VISION 2020「From Domestic No.1 to Global Top 10」

SiW Touch Driver
v 2.11

2016.06.15

R&D / Touch Team

Silicon Works

History

Version	Date	Description
1.0	2016.03.15	1st release
2.0	2016.04.15	Rebuild Driver Framework for HAL layer
2.07	2016.05.17	Add PRD, Watch
2.09	2016.05.30	3. Basic Register Setup Guide
2.11	2016.06.15	1.3 (2) IRQ Handler - I2C Protocol Example 1.3 (3) FW Upgrade 4. Flag

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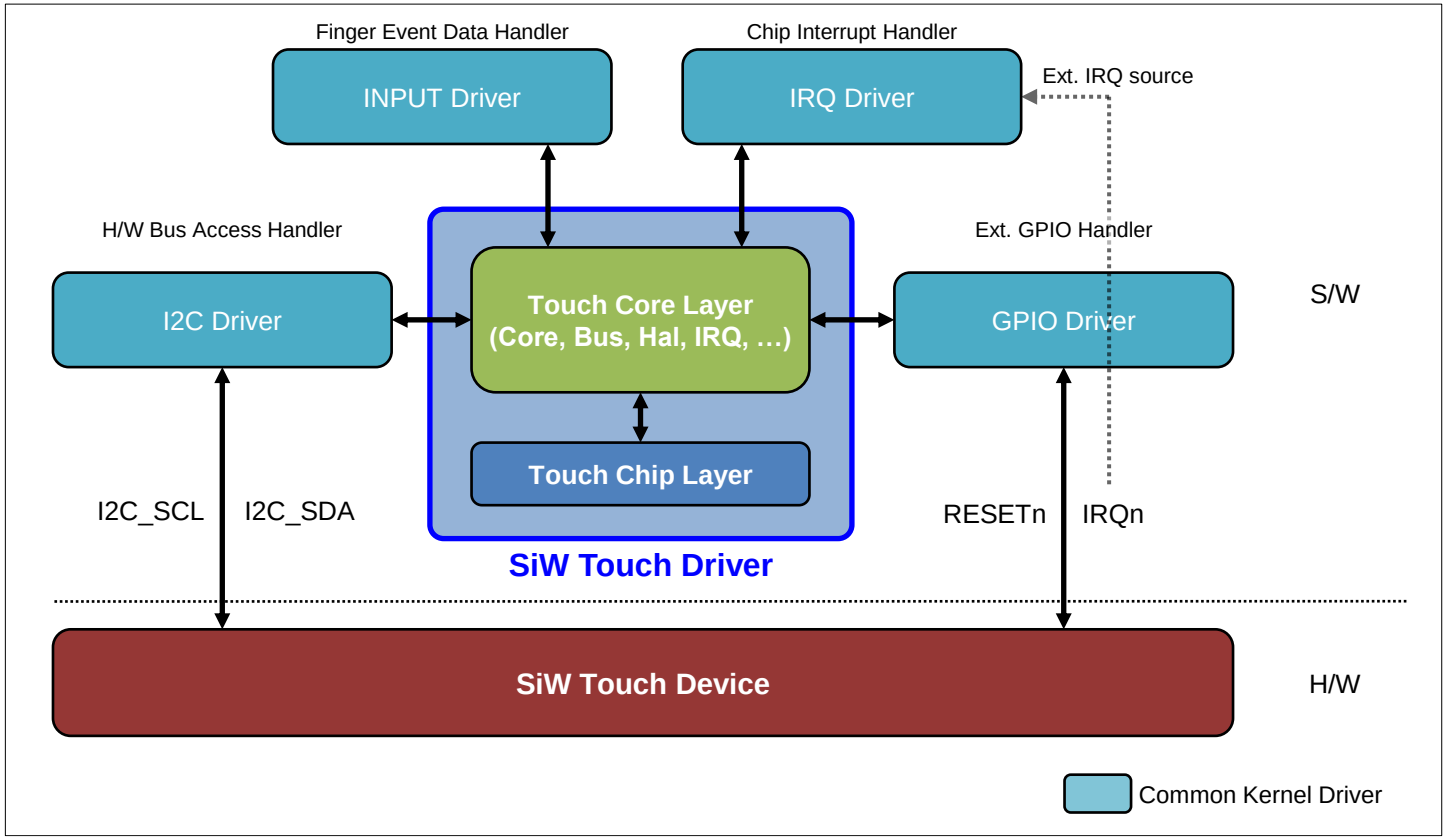
(1) Overview



[Fig. 1-1] Driver Relationship

1. Driver Operation

1.1 Driver Architecture

(2) SiW Touch Driver Files

Layer	Name	Description
Touch Core Layer	siw_touch.c	Touch Core main control
	siw_touch_bus.c	Touch Bus I/F main
	siw_touch_bus_i2c.c	Touch Bus I/F - I2C type
	siw_touch_bus_spi.c	Touch Bus I/F - SPI type
	siw_touch_bus_event.c	Touch Input & Event control
	siw_touch_gpio.c	Touch GPIO control
	siw_touch_irq.c	Touch Interrupt control
	siw_touch_notify.c	Touch Notifier Chain
	siw_touch_of.c	Touch Device Tree analysis
	siw_touch_sysfs.c	Touch Sysfs control
	siw_touch_sys.c	Helper for Touch & System Inter-connection
	siw_touch_hal.c	Touch HAL
	siw_touch_hal_abt.c	Touch HAL for ABT
	siw_touch_hal_prd.c	Touch HAL for PRD
	siw_touch_hal_sysfs.c	Touch HAL for Sysfs
	siw_touch_hal_watch.c	Touch HAL for WATCH
Touch Chip Layer	touch_lg4894.c	Initial driver for LG4894
	touch_lg4895.c	Initial driver for LG4895
	touch_lg4946.c	Initial driver for LG4946
	touch_sw1828.c	Initial driver for SW1828
Build Files	Kconfig / Makefile	

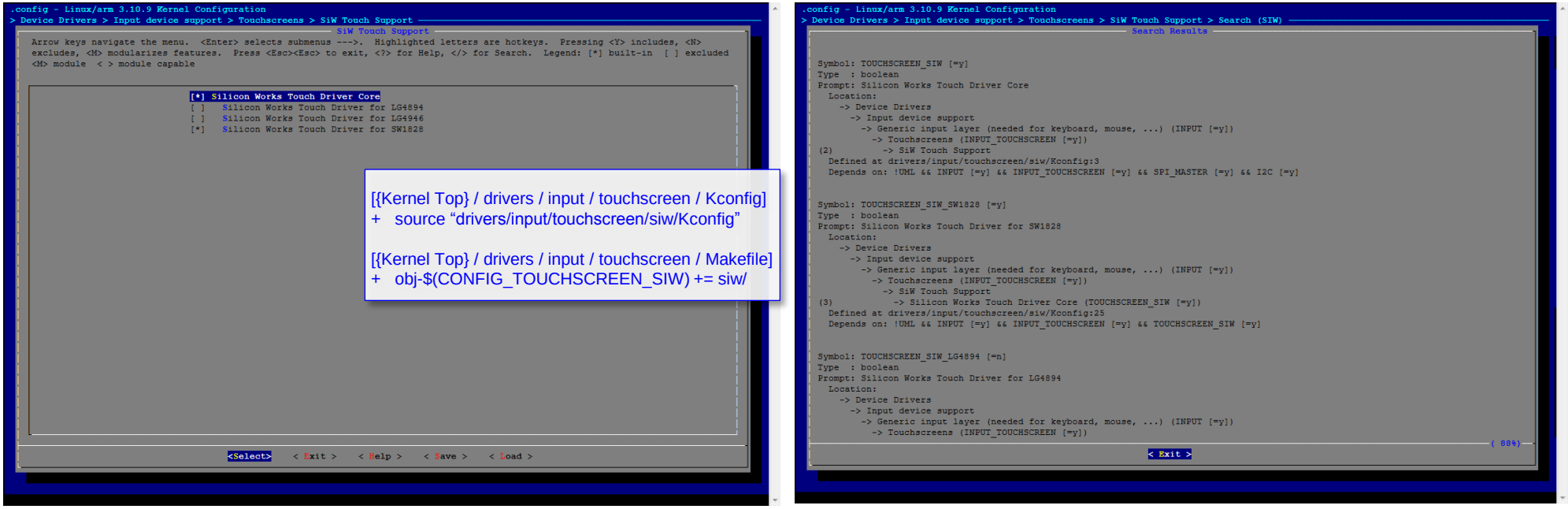
[Table. 1-1] Driver File List

* HAL : Hardware Abstraction Layer

1. Driver Operation

1.1 Driver Architecture

(2) SiW Touch Driver Files - Kconfig



[Fig. 1-2] Kconfig (example)

1. Driver Operation

1.1 Driver Architecture

(2) SiW Touch Driver Files - Test Environment

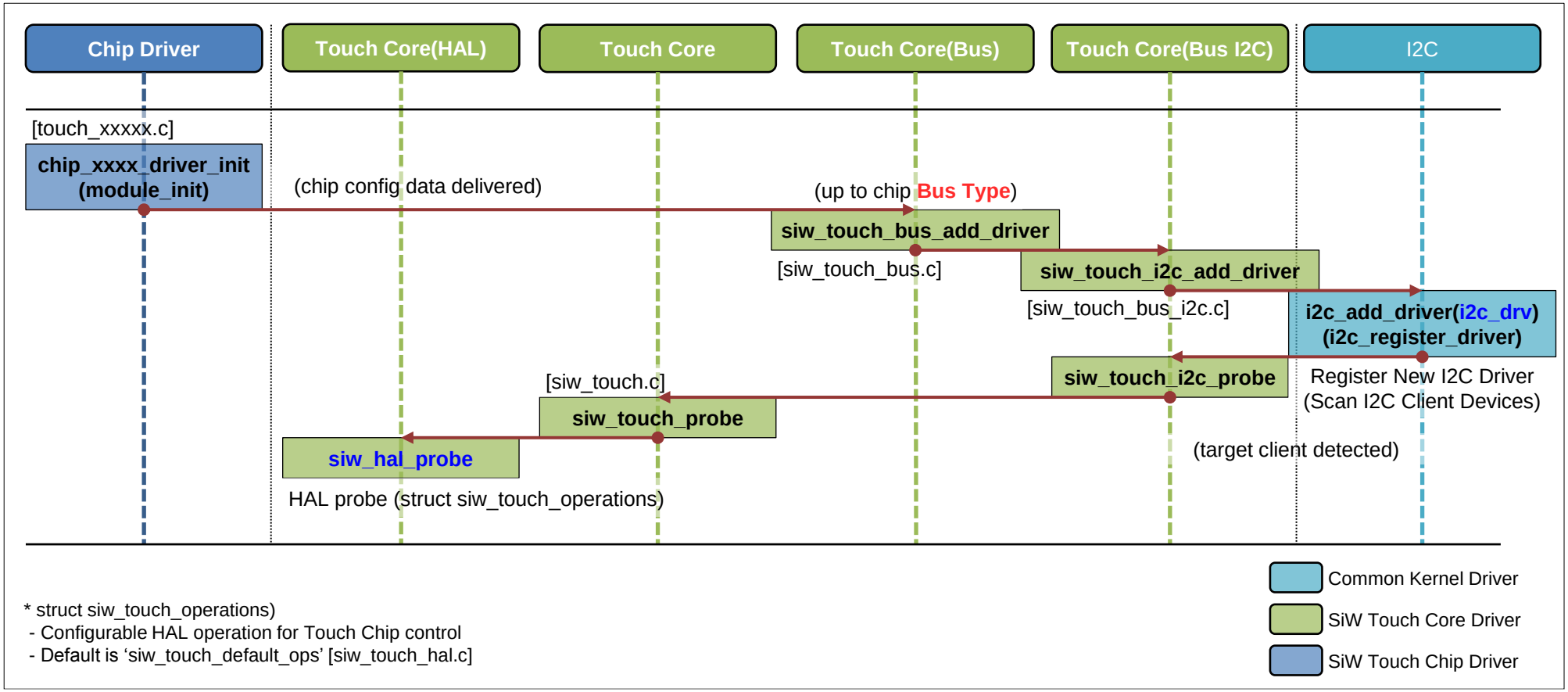
Test Environment		
H/W		Odroid-XU4(Exynos5422)
S/W	Platform Version	Android 4.4.4
		Kernel 3.10.9
	Driver Folder	{Kernel Top} / drivers / input / touchscreen / siw
		{Kernel Top} / include / linux / input : siw_touch_notify.h

[Table. 1-2] Test Environment

1. Driver Operation

1.2 Initialization Flow

(1) Probe Sequence - I2C (LG4894, SW1828)

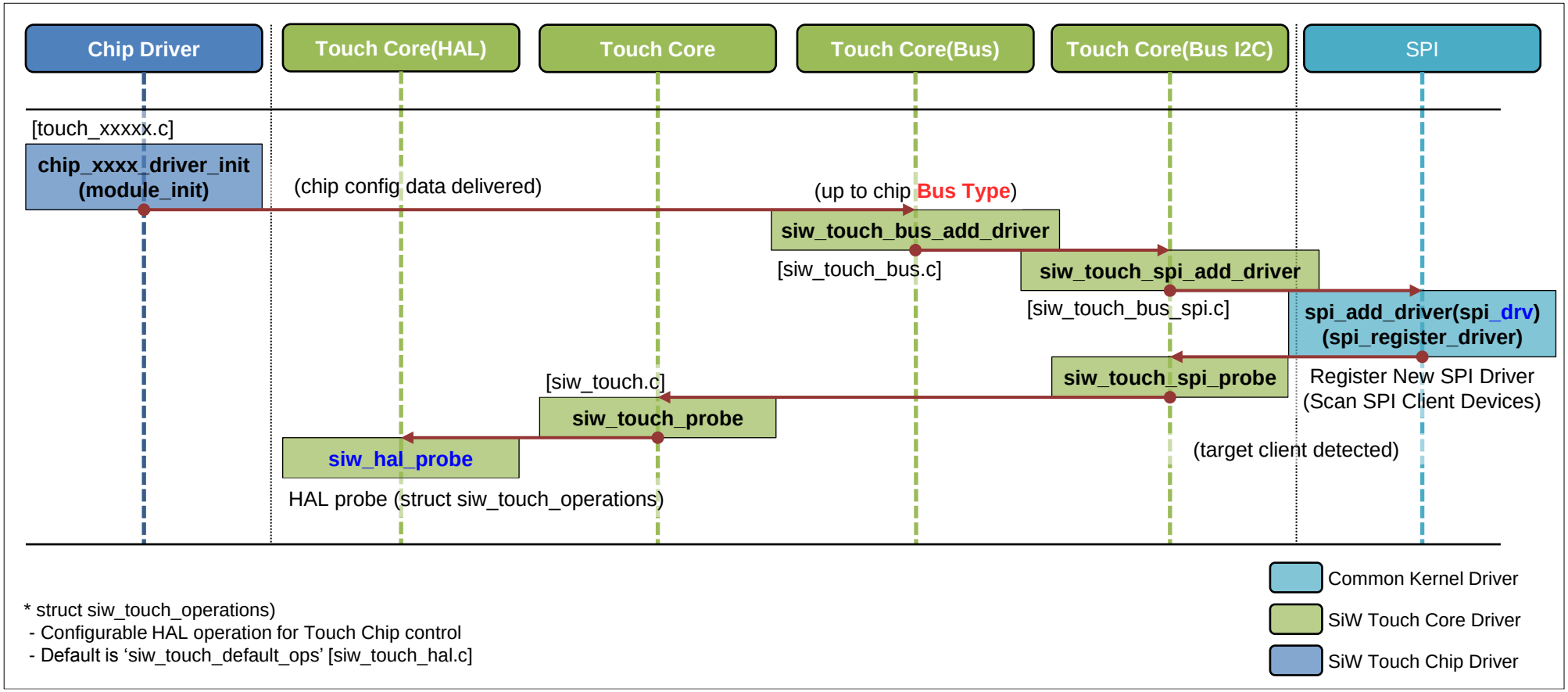


[Fig. 1-3] Initial Probe Sequence (I2C)

1. Driver Operation

1.2 Initialization Flow

(1) Probe Sequence - SPI (LG4895, LG4946)

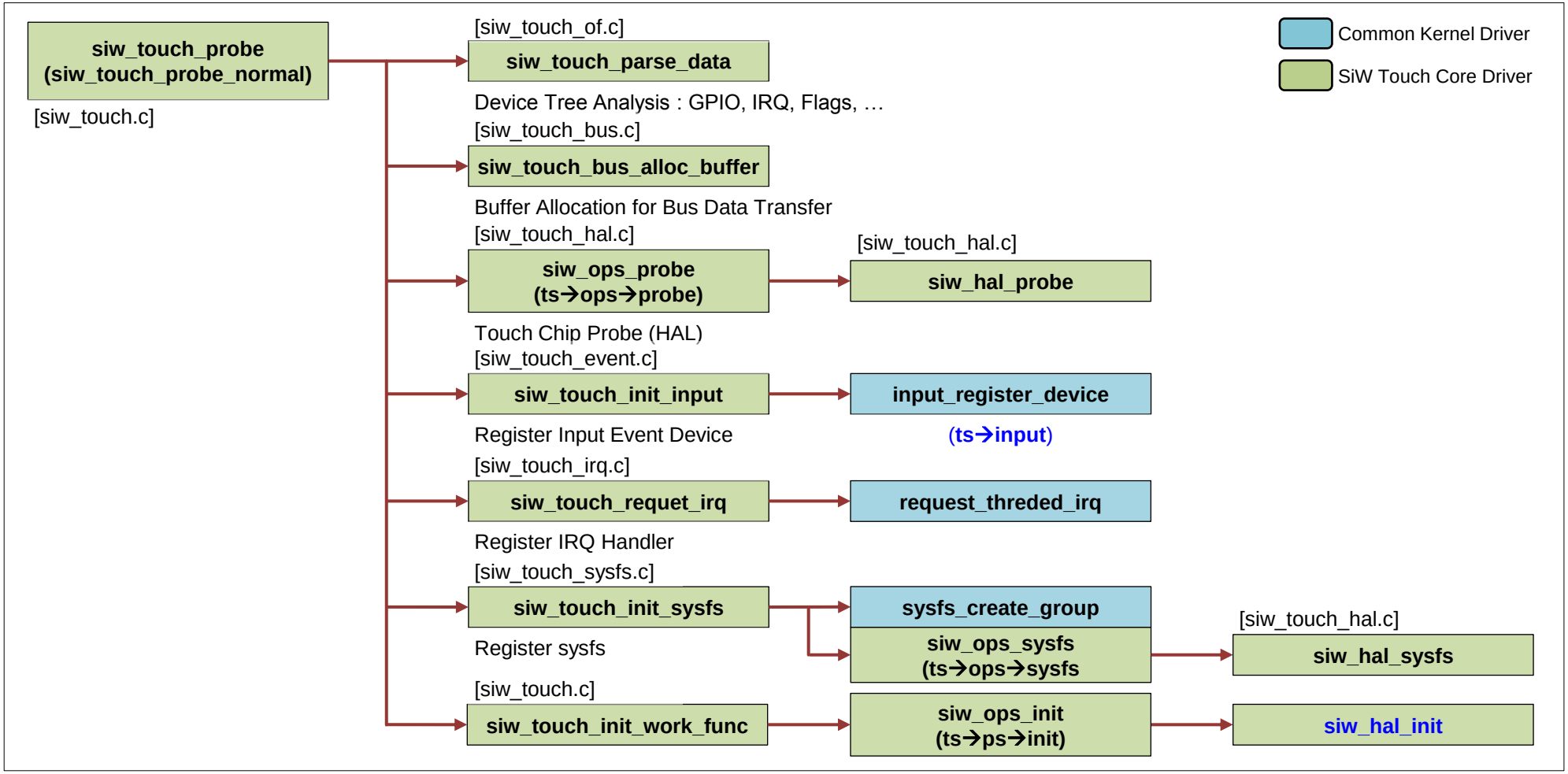


[Fig. 1-4] Initial Probe Sequence (SPI)

1. Driver Operation

1.2 Initialization Flow

(3) siw_touch_probe

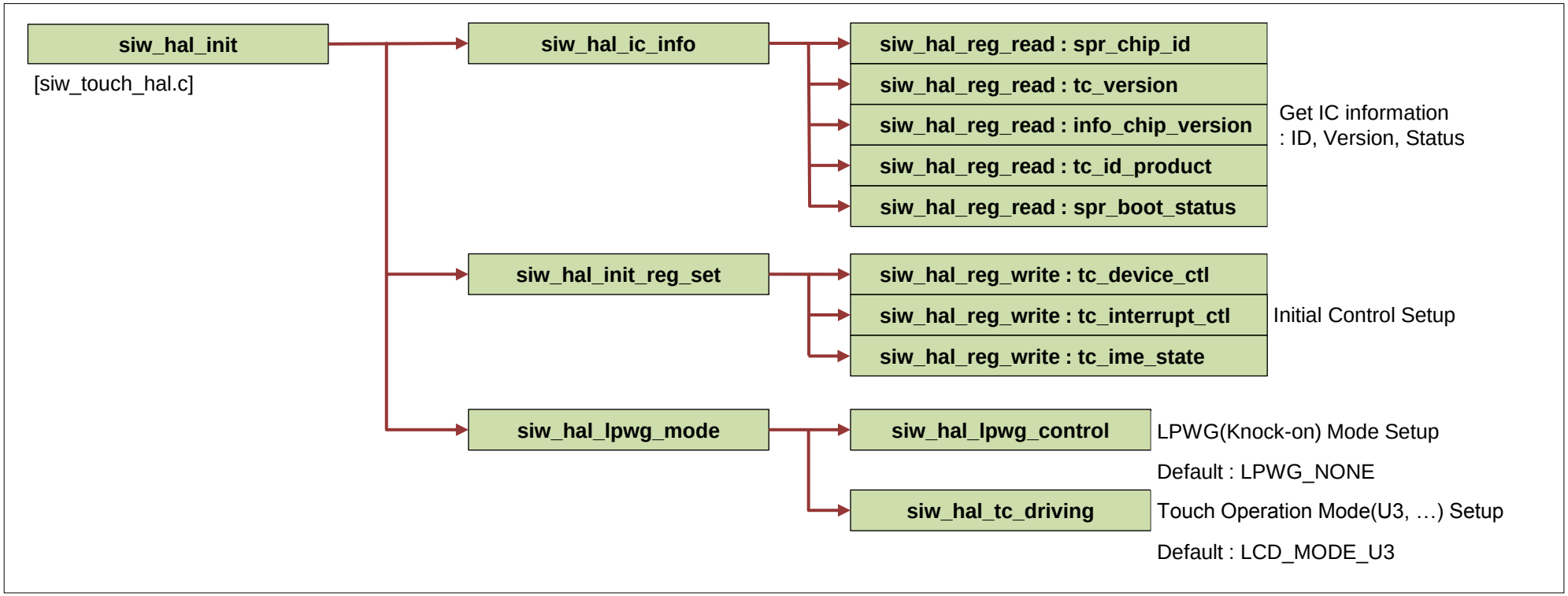


[Fig. 1-5] Inside operation of siw_touch_probe

1. Driver Operation

1.2 Initialization Flow

(4) siw_hal_init

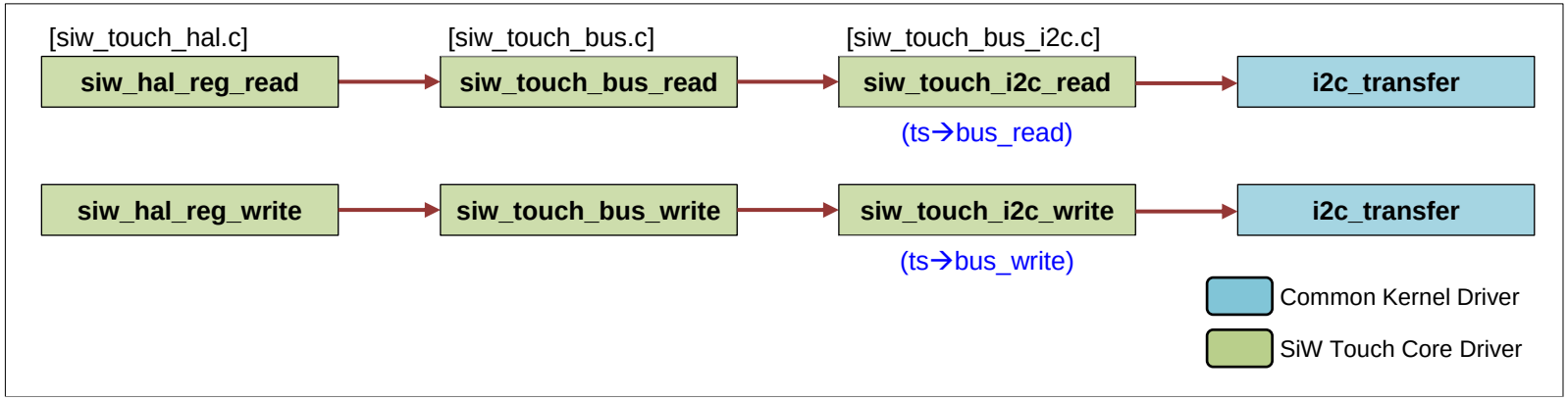


[Fig. 1-6] Inside operation of siw_hal_init

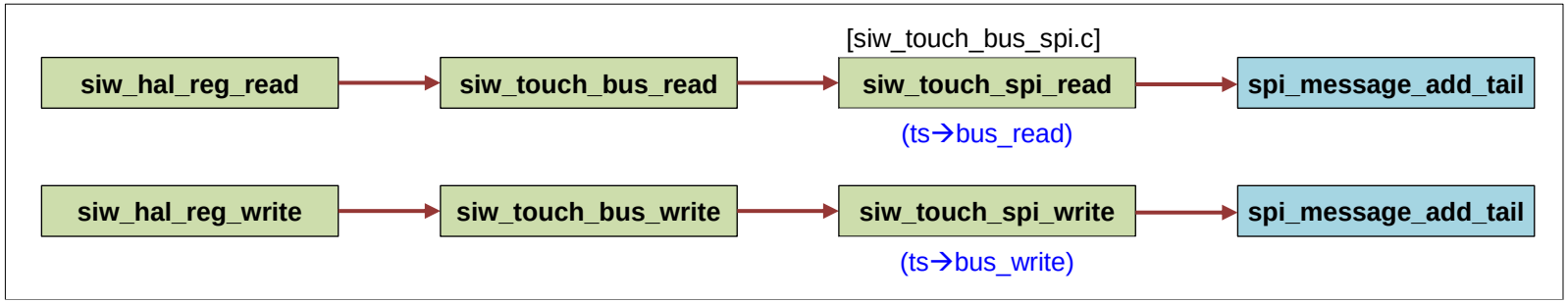
1. Driver Operation

1.3 Operation

(1) Bus Access



[Fig. 1-7] Bus Access Flow for I2C type

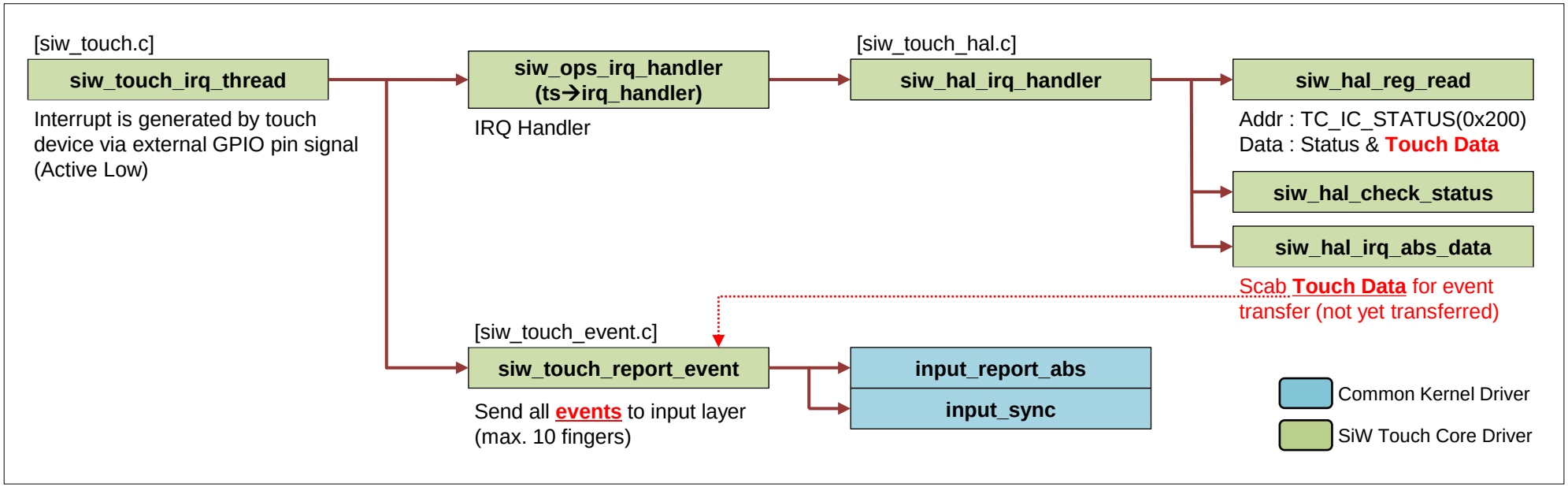


[Fig. 1-8] Bus Access Flow for SPI type

1. Driver Operation

1.3 Operation

(2) IRQ Handler (when touch event detected)



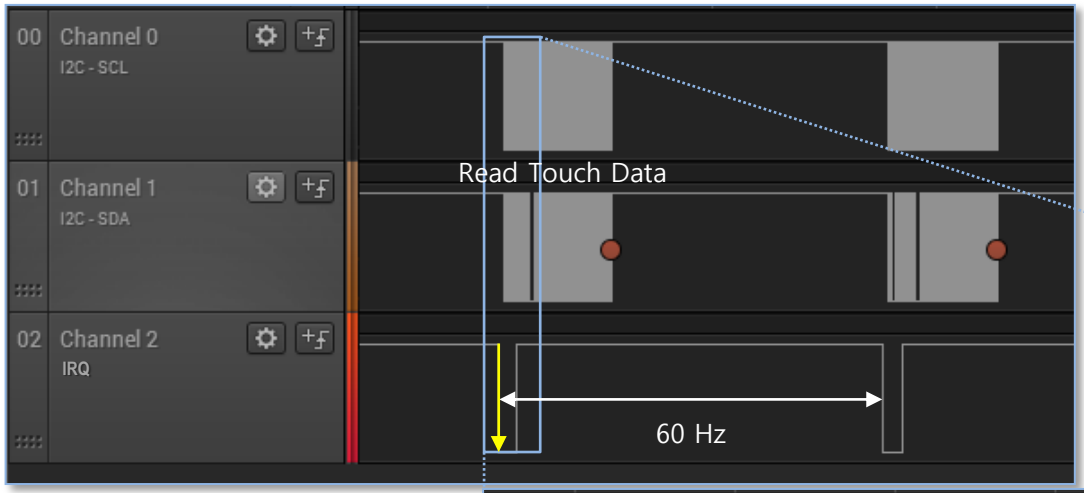
[Fig. 1-9] Interrupt Handling

- An appropriate external interrupt connection shall be guaranteed for the accuracy of this IRQ operation
- IRQ Flags
  Recommended flag setup value is **0x2002**((**IRQF_TRIGGER_FALLING**(0x02) | **IRQF_ONESHOT**(0x2000)),
  however, some problematic chipset may call handler routine twice at both edge, falling and rising.
  In this case, use **0x2008**((**IRQF_TRIGGER_LOW**(0x08) | **IRQF_ONESHOT**(0x2000)) instead of **0x2002**

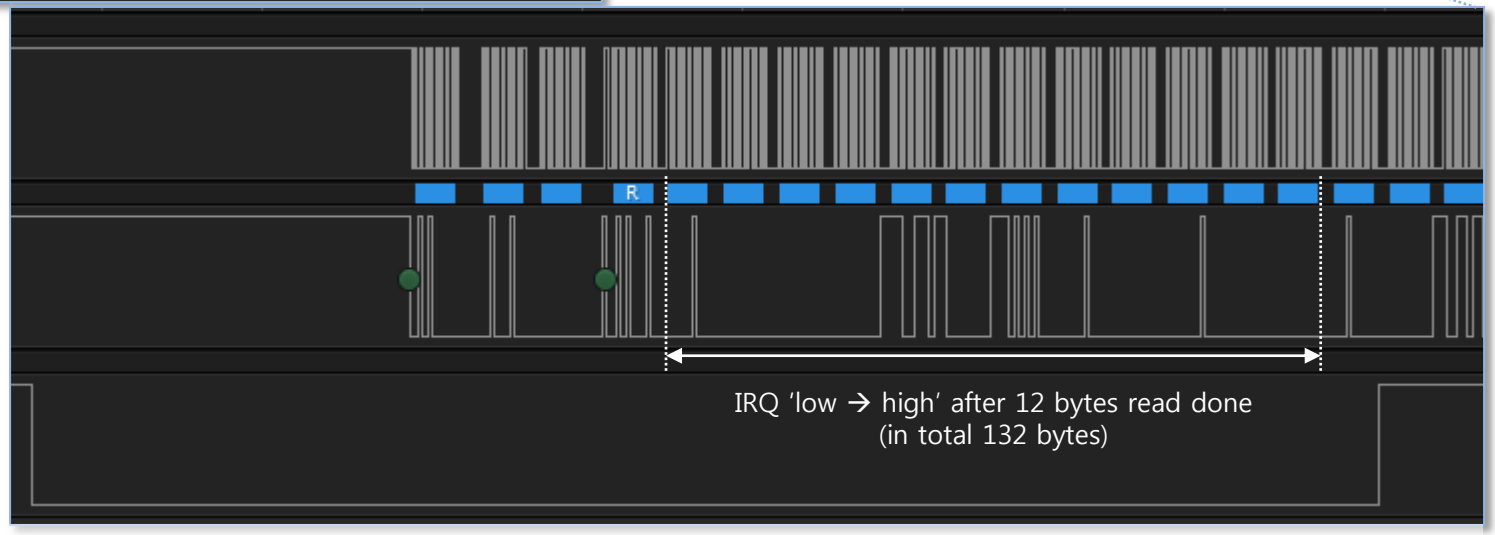
1. Driver Operation

1.3 Operation

(2) IRQ Handler - I2C protocol example



- The regular period of touch IRQ is always 60Hz.
- Reading time for 132 bytes data shall be terminated in 60Hz period or the IRQ sync distortion will happen.
- Reading data twice in single IRQ section is not permitted because 'invalid IRQ state' may be detected in 2nd reading

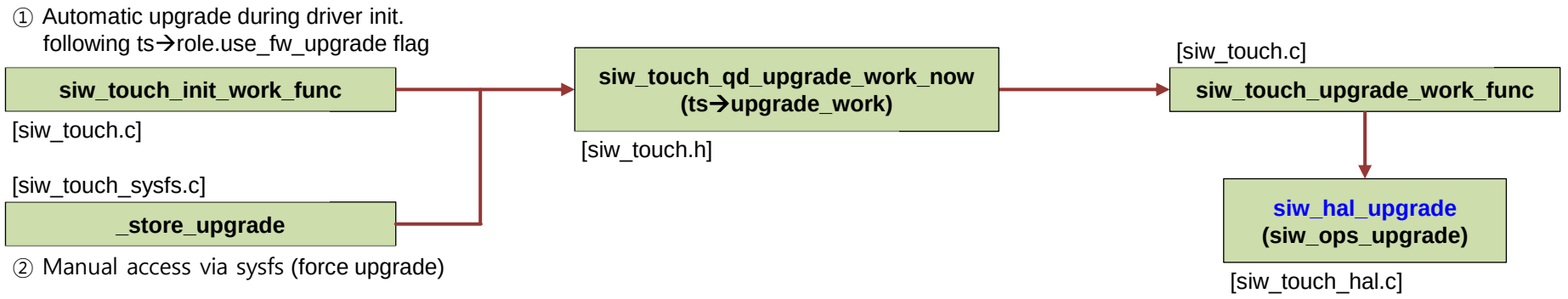


[Fig. 1-10] IRQ & I2C protocol

1. Driver Operation

1.3 Operation

(3) FW Upgrade (core layer)



1. If TOUCH_USE_FW_BINARY flag used
1-1 Default upgrade (through version comparison)
do upgarde using **binary header** link
1-2 echo {bin} > fw_upgrade
do force-upgrade using **binary header** link (same as 1-1)
1-3 echo /.../fw_img > fw_upgrade
do force-upgrade using **request_firmware** (relative path)
1-4 echo {root}/.../fw_img > fw_upgrade
do force-upgrade using **normal file open** control (absolute path)

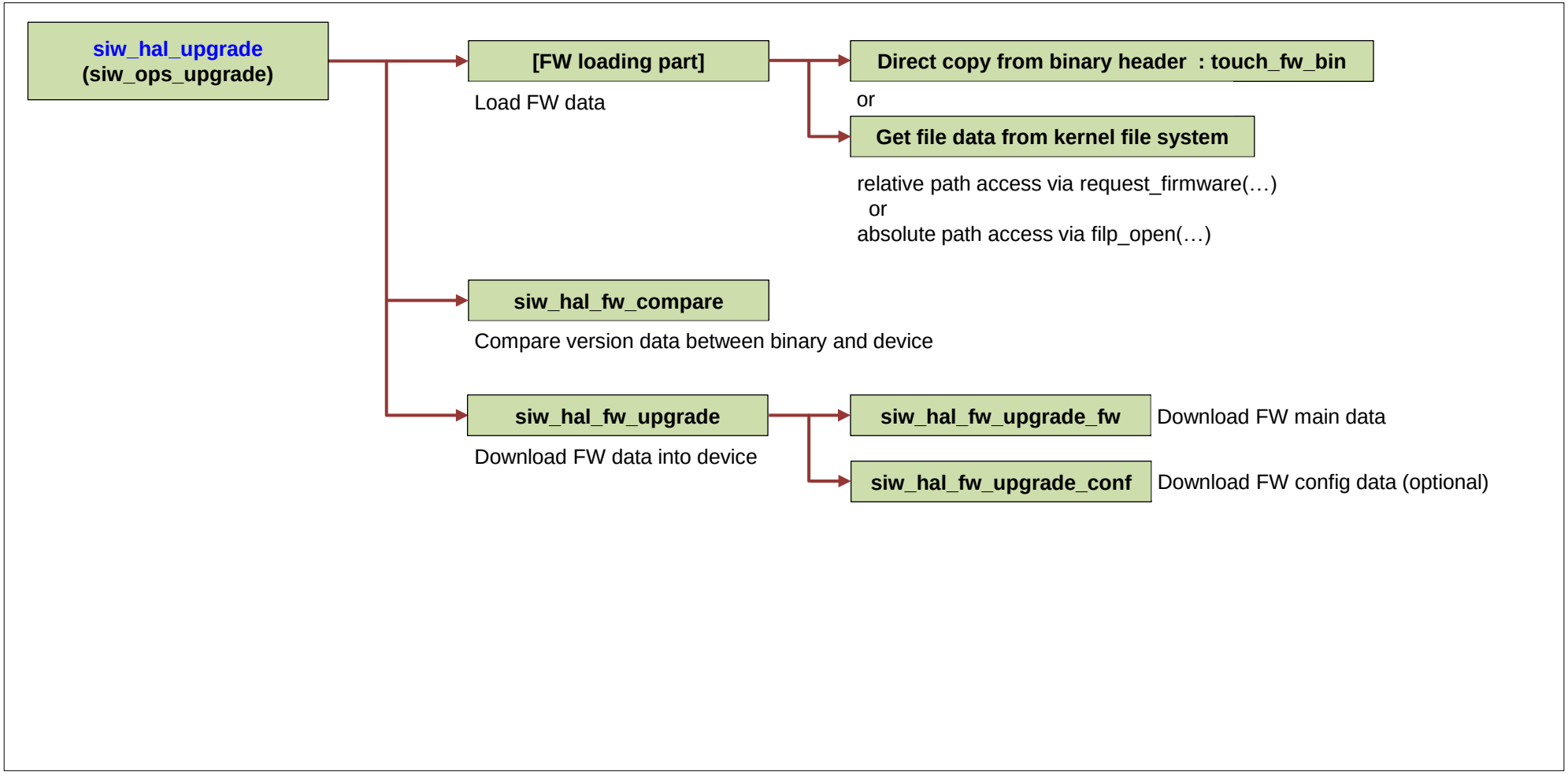
2. Else
2-1 Default upgrade (through version comparison)
do upgarde using request_firmware (relative path)
2-2 echo /.../fw_img > fw_upgrade
do force-upgrade using **request_firmware** (relative path)
2-3 echo {root}/.../fw_img > fw_upgrade
do force-upgrade using **normal file open** control (absolute path)

[Fig. 1-11] FW Upgrade (part 1)

1. Driver Operation

1.3 Operation

(3) FW Upgrade (hal layer)



[Fig. 1-12] FW upgrade (part 2)

1. Driver Operation

1.4 Kernel Log (example)

(1) Probe message

```
[ 4182.573535] SW1828 driver init
[ 4182.575821] siw_touch 5-0028: dev bus probe : 12c70000.i2c/i2c-5/5-0028
[ 4182.581784] siw_touch 5-0028: SiW Touch Probe
[ 4182.586090] siw_touch 5-0028: SW1828 quirks = 0x10030300
[ 4182.592590] siw_touch 5-0028: SW1828 ops is NULL : default ops selected
[ 4182.598057] siw_touch 5-0028: of gpio  : reset-gpio(0x1), 23
[ 4182.603801] siw_touch 5-0028: of gpio  : irq-gpio, 22
[ 4182.610170] siw_touch 5-0028: flags(of) = 0x00000100
[ 4182.613937] siw_touch 5-0028: caps max_x           = 800
[ 4182.619160] siw_touch 5-0028: caps max_y           = 480
[ 4182.625592] input: siw_touch_input as /devices/virtual/input/input13
[ 4182.631348] input input13: input device[i2c-5/5-0028 - siw_touch_input] registered (800, 480, 255, 15, 15, 1, 10)
[ 4182.641311] siw_touch 5-0028: threaded irq request done(530, siw_touch, 0x2002)
[ 4182.649485] siw_touch 5-0028: hw_reset_delay : 210 ms
[ 4182.863458] siw_touch 5-0028: fb_notif change
[ 4182.869007] siw_touch 5-0028: [T] chip id    : 1828
[ 4182.872426] siw_touch 5-0028: [T] version    : v0.00 (0x00000000, 0xFF)
[ 4182.879125] siw_touch 5-0028: [T] product id : L0L53P1
[ 4182.884244] siw_touch 5-0028: [T] flash boot : idle(done), crc : ok (0x00000044)
[ 4182.894245] siw_touch 5-0028: current driving mode is U3
[ 4182.898659] siw_touch 5-0028: DDI Display Mode = 0x00000003
[ 4182.928510] siw_touch 5-0028: SW1828 init done
[ 4182.972872] siw_touch 5-0028: mon thread[siw_touch-0, 5] begin
```

- 5-0028 : I2C adaptor(0x12C70000) is registered as I2C-5 and the slave address of the client(SW1828) is 0x28.

1. Driver Operation

1.4 Kernel Log (example)

(2) System Information

```
root@odroidxu3:/sys/bus/i2c/devices/5-0028 # ll
lrwxrwxrwx root     root              2016-04-12 08:48 driver -> ../../../../bus/i2c/drivers/siw_touch
-r--r--r-- root     root         4096 2016-04-12 08:40 modalias          // = i2c:sw1828
-r--r--r-- root     root         4096 2016-04-12 08:40 name              // = sw1828
drwxr-xr-x root     root              2016-04-12 08:40 power
lrwxrwxrwx root     root              2016-04-12 08:40 subsystem -> ../../../../bus/i2c
-rw-r--r-- root     root         4096 2016-04-12 08:40 uevent

root@odroidxu3:/sys/device/virtual/input # ll
drwxr-xr-x root     root              2016-04-12 08:40 input2
drwxr-xr-x root     root              2016-04-12 08:41 input4
drwxr-xr-x root     root              2016-04-12 08:40 mice
drwxr-xr-x root     root              2016-04-12 08:47 siw_touch_input


root@odroidxu3:/proc/bus/input # cat devices
…
I: Bus=0018 Vendor=abcd Product=9876 Version=1234
N: Name="siw_touch_input"
P: Phys=i2c-5/5-0028 - siw_touch_input
S: Sysfs=/devices/virtual/input/input4
U: Uniq=
H: Handlers=event4
B: PROP=2
B: EV=9
B: ABS=67c8000 0
```

2. Device Tree (example for I2C)

- Definition of I2C client device for SW1828 (refer to DTS example files for more information)

```
&i2c_1 {                                    // indicates parent device : I2C_1 adapter block
   sw1828@28 {                              // define new client device(sw1828) and slave addr. is 0x28
      status = "okay";                                                                          (mandatory)
      compatible = "siw,sw1828";            // compatible name (see touch_xxxxxx.c)
      reg = <0x28>;                         // slave addr. : 0x28
      interrupt-parent = <&gpx1>;           // interrupt source : GPIO group gpx1
      interrupts = <6 0x02>;                // index 6(0~7) in gpx1 external interrupts
      irqflags = <0x2002>;                  // IRQF_ONESHOT(0x2000) | IRQF_TRIGGER_FALLING(0x2)
      chip_flags = <0>;
      reset-gpio = <&gpx1 7 GPIO_ACTIVE_LOW>;          // index 7 in gpx1
      irq-gpio = <&gpx1 6 GPIO_ACTIVE_LOW>;            // index 6 in gpx1

      /* Caps */
      max_x = <800>;
      max_y = <480>;
      max_pressure = <0xff>;
      max_width = <15>;
      max_orientation = <1>;
      max_id = <10>;
      /* role */
      hw_reset_delay = <210>;
      sw_reset_delay = <90>;
      use_lpwg = <0>;
      use_lpwg_test = <0>;
      /* firmware */
      use_firmware = <1>;          // enable firmware control
      use_fw_upgrade = <1>;        // auto-update during driver initialization
      fw_image = "siw/sw1828/LA080WV9_9_02_00_3V.img";      // in android -> /lib/firmware/siw/..
      //absoulte path
      prd_in_file = "/sdcard/siw/sw1828_test_spec_V0.1.txt";
      prd_in_file_m = "/sdcard/siw/sw1828_test_spec_mfts_V0.1.txt";
      prd_out_file = "/sdcard/siw/touch_self_test.txt";
   };
};
```

[gpx1 definition in exynos5422 pinctrl device tree]

```
...
   pinctrl@13400000 {
   …
      gpx1: gpx1 {
         …
                  interrupt-controller;
                  interrupt-parent = <&combiner>;
                  #interrupt-cells = <2>;
                  interrupts = <28 0>, <28 1>, <29 0>, <29 1>,
                               <30 0>, <30 1>, <31 0>, <31 1>;
      };
      …
   };
…
```

- This example has been established based on odroidx-xu4(exynos5422) platform
- The detail configuration shall be modified up to main chipset.

2. Device Tree (example for SPI)

- Definition of SPI client device for LG4895 (refer to DTS example files for more information) (1/2)

```
&spi_1 {                                    // indicates parent device : SPI_1 block
    status = “okay”;
    samsung,spi-src-clk = <0>;
    num-cs = <1>;

    lg4895@0 {                              // define new spi device(lg4895)
        status = "okay";
        compatible = "siw,lg4895";          // compatible name (see touch_xxxxxx.c)
        reg = <0>;
        interrupt-parent = <&gpx1>;         // interrupt source : GPIO group gpx1
        interrupts = <6 0x02>;              // index 6(0~7) in gpx1 external interrupts
        irqflags = <0x2002>;                // IRQF_ONESHOT(0x2000) | IRQF_TRIGGER_FALLING(0x2)
        chip_flags = <0>;
        reset-gpio = <&gpx1 7 GPIO_ACTIVE_LOW>;          // index 7 in gpx1
        irq-gpio = <&gpx1 6 GPIO_ACTIVE_LOW>;            // index 6 in gpx1
        /* Caps */
        max_x = <800>;
        max_y = <480>;
        max_pressure = <0xff>;
        max_width = <15>;
        max_orientation = <1>;
        max_id = <10>;
        /* role */
        hw_reset_delay = <210>;
        sw_reset_delay = <90>;
        use_lpwg = <0>;
        use_lpwg_test = <0>;
        /* firmware */
        use_firmware = <1>;         // enable firmware control
        use_fw_upgrade = <1>;       // auto-update during driver initialization
        fw_image = "siw/lg4895/L0W49P1_1_13.img.img";          // in android -> /lib/firmware/siw/..
        …
```

(mandatory)

- This example has been established based on odroidx-xu4(exynos5422) platform
- The detail configuration shall be modified up to main chipset.

2. Device Tree (example for SPI)

- Definition of SPI client device for LG4895 (refer to DTS example files for more information) (2/2)

```
&spi_1 {
    …
    lg4895@0 {
        …
        (after /* firmware */)

        //absoulte path
        prd_in_file = "/sdcard/siw/lg4895_test_spec_V0.1.txt";
        prd_in_file_m = "/sdcard/siw/lg4895_test_spec_mfts_V0.1.txt";
        prd_out_file = "/sdcard/siw/touch_self_test.txt";

        controller-data {
            cs-gpio = <&gpa2 5 GPIO_ACTIVE_LOW>;
            samsung,spi-feedback-delay = <0>;
            samsung,spi-chip-select-mode = <0>;      //MANUAL_CS_MODE = 0, AUTO_CS_MODE = 1,
        };
};
```

- This example has been established based on odroidx-xu4(exynos5422) platform
- The detail configuration shall be modified up to main chipset.

3. Basic Register Setup Guide

Chip Type		Type - I										Type - II										Type - III		
	이형부	O										X										X		
	Knock On	O										O										X		
	Mode	U3		U2				U0				U3		U2				U0				U3	U2	U0
	LPWG_DOUBLE_TAP	X	O	X	O	X	O	X	O	X	O	X	O	X	O	X	O	X	O	X	O	X	X	X
	LPWG_PASSWORD	X	X	X	X	O	O	X	X	O	O	X	X	X	X	O	O	X	X	O	O	X	X	X
	SWIPE_MODE	X	X	X	O	O	O	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Reg	Description	Value										Value										Value		
C00h	TC_DEVICE_CTL Indicate checked status	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C01h	TC_INTERRUPT_CTL Clear touch INT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C20h	TCI_ENABLE_W Enable tci_0/1	0	1	0	1	10000h	10001h	0	1	10000h	10001h	0	1	0	1	10000h	10001h	0	1	10000h	10001h	0	0	0
C30h	SWIPE_ENABLE_W Enable swipe	0	0	0	10001h	10001h	10001h	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C03h	TC_DRIVE_CTL Driving start	181h		101h				1				181h		101h				1				181h		1
C21h	TAP_COUNT_W Tap_Count	0	2	0	2	0	2h	0	2	0	2h	0	2	0	2	0	2h	0	2	0	2h	0	0	0
C22h	MIN_INTERTAP_W Min_intertap	0	[32:16] 0 [15:00] 6	0	[32:16] 0 [15:00] 6	[32:16] 6 [15:00] 0	[32:16] 6 [15:00] 6	0	[32:16] 0 [15:00] 6	[32:16] 6 [15:00] 0	[32:16] 6 [15:00] 6	0	[32:16] 0 [15:00] 6	0	[32:16] 0 [15:00] 6	[32:16] 6 [15:00] 0	[32:16] 6 [15:00] 6	0	[32:16] 0 [15:00] 6	[32:16] 6 [15:00] 0	[32:16] 6 [15:00] 6	0	0	0
C23h	MAX_INTERTAP_W Max_intertap	0	[32:16] 0 [15:00] 70	0	[32:16] 0 [15:00] 70	[32:16] 70 [15:00] 0	[32:16] 70 [15:00] 70	0	[32:16] 0 [15:00] 70	[32:16] 70 [15:00] 0	[32:16] 70 [15:00] 70	0	[32:16] 0 [15:00] 70	0	[32:16] 0 [15:00] 70	[32:16] 70 [15:00] 0	[32:16] 70 [15:00] 70	0	[32:16] 0 [15:00] 70	[32:16] 70 [15:00] 0	[32:16] 70 [15:00] 70	0	0	0
C24h	TOUCH_SLOP_W Touch_slop	0	[32:16] 0 [15:00] 100	0	[32:16] 0 [15:00] 100	[32:16] 100 [15:00] 0	[32:16] 100 [15:00] 100	0	[32:16] 0 [15:00] 100	[32:16] 100 [15:00] 0	[32:16] 100 [15:00] 100	0	[32:16] 0 [15:00] 100	0	[32:16] 0 [15:00] 100	[32:16] 100 [15:00] 0	[32:16] 100 [15:00] 100	0	[32:16] 0 [15:00] 100	[32:16] 100 [15:00] 0	[32:16] 100 [15:00] 100	0	0	0
C25h	TAP_DISTANCE_W Tap_distance	0	[32:16] 0 [15:00] 10	0	[32:16] 0 [15:00] 10	[32:16] 255 [15:00] 0	[32:16] 255 [15:00] 10	0	[32:16] 0 [15:00] 10	[32:16] 255 [15:00] 0	[32:16] 255 [15:00] 10	0	[32:16] 0 [15:00] 10	0	[32:16] 0 [15:00] 10	[32:16] 255 [15:00] 0	[32:16] 255 [15:00] 10	0	[32:16] 0 [15:00] 10	[32:16] 255 [15:00] 0	[32:16] 255 [15:00] 10	0	0	0
C26h	INT_DELAY_W Intr_delay	0	0	0	0	[32:16] 20 [15:00] 0	[32:16] 20 [15:00] 0	0	0	[32:16] 20 [15:00] 0	[32:16] 20 [15:00] 0	0	0	0	0	[32:16] 20 [15:00] 0	[32:16] 20 [15:00] 0	0	0	[32:16] 20 [15:00] 0	[32:16] 20 [15:00] 0	0	0	0
C31h	SWIPE_DIST_W distance	0	0	0	[32:16] 5 [15:00] 5	[32:16] 5 [15:00] 5	[32:16] 5 [15:00] 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C32h	SWIPE_RATIO_THR_W ratio_thres	0	0	0	[32:16] 100 [15:00] 100	[32:16] 100 [15:00] 100	[32:16] 100 [15:00] 100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C33h	SWIPE_RATIO_DIST_W ratio_distance	0	0	0	[32:16] 2 [15:00] 2	[32:16] 2 [15:00] 2	[32:16] 2 [15:00] 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C34h	SWIPE_RATIO_PERIOD_W ratio_period	0	0	0	[32:16] 5 [15:00] 5	[32:16] 5 [15:00] 5	[32:16] 5 [15:00] 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C35h	SWIPE_RATIO_PERIOD_W min_time	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C36h	SWIPE_TIME_MAX_W max_time	0	0	0	[32:16] 150 [15:00] 150	[32:16] 150 [15:00] 150	[32:16] 150 [15:00] 150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C37h	SWIPE_ACT_AREA_X1_W area.x1	0	0	0	[32:16] 401 [15:00] 401	[32:16] 401 [15:00] 401	[32:16] 401 [15:00] 401	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C38h	SWIPE_ACT_AREA_Y1_W area.y1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C39h	SWIPE_ACT_AREA_X2_W area.x2	0	0	0	[32:16] 1439 [15:00] 1439	[32:16] 1439 [15:00] 1439	[32:16] 1439 [15:00] 1439	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C3Ah	SWIPE_ACT_AREA_X2_W area.y2	0	0	0	[32:16] 159 [15:00] 159	[32:16] 159 [15:00] 159	[32:16] 159 [15:00] 159	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Chipset	LG4895	LG4894	SW1828

4. Flag

struct siw_ts: flags		
Name	**Bit**	**Description**
IRQ_USE_SCHEDULE_WORK	1	Use local IRQ work function (includes debounce control)
TOUCH_USE_MON_THREAD	8	Use monitor thread for self recovery and etc.
TOUCH_USE_PINCTRL	9	Use pin control
TOUCH_USE_PWRCTRL	10	Use power control
TOUCH_USE_VIRT_DIR_WATCH	16	Option to select watch sysfs parent folder (LG4895 & LG4946 only)
TOUCH_USE_DRV_NAME_SYSFS	17	Option to select driver's sysfs name
TOUCH_USE_FW_BINARY	18	Get FW binary data from dedicated internal data, not external image file. See 'struct siw_touch_fw_bin'
TOUCH_USE_PROBE_INIT_LATE	24	Skip IC initialization sequence when driver probe is called. This is useful when a system needs to control to judge the IC initialization time regardless the driver probing time. Use 'echo' command like below example to perform this postponed IC initialization after driver probing completion: $ echo 0x55AA > /sys/devices/virtual/input/siw_touch_input/init_late
TOUCH_IGNORE_DT_FLAGS	31	Use driver setup value ignoring external DTS flag value General format under DTS environment: MSB[31:16] - Driver-inside setup value LSB[15:00] - External DTS flag value See 'siw_touch_do_parse_dts' in siw_touch_of.c

4. Flag

struct siw_touch_pdata: quirks		
Name	**Bit**	**Description**
CHIP_QUIRK_NOT_SUPPORT_XFER	0	Disable multiple data transfer when the host bus (I2C/SPI) doesn't support it
CHIP_QUIRK_NOT_SUPPORT_ASC	16	Disable ASC control
CHIP_QUIRK_NOT_SUPPORT_LPWG	17	Disable LPWG(knock-on) control
CHIP_QUIRK_NOT_SUPPORT_WATCH	18	Disable WATCH(2^{nd} screen) control
CHIP_QUIRK_NOT_SUPPORT_IME	28	Disable IME control