can then call `z8530_init()`. This will probe the chip and reset it into a known state. An identification sequence is then run to identify the chip type. If the checks fail to pass the function returns a non zero error code. Typically this indicates that the port given is not valid. After this call the type field of the `z8530_dev` structure is initialised to either Z8530, Z85C30 or Z85230 according to the chip found.

Once you have called `z8530_init` you can also make use of the utility function `z8530_describe()`. This provides a consistent reporting format for the Z8530 devices, and allows all the drivers to provide consistent reporting.

## 1.4 Attaching Network Interfaces

If you wish to use the network interface facilities of the driver, then you need to attach a network device to each channel that is present and in use. In addition to use the generic HDLC you need to follow some additional plumbing rules. They may seem complex but a look at the example `hostess_sv11` driver should reassure you.

The network device used for each channel should be pointed to by the `netdevice` field of each channel. The `hdlc->priv` field of the network device points to your private data - you will need to be able to find your private data from this.

The way most drivers approach this particular problem is to create a structure holding the Z8530 device definition and put that into the private field of the network device. The network device fields of the channels then point back to the network devices.

If you wish to use the generic HDLC then you need to register the HDLC device.

Before you register your network device you will also need to provide suitable handlers for most of the network device callbacks. See the network device documentation for more details on this.

## 1.5 Configuring And Activating The Port

The Z85230 driver provides helper functions and tables to load the port registers on the Z8530 chips. When programming the register settings for a channel be aware that the documentation recommends initialisation orders. Strange things happen when these are not followed.

`z8530_channel_load()` takes an array of pairs of initialisation values in an array of `u8` type. The first value is the Z8530 register number. Add 16 to indicate the alternate register bank on the later chips. The array is terminated by a 255.

The driver provides a pair of public tables. The `z8530_hdlc_kilostream` table is for the UK 'Kilostream' service and also happens to cover most other end host configurations. The `z8530_hdlc_kilostream_85230` table is the same configuration using the enhancements of the 85230 chip. The configuration loaded is standard NRZ encoded synchronous data with HDLC bitstuffing. All of the timing is taken from the other end of the link.

When writing your own tables be aware that the driver internally tracks register values. It may need to reload values. You should therefore be sure to set registers 1-7, 9-11, 14 and 15 in all configurations. Where the register settings depend on DMA selection the driver will update the bits itself when you open or close. Loading a new table with the interface open is not recommended.

There are three standard configurations supported by the core code. In PIO mode the interface is programmed up to use interrupt driven PIO. This places high demands on the host processor to avoid latency. The driver is written to take account of latency issues but it cannot avoid latencies caused by other drivers, notably IDE in PIO mode. Because the drivers allocate buffers you must also prevent MTU changes while the port is open.

Once the port is open it will call the `rx_function` of each channel whenever a completed packet arrived. This is invoked from interrupt context and passes you the channel and a network buffer (struct `sk_buff`) holding the data. The data includes the CRC bytes so most users will want to trim the last two bytes before processing the data. This function is very timing critical. When you wish to simply discard data the support code provides the function `z8530_null_rx()` to discard the data.

To active PIO mode sending and receiving the `z8530_sync_open` is called. This expects to be passed the network device and the channel. Typically this is called from your network device open callback. On a failure a non zero error status is returned. The `z8530_sync_close()` function shuts down a PIO channel. This must be done before the channel is opened again and before the driver shuts down and unloads.

The ideal mode of operation is dual channel DMA mode. Here the kernel driver will configure the board for DMA in both directions. The driver also handles ISA DMA issues such as controller programming and the memory range limit for you. This mode is activated by calling the `z8530_sync_dma_open()` function. On failure a non zero error value is returned. Once this mode is activated it can be shut down by calling the `z8530_sync_dma_close()`. You must call the close function matching the open mode you used.

The final supported mode uses a single DMA channel to drive the transmit side. As the Z85C30 has a larger FIFO on the receive channel this tends to increase the maximum speed a little. This is activated by calling the `z8530_sync_txdma_open`. This returns a non zero error code on failure. The `z8530_sync_txdma_close()` function closes down the Z8530 interface from this mode.

## 1.6 Network Layer Functions

The Z8530 layer provides functions to queue packets for transmission. The driver internally buffers the frame currently being transmitted and one further frame (in order to keep back to back transmission running). Any further buffering is up to the caller.

The function `z8530_queue_xmit()` takes a network buffer in `sk_buff` format and queues it for transmission. The caller must provide the entire packet with the exception of the bitstuffing and CRC. This is normally done by the caller via the generic HDLC interface layer. It returns 0 if the buffer has been queued and non zero values for queue full. If the function accepts the buffer it becomes property of the Z8530 layer and the caller should not free it.

The function `z8530_get_stats()` returns a pointer to an internally maintained per interface statistics block. This provides most of the interface code needed to implement the network layer `get_stats` callback.

## 1.7 Porting The Z8530 Driver

The Z8530 driver is written to be portable. In DMA mode it makes assumptions about the use of ISA DMA. These are probably warranted in most cases as the Z85230 in particular was designed to glue to PC type machines. The PIO mode makes no real assumptions.

Should you need to retarget the Z8530 driver to another architecture the only code that should need changing are the port I/O functions. At the moment these assume PC I/O port accesses. This may not be appropriate for all platforms. Replacing `z8530_read_port()` and `z8530_write_port` is intended to be all that is required to port this driver layer.

## 1.8 Known Bugs And Assumptions

**Interrupt Locking** The locking in the driver is done via the global cli/sti lock. This makes for relatively poor SMP performance. Switching this to use a per device spin lock would probably materially improve performance.

**Occasional Failures** We have reports of occasional failures when run for very long periods of time and the driver starts to receive junk frames. At the moment the cause of this is not clear.

## 1.9 Public Functions Provided

`irqreturn_t z8530_interrupt(int irq, void * dev_id)`  
Handle an interrupt from a Z8530

### Parameters

`int irq` Interrupt number

`void * dev_id` The Z8530 device that is interrupting.

### Description

A Z85[2]30 device has stuck its hand in the air for attention. We scan both the channels on the chip for events and then call the channel specific call backs for each channel that has events. We have to use callback functions because the two channels can be in different modes.

Locking is done for the handlers. Note that locking is done at the chip level (the 5uS delay issue is per chip not per channel). `c->lock` for both channels points to `dev->lock`

`int z8530_sync_open(struct net_device * dev, struct z8530_channel * c)`  
Open a Z8530 channel for PIO

### Parameters

`struct net_device * dev` The network interface we are using

`struct z8530_channel * c` The Z8530 channel to open in synchronous PIO mode

### Description

Switch a Z8530 into synchronous mode without DMA assist. We raise the RTS/DTR and commence network operation.

`int z8530_sync_close(struct net_device * dev, struct z8530_channel * c)`  
Close a PIO Z8530 channel

### Parameters

`struct net_device * dev` Network device to close

`struct z8530_channel * c` Z8530 channel to disassociate and move to idle

### Description

Close down a Z8530 interface and switch its interrupt handlers to discard future events.

`int z8530_sync_dma_open(struct net_device * dev, struct z8530_channel * c)`  
Open a Z8530 for DMA I/O

### Parameters

**struct net\_device \* dev** The network device to attach

**struct z8530\_channel \* c** The Z8530 channel to configure in sync DMA mode.

### Description

Set up a Z85x30 device for synchronous DMA in both directions. Two ISA DMA channels must be available for this to work. We assume ISA DMA driven I/O and PC limits on access.

int **z8530\_sync\_dma\_close**(struct net\_device \* *dev*, struct z8530\_channel \* *c*)  
Close down DMA I/O

### Parameters

**struct net\_device \* dev** Network device to detach

**struct z8530\_channel \* c** Z8530 channel to move into discard mode

### Description

Shut down a DMA mode synchronous interface. Halt the DMA, and free the buffers.

int **z8530\_sync\_txdma\_open**(struct net\_device \* *dev*, struct z8530\_channel \* *c*)  
Open a Z8530 for TX driven DMA

### Parameters

**struct net\_device \* dev** The network device to attach

**struct z8530\_channel \* c** The Z8530 channel to configure in sync DMA mode.

### Description

Set up a Z85x30 device for synchronous DMA transmission. One ISA DMA channel must be available for this to work. The receive side is run in PIO mode, but then it has the bigger FIFO.

int **z8530\_sync\_txdma\_close**(struct net\_device \* *dev*, struct z8530\_channel \* *c*)  
Close down a TX driven DMA channel

### Parameters

**struct net\_device \* dev** Network device to detach

**struct z8530\_channel \* c** Z8530 channel to move into discard mode

### Description

Shut down a DMA/PIO split mode synchronous interface. Halt the DMA, and free the buffers.

void **z8530\_describe**(struct z8530\_dev \* *dev*, char \* *mapping*, unsigned long *io*)  
Uniformly describe a Z8530 port

### Parameters

**struct z8530\_dev \* dev** Z8530 device to describe

**char \* mapping** string holding mapping type (eg "I/O" or "Mem")

**unsigned long io** the port value in question

### Description

Describe a Z8530 in a standard format. We must pass the I/O as the port offset isn't predictable. The main reason for this function is to try and get a common format of report.

int **z8530\_init**(struct z8530\_dev \* *dev*)  
Initialise a Z8530 device

### Parameters

**struct z8530\_dev \* dev** Z8530 device to initialise.

### Description

Configure up a Z8530/Z85C30 or Z85230 chip. We check the device is present, identify the type and then program it to hopefully keep quiet and behave. This matters a lot, a Z8530 in the wrong state will sometimes get into stupid modes generating 10Khz interrupt streams and the like.

We set the interrupt handler up to discard any events, in case we get them during reset or setp.

Return 0 for success, or a negative value indicating the problem in errno form.

int **z8530\_shutdown**(struct z8530\_dev \* dev)  
Shutdown a Z8530 device

#### Parameters

**struct z8530\_dev \* dev** The Z8530 chip to shutdown

#### Description

We set the interrupt handlers to silence any interrupts. We then reset the chip and wait 100uS to be sure the reset completed. Just in case the caller then tries to do stuff.

This is called without the lock held

int **z8530\_channel\_load**(struct z8530\_channel \* c, u8 \* rtable)  
Load channel data

#### Parameters

**struct z8530\_channel \* c** Z8530 channel to configure

**u8 \* rtable** table of register, value pairs FIXME: ioctl to allow user uploaded tables

#### Description

Load a Z8530 channel up from the system data. We use +16 to indicate the "prime" registers. The value 255 terminates the table.

void **z8530\_null\_rx**(struct z8530\_channel \* c, struct sk\_buff \* skb)  
Discard a packet

#### Parameters

**struct z8530\_channel \* c** The channel the packet arrived on

**struct sk\_buff \* skb** The buffer

#### Description

We point the receive handler at this function when idle. Instead of processing the frames we get to throw them away.

netdev\_tx\_t **z8530\_queue\_xmit**(struct z8530\_channel \* c, struct sk\_buff \* skb)  
Queue a packet

#### Parameters

**struct z8530\_channel \* c** The channel to use

**struct sk\_buff \* skb** The packet to kick down the channel

#### Description

Queue a packet for transmission. Because we have rather hard to hit interrupt latencies for the Z85230 per packet even in DMA mode we do the flip to DMA buffer if needed here not in the IRQ.

Called from the network code. The lock is not held at this point.

## 1.10 Internal Functions

int **z8530\_read\_port**(unsigned long *p*)  
Architecture specific interface function

### Parameters

unsigned long *p* port to read

### Description

Provided port access methods. The Control SV11 requires no delays between accesses and uses PC I/O. Some drivers may need a 5uS delay

In the longer term this should become an architecture specific section so that this can become a generic driver interface for all platforms. For now we only handle PC I/O ports with or without the dread 5uS sanity delay.

The caller must hold sufficient locks to avoid violating the horrible 5uS delay rule.

void **z8530\_write\_port**(unsigned long *p*, u8 *d*)  
Architecture specific interface function

### Parameters

unsigned long *p* port to write

u8 *d* value to write

### Description

Write a value to a port with delays if need be. Note that the caller must hold locks to avoid read/writes from other contexts violating the 5uS rule

In the longer term this should become an architecture specific section so that this can become a generic driver interface for all platforms. For now we only handle PC I/O ports with or without the dread 5uS sanity delay.

u8 **read\_zsreg**(struct z8530\_channel \* *c*, u8 *reg*)  
Read a register from a Z85230

### Parameters

struct z8530\_channel \* *c* Z8530 channel to read from (2 per chip)

u8 *reg* Register to read FIXME: Use a spinlock.

Most of the Z8530 registers are indexed off the control registers. A read is done by writing to the control register and reading the register back. The caller must hold the lock

u8 **read\_zsdata**(struct z8530\_channel \* *c*)  
Read the data port of a Z8530 channel

### Parameters

struct z8530\_channel \* *c* The Z8530 channel to read the data port from

### Description

The data port provides fast access to some things. We still have all the 5uS delays to worry about.

void **write\_zsreg**(struct z8530\_channel \* *c*, u8 *reg*, u8 *val*)  
Write to a Z8530 channel register

### Parameters

struct z8530\_channel \* *c* The Z8530 channel

u8 *reg* Register number

**u8 val** Value to write

**Description**

Write a value to an indexed register. The caller must hold the lock to honour the irritating delay rules. We know about register 0 being fast to access.

Assumes `c->lock` is held.

void **write\_zsctrl**(struct z8530\_channel \* c, u8 val)  
Write to a Z8530 control register

**Parameters**

**struct z8530\_channel \* c** The Z8530 channel

**u8 val** Value to write

**Description**

Write directly to the control register on the Z8530

void **write\_zsdata**(struct z8530\_channel \* c, u8 val)  
Write to a Z8530 control register

**Parameters**

**struct z8530\_channel \* c** The Z8530 channel

**u8 val** Value to write

**Description**

Write directly to the data register on the Z8530

void **z8530\_flush\_fifo**(struct z8530\_channel \* c)  
Flush on chip RX FIFO

**Parameters**

**struct z8530\_channel \* c** Channel to flush

**Description**

Flush the receive FIFO. There is no specific option for this, we blindly read bytes and discard them. Reading when there is no data is harmless. The 8530 has a 4 byte FIFO, the 85230 has 8 bytes.

All locking is handled for the caller. On return data may still be present if it arrived during the flush.

void **z8530\_rtsdtr**(struct z8530\_channel \* c, int set)  
Control the outgoing DTS/RTS line

**Parameters**

**struct z8530\_channel \* c** The Z8530 channel to control;

**int set** 1 to set, 0 to clear

**Description**

Sets or clears DTR/RTS on the requested line. All locking is handled by the caller. For now we assume all boards use the actual RTS/DTR on the chip. Apparently one or two don't. We'll scream about them later.

void **z8530\_rx**(struct z8530\_channel \* c)  
Handle a PIO receive event

**Parameters**

**struct z8530\_channel \* c** Z8530 channel to process

**Description**

Receive handler for receiving in PIO mode. This is much like the async one but not quite the same or as complex

### Note

**Its intended that this handler can easily be separated from** the main code to run realtime. That'll be needed for some machines (eg to ever clock 64kbits on a sparc ;)).

The RT\_LOCK macros don't do anything now. Keep the code covered by them as short as possible in all circumstances - clocks cost baud. The interrupt handler is assumed to be atomic w.r.t. to other code - this is true in the RT case too.

We only cover the sync cases for this. If you want 2Mbit async do it yourself but consider medical assistance first. This non DMA synchronous mode is portable code. The DMA mode assumes PCI like ISA DMA

Called with the device lock held

```
void z8530_tx(struct z8530_channel * c)
    Handle a PIO transmit event
```

### Parameters

**struct z8530\_channel \* c** Z8530 channel to process

### Description

Z8530 transmit interrupt handler for the PIO mode. The basic idea is to attempt to keep the FIFO fed. We fill as many bytes in as possible, its quite possible that we won't keep up with the data rate otherwise.

```
void z8530_status(struct z8530_channel * chan)
    Handle a PIO status exception
```

### Parameters

**struct z8530\_channel \* chan** Z8530 channel to process

### Description

A status event occurred in PIO synchronous mode. There are several reasons the chip will bother us here. A transmit underrun means we failed to feed the chip fast enough and just broke a packet. A DCD change is a line up or down.

```
void z8530_dma_rx(struct z8530_channel * chan)
    Handle a DMA RX event
```

### Parameters

**struct z8530\_channel \* chan** Channel to handle

### Description

Non bus mastering DMA interfaces for the Z8x30 devices. This is really pretty PC specific. The DMA mode means that most receive events are handled by the DMA hardware. We get a kick here only if a frame ended.

```
void z8530_dma_tx(struct z8530_channel * chan)
    Handle a DMA TX event
```

### Parameters

**struct z8530\_channel \* chan** The Z8530 channel to handle

### Description

We have received an interrupt while doing DMA transmissions. It shouldn't happen. Scream loudly if it does.

```
void z8530_dma_status(struct z8530_channel * chan)
    Handle a DMA status exception
```

### Parameters

**struct z8530\_channel \* chan** Z8530 channel to process

A status event occurred on the Z8530. We receive these for two reasons when in DMA mode. Firstly if we finished a packet transfer we get one and kick the next packet out. Secondly we may see a DCD change.

void **z8530\_rx\_clear**(struct z8530\_channel \* c)  
Handle RX events from a stopped chip

### Parameters

**struct z8530\_channel \* c** Z8530 channel to shut up

### Description

Receive interrupt vectors for a Z8530 that is in 'parked' mode. For machines with PCI Z85x30 cards, or level triggered interrupts (eg the Macll) we must clear the interrupt cause or die.

void **z8530\_tx\_clear**(struct z8530\_channel \* c)  
Handle TX events from a stopped chip

### Parameters

**struct z8530\_channel \* c** Z8530 channel to shut up

### Description

Transmit interrupt vectors for a Z8530 that is in 'parked' mode. For machines with PCI Z85x30 cards, or level triggered interrupts (eg the Macll) we must clear the interrupt cause or die.

void **z8530\_status\_clear**(struct z8530\_channel \* chan)  
Handle status events from a stopped chip

### Parameters

**struct z8530\_channel \* chan** Z8530 channel to shut up

### Description

Status interrupt vectors for a Z8530 that is in 'parked' mode. For machines with PCI Z85x30 cards, or level triggered interrupts (eg the Macll) we must clear the interrupt cause or die.

void **z8530\_tx\_begin**(struct z8530\_channel \* c)  
Begin packet transmission

### Parameters

**struct z8530\_channel \* c** The Z8530 channel to kick

### Description

This is the speed sensitive side of transmission. If we are called and no buffer is being transmitted we commence the next buffer. If nothing is queued we idle the sync.

### Note

**We are handling this code path in the interrupt path, keep it** fast or bad things will happen.

Called with the lock held.

void **z8530\_tx\_done**(struct z8530\_channel \* c)  
TX complete callback

### Parameters

**struct z8530\_channel \* c** The channel that completed a transmit.

### Description

This is called when we complete a packet send. We wake the queue, start the next packet going and then free the buffer of the existing packet. This code is fairly timing sensitive.

Called with the register lock held.

```
void z8530_rx_done(struct z8530_channel * c)  
    Receive completion callback
```

#### Parameters

**struct z8530\_channel \* c** The channel that completed a receive

#### Description

A new packet is complete. Our goal here is to get back into receive mode as fast as possible. On the Z85230 we could change to using ESCC mode, but on the older chips we have no choice. We flip to the new buffer immediately in DMA mode so that the DMA of the next frame can occur while we are copying the previous buffer to an `sk_buff`

Called with the lock held

```
int spans_boundary(struct sk_buff * skb)  
    Check a packet can be ISA DMA'd
```

#### Parameters

**struct sk\_buff \* skb** The buffer to check

#### Description

Returns true if the buffer cross a DMA boundary on a PC. The poor thing can only DMA within a 64K block not across the edges of it.



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