Zephyr RTOS GPIO driver system

```
#include
#include
const struct device *get_gpio_device(const char *label) {
return device_get_binding(label);
}
```

## Zephyr Device Model

Zephyr uses a device model where hardware peripherals (like GPIOs, UARTs, etc.) are represented as struct device objects. These are registered during system initialization.

## device_get_binding(label)

This function looks up a device by its **label**, which is defined in the **Device Tree** or board configuration files. For example, "GPIO_0" or "GPIOA".

- It returns a pointer to the struct device representing the GPIO controller.
- If the label is incorrect or the device isn't initialized, it returns NULL.

## GPIO Driver Interaction

Once you have the device pointer, you can use it with GPIO driver APIs like:

gpio_pin_configure(dev, pin, GPIO_OUTPUT);

gpio_pin_set(dev, pin, value);

These functions use the device pointer to interact with the actual hardware registers via the GPIO driver.

gpio_setup() → get_gpio_device(label) → device_get_binding(label)

→ DEVICE_DT_DEFINE(...) → gpio_emul_driver (via DEVICE_API)

- **get_gpio_device()** is a helper to fetch the GPIO device.
- It enables your code to be **hardware-agnostic**, relying on labels from the Device Tree.
- Once you have the device, you can **configure pins**, **read/write values**, and **handle interrupts** using Zephyr's GPIO API.

## 1. Device Tree Source (DTS) Path for QEMU x86

```
vi ../../../boards/qemu/x86/qemu_x86.dts
```

```
	gpio0: gpio_sim {
		compatible = "zephyr,gpio-emul";
		gpio-controller;
		#gpio-cells = <2>;
		ngpios = <32>;
		label = "GPIO_0";
	};
```

```
static void gpio_setup(void *fixture){
gpio_dev = get_gpio_device(GPIO_LABEL);
zassert_not_null(gpio_dev, "Failed to get GPIO device");
}
```

- This function is part of a test setup.
- It calls **get_gpio_device(**) with a label like "GPIO_0".
- 
- This wraps device_get_binding(), which looks up a device by its label.

### device_get_binding(label)

- This searches the global device list for a device with a matching label (from the Device Tree).
- If found, it returns a pointer to the struct device.

### Device Tree + Driver Binding

- The label (e.g., "GPIO_0") is defined in the Device Tree (.dts or .overlay).
- The corresponding node is associated with a driver using DEVICE_DT_DEFINE() or DEVICE_DEFINE().

```
	DEVICE_DT_INST_DEFINE(_num, gpio_emul_init,                 \
			      PM_DEVICE_DT_INST_GET(_num),          \
			      &gpio_emul_data_##_num,               \
			      &gpio_emul_config_##_num, POST_KERNEL,    \
			      CONFIG_GPIO_INIT_PRIORITY,            \
			      &gpio_emul_driver);
```

**"../../../drivers/gpio/gpio_emul.c**

```
static DEVICE_API(gpio, gpio_emul_driver) = {
	.pin_configure = gpio_emul_pin_configure,
#ifdef CONFIG_GPIO_GET_CONFIG
	.pin_get_config = gpio_emul_pin_get_config,
#endif
	.port_get_raw = gpio_emul_port_get_raw,
	.port_set_masked_raw = gpio_emul_port_set_masked_raw,
	.port_set_bits_raw = gpio_emul_port_set_bits_raw,
	.port_clear_bits_raw = gpio_emul_port_clear_bits_raw,
	.port_toggle_bits = gpio_emul_port_toggle_bits,
	.pin_interrupt_configure = gpio_emul_pin_interrupt_configure,
	.manage_callback = gpio_emul_manage_callback,
	.get_pending_int = gpio_emul_get_pending_int,
#ifdef CONFIG_GPIO_GET_DIRECTION
	.port_get_direction = gpio_emul_port_get_direction,
#endif /* CONFIG_GPIO_GET_DIRECTION */
```

- This struct defines the function pointers for the GPIO emulator's API.
- It is passed to DEVICE_DT_DEFINE() to register the device.

## Final Mapping

- When device_get_binding("GPIO_0") is called, it returns a struct device whose .api field points to gpio_emul_driver.
- So when you later call gpio_pin_configure(gpio_dev, ...), it internally calls gpio_emul_pin_configure().

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[illegible]

## How gpio_pin_set() Maps to the Emulator Driver

```
gpio_pin_set(gpio_dev, TEST_PIN, 1);
```

This is a public Zephyr API defined in include/zephyr/drivers/gpio.h.

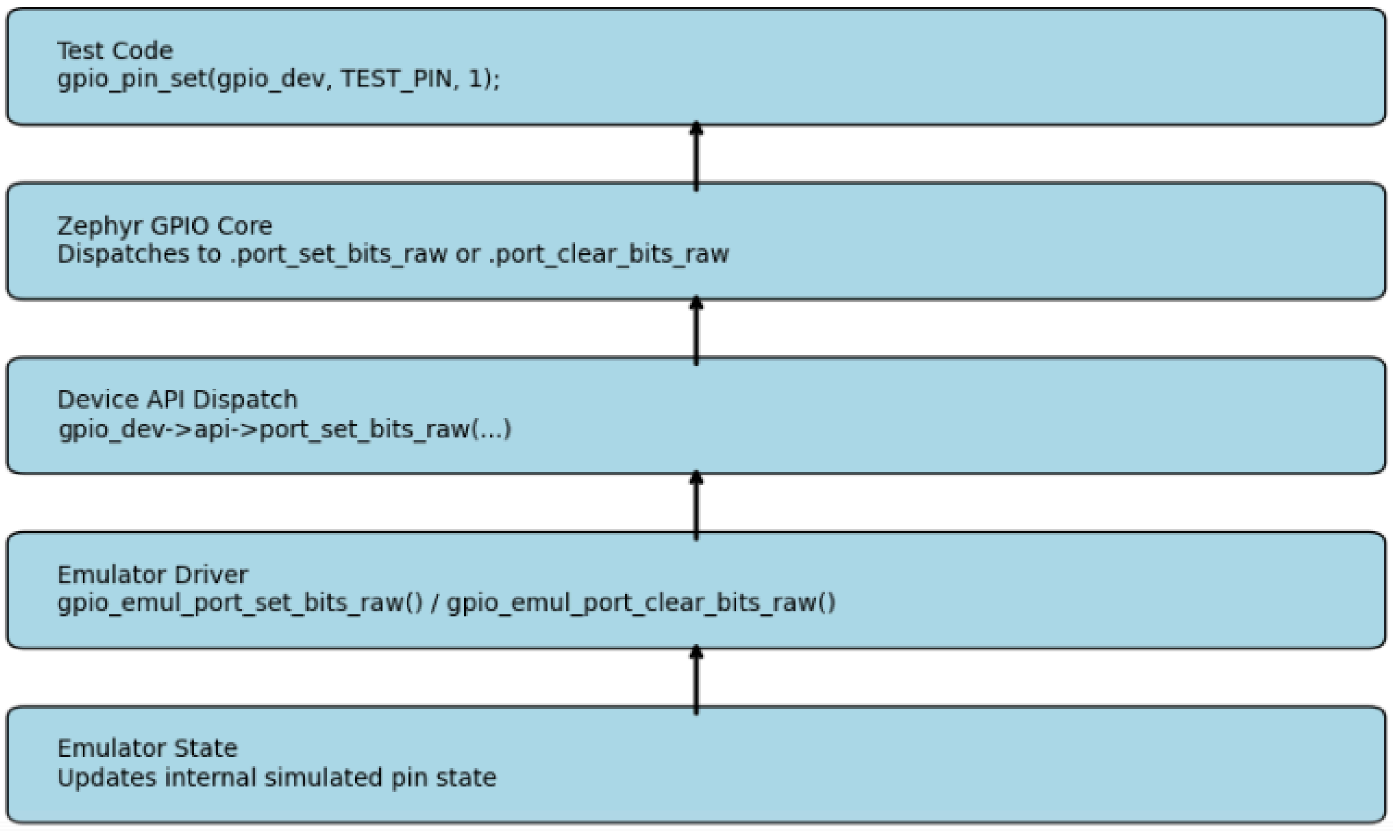
### Device API Dispatch

Internally, this calls the function pointer from the device's driver API:

```
gpio_dev->api->port_set_bits_raw(...)
```

This pointer is set to the emulator's implementation in gpio_emul_driver:

```
static const struct gpio_driver_api gpio_emul_driver = {
...
.port_set_bits_raw = gpio_emul_port_set_bits_raw,
.port_clear_bits_raw = gpio_emul_port_clear_bits_raw,
...
};
```


Test Code
gpio_pin_set(gpio_dev, TEST_PIN, 1);
Zephyr GPIO Core
Dispatches to .port_set_bits_raw or .port_clear_bits_raw
Device API Dispatch
gpio_dev->api->port_set_bits_raw(...)
Emulator Driver
gpio_emul_port_set_bits_raw() / gpio_emul_port_clear_bits_raw()
Emulator State
Updates internal simulated pin state

## Diagram Layers Explained

1. **Test Code**
   Calls gpio_pin_set(gpio_dev, TEST_PIN, 1); in your test suite.

2. **Zephyr GPIO Core**
   Routes the call to the appropriate function pointer in the GPIO driver API.
3. **Device API Dispatch**
   Internally calls gpio_dev->api->port_set_bits_raw(...) or port_clear_bits_raw(...).
4. **Emulator Driver**
   Executes gpio_emul_port_set_bits_raw() or gpio_emul_port_clear_bits_raw() from gpio_emul.c.
5. **Emulator State**
   Updates the internal simulated pin state (e.g., a bitfield or array) to reflect the pin value.