RZ/T2L Group

HIPERFACE DSL Safety sample program

Introduction

This application note explains a sample program for acquiring and indicating information including safety data from an encoder in conformance with the HIPERFACE DSL® communications protocol specification by using the encoder Interface of the RZ/T2L.

The features of the program:

- Acquiring angle information, etc. from an encoder (EDM35-2KF0A020A) compliant with the HIPERFACE DSL® communications protocol specification

Target Device

RZ/T2L

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1. Specifications

Table 1.1 lists the peripheral functions to be used and their applications and Figure 1.1 shows the operating environment when the sample code is being executed.

Table 1.1 Peripheral Functions and Applications

Peripheral Module	Application
HIPERFACE DSL controller (HDSL)	Handling transfer to and from an absolute encoder incorporating a facility for handling the HIPERFACE DSL communications protocol
Interrupt controller (ICU)	Controlling interrupts from the HDSL controller
General PWM timer (GPT) unit 0 channel 0	Generating event cycles for input to the ELC
Event link controller (ELC)	Makes the link between events output from unit 0 channel 0 of the GPT and the HDSL module.
Serial Communication Interface (SCI) UART	Asynchronous communications of the SCI are used for COM port communications by using USB interface. It is used for console interface of the sample program.

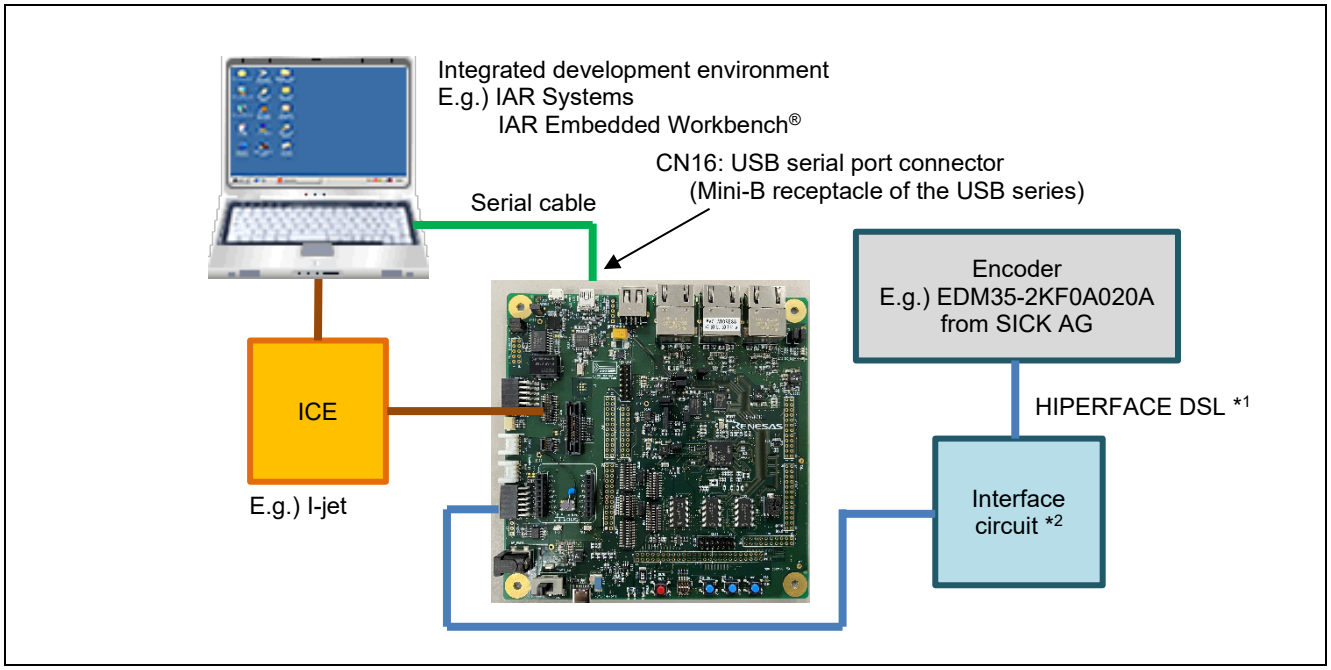

Figure 1.1 Operating Environment

Note: 1. For allowable cable length, refer to the encoder manuals.
2. Refer to the “HIPERFACE DSL® MASTER Safety Integration Manual”.

2. Operating Environment

The sample code covered in this application note is for the environment below.

Table 2.1 Operating Environment

Item	Description
MCU	RZ/T2L Group
Operating frequency	CPUCLK = 800 MHz
Operating voltage	1.1 V (Core) / 1.8 V (PLL, etc.) / 3.3 V (I/O)
Integrated development environment *1	IAR Systems: IAR Embedded Workbench® for Arm® RENESAS: e² studio
Board	RSK+RZT2L (RTK9RZT2L0C00000BJ)
Devices (function to be used on the board)	None

Note 1. Refer to the RZ/T2L Group Encoder I/F HIPERFACE DSL Safety sample program Release Note to check the version number of the integrated development environment.

3. Peripheral Functions

The basics of the peripheral modules, operating modes, and registers are described in the “RZ/T2L Group User’s Manual: Hardware”.

3.1 Pins

The pins used and their functions are listed in the table below.

Table 3.1 Pins Used and Their Functions

Channel	Pin Name	I/O Port	Input /Output	Description
HFDSL0	ENCIFDI0 (dsl_in0)	P02_2	Input	Data input pin
	ENCIFDO0 (dsl_out0)	P02_3	Output	Data output pin
	ENCIFOE0 (dsl_en0)	P01_7	Output	Drive/receive control pin
HFDSL1	ENCIFDI1 (dsl_in1)	P10_1	Input	Data input pin
	ENCIFDO1 (dsl_out1)	P10_0	Output	Data output pin
	ENCIFOE1 (dsl_en1)	P09_7	Output	Drive/receive control pin

4. Software

4.1 HFDSL Driver Function

The functions of the HFDSL driver are listed below.

1. Initial settings
2. Acquiring positional data
3. Transmitting and receiving messages

4.2 File Structure

For the file structure, refer to the release note for the RZ/T2L Group Encoder I/F HIPERFACE DSL Safety sample program.

4.3 Functions

The functions to be used are listed in the table below.

Table 4.1 Functions

Category	Function Name	Page Number
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4.4 Specifications of API Functions

4.4.1 R_HFDSL_Open

R_HFDSL_Open	
Synopsis	Starts controlling operation of the encoder.
Header	r_hfdsl_rzt2_if.h
Declaration	int32_t R_HFDSL_Open(const int32_t id, r_hfdsl_info_t* p_info);
Description	Call this function before using the HFDSL driver. It initializes the driver. ・Setting the interrupts ・Setting the callback functions
Argument	id : Specifies the ID to be used. (It is defined in r_hfdsl_rzt2_dat.h.) R_HFDSL0_ID : Specifies channel 0. R_HFDSL1_ID : Specifies channel 1. Others : Setting is not allowed. p_info : Holder for the initial settings of the driver Set the pointer to the r_hfdsl_info_t structure which holds the information on the initial settings of the driver.
Return value	R_HFDSL_SUCCESS: Normal termination R_HFDSL_ERR_INVALID_ARG: Abnormal termination (The id or the r_hfdsl_info_t structure member pointed by the p_info is not specified.) R_HFDSL_ERR_ACCESS: Abnormal termination (This function is already executed.)
Note	Calling this API function from within a callback function is prohibited.

4.4.2 R_HFDSL_Close

R_HFDSL_Close	
Synopsis	Ending control of the encoder
Header	r_hfdsl_rzt2_if.h
Declaration	int32_t R_HFDSL_Close(const int32_t id);
Description	This function stops controlling operation of the encoder on the designated channel.
Argument	id : Specifies the ID to be used. (It is defined in r_hfdsl_rzt2_dat.h.) R_HFDSL0_ID : Specifies Channel 0. R_HFDSL1_ID : Specifies Channel 1. Others : Setting is not allowed.
Return Value	R_HFDSL_SUCCESS: Normal termination R_HFDSL_ERR_INVALID_ARG: Abnormal termination (The id is not specified.)
Note	Before calling this function, be sure to call R_HFDSL_Open. Calling this API function from within a callback function is prohibited.

4.4.3 R_HFDSL_GetVersion

R_HFDSL_GetVersion	
Synopsis	Acquire the version number of the encoder interface driver.
Header	r_hfdsl_rzt2_if.h
Declaration	uint32_t R_HFDSL_GetVersion(void);
Description	This function acquires the version number of the HFDSL driver.
Argument	None
Return value	The major part of the version number is stored in the sixteen MSBs and the minor part of the version number is stored in the sixteen LSBs. Ex.) For ver.1.2, the value returned is 0x00010002.

4.4.4 R_HFDSL_Control

R_HFDSL_Control	
Synopsis	Controlling operation of the encoder.
Header	r_hfdsl_rzt2_if.h
Declaration	int32_t R_HFDSL_Control(const int32_t id, const r_hfdsl_cmd_t cmd, void *const p_buf);
Description	This function controls operations of the encoder by using the cmd argument. See section “4.4.4(1), Protocol Initialization Commands” and section “4.4.4(2), Control Commands” for the operation.
Argument	id : Specifies the ID to be used. (It is defined in r_hfdsl_rzt2_dat.h.) R_HFDSL0_ID : Specifies channel 0. R_HFDSL1_ID : Specifies channel 1. Others : Setting is not allowed. cmd : Command For details, see section “4.4.4(1), Protocol Initialization Commands” and section “4.4.4(2), Control Commands”. p_buf : Arguments corresponding to each cmd.
Return value	R_HFDSL_SUCCESS: Normal termination R_HFDSL_ERR_INVALID_ARG: Abnormal termination (The id or cmd is not specified.) See section “4.4.4(1), Protocol Initialization Commands” and section “4.4.4(2), Control Commands” for other returned values.

(1) Protocol Initialization Commands

(a) R_HFDSL_CMD_INIT

R_HFDSL_CMD_INIT	
Synopsis	Protocol initialization
Header	r_hfdsl_rzt2_if.h
Declaration	int32_t R_HFDSL_Control(const int32_t id, const r_hfdsl_cmd_t cmd, void *const p_buf);
Description	Call this function after executing function R_HFDSL_Open or after a protocol reset. For how to detect a protocol reset, see section “4.5.2 hfdsl_int_err_callback”.
Argument	id : Specifies the ID to be used. (It is defined in r_hfdsl_rzt2_dat.h.) R_HFDSL0_ID : Specifies channel 0. R_HFDSL1_ID : Specifies channel 1. Others : Setting is not allowed. cmd : Specify R_HFDSL_CMD_INIT. p_buf : Specify NULL.
Return value	R_HFDSL_SUCCESS: Normal termination R_HFDSL_ERR_INVALID_ARG: Abnormal termination (The id or p_buf is invalid.) R_HFDSL_ERR_ACCESS: Abnormal termination (R_HFDSL_Open has not been executed.) R_HFDSL_ERR_INIT: Abnormal termination (Link check timed out.)
Note	Calling this API function from within a callback function is prohibited.

(b) R_HFDSL_CMD_ENCID

R_HFDSL_CMD_ENCID	
Synopsis	Check encoder ID
Header	r_hfdsl_rzt2_if.h
Declaration	int32_t R_HFDSL_Control(const int32_t id, const r_hfdsl_cmd_t cmd, void *const p_buf);
Description	Call this function after the R_HFDSL_CMD_INIT protocol initialization command. If the value returned is R_HFDSL_ERR_INIT and the protocol is to be initialized again, start over again from the protocol initialization command R_HFDSL_CMD_INIT after executing the control command R_HFDSL_CMD_RST.
Argument	id : Specifies the ID to be used. (It is defined in r_hfdsl_rzt2_dat.h.) R_HFDSL0_ID : Specifies channel 0. R_HFDSL1_ID : Specifies channel 1. Others : Setting is not allowed. cmd : Specify R_HFDSL_CMD_ENCID. p_buf : Encoder ID Specify the unit32_t pointer which holds the encoder ID.
Return value	R_HFDSL_SUCCESS: Normal termination R_HFDSL_ERR_INVALID_ARG: Abnormal termination (The id is invalid or p_buf is null.) R_HFDSL_ERR_ACCESS: Abnormal termination (R_HFDSL_CMD_INIT has not been executed.) R_HFDSL_ERR_INIT: Abnormal termination (The connected encoder ID does not match the specified ID.)
Note	Calling this API function form within a callback function is prohibited.

(2) Control Commands

(a) R_HFDSL_CMD_POS

R_HFDSL_CMD_POS	
Synopsis	Acquiring the fast position
Header	r_hfdsl_rzt2_if.h
Declaration	int32_t R_HFDSL_Control(const int32_t id, const r_hfdsl_cmd_t cmd, void *const p_buf);
Description	This function acquires the fast position by reading the fast position registers (POS4 to POS0).
Argument	id : Specifies the ID to be used. (It is defined in r_hfdsl_rzt2_dat.h.) R_HFDSL0_ID : Specifies channel 0. R_HFDSL1_ID : Specifies channel 1. Others : Setting is not allowed. cmd : Specify R_HFDSL_CMD_POS. p_buf : Fast position Specifies the pointer to the r_hfdsl_pos_t structure which holds the fast position value. For details, see section “4.10.1(2) r_hfdsl_pos_t”.
Return value	R_HFDSL_SUCCESS: Normal termination R_HFDSL_ERR_INVALID_ARG： Abnormal termination (The id is invalid or p_buf is null.)

(b) R_HFDSL_CMD_VPOS

R_HFDSL_CMD_VPOS	
Synopsis	Acquiring the safe position
Header	r_hfdsl_rzt2_if.h
Declaration	int32_t R_HFDSL_Control(const int32_t id, const r_hfdsl_cmd_t cmd, void *const p_buf);
Description	This function acquires the safe position by reading the safe position registers (VPOS4 to VPOS0), and safe position CRC registers (VPOSCRC_H, VPOSCRC_L). If the safety channel 1 interface register access is disabled, this function returns access error.
Argument	id : Specifies the ID to be used. (It is defined in r_hfdsl_rzt2_dat.h.) R_HFDSL0_ID : Specifies channel 0. R_HFDSL1_ID : Specifies channel 1. Others : Setting is not allowed. cmd : Specify R_HFDSL_CMD_VPOS. p_buf : Safe position Specifies the pointer to the r_hfdsl_vpos_t structure which holds the safe position value. For details, see section “4.10.1(3) r_hfdsl_vpos_t”.
Return value	R_HFDSL_SUCCESS: Normal termination R_HFDSL_ERR_INVALID_ARG: Abnormal termination (The id is invalid or p_buf is null.) R_HFDSL_ERR_ACCESS: Abnormal termination (Access to the safety channel 1 interface registers is disabled.)

(c) R_HFDSL_CMD_VEL

R_HFDSL_CMD_VEL	
Synopsis	Acquiring the rotational velocity of the motor.
Header	r_hfdsl_rzt2_if.h
Declaration	int32_t R_HFDSL_Control(const int32_t id, const r_hfdsl_cmd_t cmd, void *const p_buf);
Description	This function acquires the rotational velocity of the motor by reading the velocity registers (VEL2 to VEL0).
Argument	id : Specifies the ID to be used. (It is defined in r_hfdsl_rzt2_dat.h.) R_HFDSL0_ID : Specifies channel 0. R_HFDSL1_ID : Specifies channel 1. Others : Setting is not allowed. cmd : Specify R_HFDSL_CMD_VEL. p_buf : Rotational velocity of the motor Specifies the pointer to uint32_t which holds the rotational velocity of the motor.
Return value	R_HFDSL_SUCCESS: Normal termination R_HFDSL_ERR_INVALID_ARG: Abnormal termination (The id is invalid or p_buf is null.)

(d) R_HFDSL_CMD_MSG

R_HFDSL_CMD_MSG	
Synopsis	Transmitting messages
Header	r_hfdsl_rzt2_if.h
Declaration	int32_t R_HFDSL_Control(const int32_t id, const r_hfdsl_cmd_t cmd, void *const p_buf);
Description	This function transmits messages. The data received is indicated by function hfdsl_int_mrcv_callback. For details of the function, see section “4.5.4 hfdsl_int_mrcv_callback”.
Argument	id : Specifies the ID to be used. (It is defined in r_hfdsl_rzt2_dat.h.) R_HFDSL0_ID : Specifies channel 0. R_HFDSL1_ID : Specifies channel 1. Others : Setting is not allowed. cmd : Specify R_HFDSL_CMD_MSG. p_buf : Message data for transmission Specifies the pointer to the r_hfdsl_send_msg_t structure which holds message data for transmission. For details, see section “4.10.1(4) r_hfdsl_send_msg_t”.
Return value	R_HFDSL_SUCCESS: Normal termination R_HFDSL_ERR_INVALID_ARG: Abnormal termination (The id is invalid or p_buf is null.) R_HFDSL_ERR_ACCESS: Abnormal termination (The protocol initialization function described in section “4.4.4(1) Protocol Initialization Commands”, has not been executed.)
Note	Calling this API function from within a callback function is prohibited. To proceed with the next transmission, execute this function following the hfdsl_int_mrcv_callback function.

(e) R_HFDSL_CMD_RST

R_HFDSL_CMD_RST	
Synopsis	Protocol reset
Header	r_hfdsl_rzt2_if.h
Declaration	int32_t R_HFDSL_Control(const int32_t id, const r_hfdsl_cmd_t cmd, void *const p_buf);
Description	This function resets the protocol. After this function is called. An HDSLn_INT interrupt is generated in response to the PRST bit in the EVENT_H being set to 1. To resume communications, call the functions described in section “4.4.4(1), Protocol Initialization Commands”.
Argument	id : Specifies the ID to be used. (It is defined in r_hfdsl_rzt2_dat.h.) R_HFDSL0_ID : Specifies channel 0. R_HFDSL1_ID : Specifies channel 1. Others : Setting is not allowed. cmd : Specify R_HFDSL_CMD_RST. p_buf : Specify NULL.
Return value	R_HFDSL_SUCCESS: Normal termination R_HFDSL_ERR_INVALID_ARG: Abnormal termination (The id or p_buf is invalid.)

(f) R_HFDSL_CMD_SMSG

R_HFDSL_CMD_SMSG	
Synopsis	Transmitting short message
Header	r_hfdsl_rzt2_if.h
Declaration	int32_t R_HFDSL_Control(const int32_t id, const r_hfdsl_cmd_t cmd, void *const p_buf);
Description	This function transmits messages. The data received is indicated by function hfdsl_int_smrcv_callback. For details of the function, see section “4.5.5 hfdsl_int_smrcv_callback”.
Argument	id : Specifies the ID to be used. (It is defined in r_hfdsl_rzt2_dat.h.) R_HFDSL0_ID : Specifies channel 0. R_HFDSL1_ID : Specifies channel 1. Others : Setting is not allowed. cmd : Specify R_HFDSL_CMD_SMSG. p_buf : Message data for transmission Specifies the pointer to the r_hfdsl_send_msg_t structure which holds message data for transmission. For details, see section “4.10.1(4) r_hfdsl_send_msg_t”.
Return value	R_HFDSL_SUCCESS: Normal termination R_HFDSL_ERR_INVALID_ARG: Abnormal termination (The id is invalid or p_buf is null.) R_HFDSL_ERR_ACCESS: Abnormal termination (the protocol initialization function described in section “4.4.4(1) Protocol Initialization Commands”, has not been executed.)
Note	Calling this API function from within a callback function is prohibited. To proceed with the next transmission, execute this function following the hfdsl_int_smrcv_callback function.

4.5 Specifications of User-defined Functions

4.5.1 hfdsl_int_nml_callback

hfdsl_int_nml_callback	
Synopsis	Indicating the generation of HDSLn_FPR interrupt
Header	-
Declaration	void hfdsl_int_nml_callback(uint8_t event);
Description	This callback function is registered with the member variable p_cb_nml of the argument r_hfdsl_info_t structure of the R_HFDSL_Open function. It is called when an HDSLn_FPR interrupt is generated. This interrupt shows that the fast position registers (POS4 to POS0) have been updated. The fast position can be acquired by executing the function R_HFDSL_Control (R_HFDSL_CMD_POS) from within this function. This function is the context of the interrupt handler. To ensure interrupt responsiveness, return immediately. The function name is an example and can be set freely.
Argument	event : Source of the interrupt Holds the value POS_RDY_BIT. The value of this argument is only valid within this function.
Return value	None

4.5.2 hfdsl_int_err_callback

hfdsl_int_err_callback	
Synopsis	Indicating the generation of HDSLn_INT interrupt
Header	-
Declaration	void hfdsl_int_err_callback(uint32_t event_err);
Description	This callback function is registered with the member variable p_cb_err of the argument r_hfdsl_info_t structure of the R_HFDSL_Open function. It is called when an HDSLn_INT interrupt is generated in response to the SUM, POS, DTE or PRST bits in the EVENT_H register, or the MIN, ANS or QMLW bits in the EVENT_L register being set to 1. This function is the context of the interrupt handler. To ensure interrupt responsiveness, return immediately. The function name is an example and can be set freely.
Argument	event_err : Source of the HDSLn_INT interrupt Holds the value of the EVENT_H, EVENT_L registers. The value of this argument is only valid within this function.
Return value	None
Note	This function is not called when an HDSLn_INT is generated in response to the FREL bit in the EVENT_L register being set to 1.

4.5.3 hfdsl_int_safety_callback

hfdsl_int_safety_callback	
Synopsis	Indicating the generation of HDSLn_SP interrupt
Header	-
Declaration	void hfdsl_int_safety_callback(uint8_t *p_safety1);
Description	This callback function is registered with the member variable p_cb_safety of the argument r_hfdsl_info_t structure of the R_HFDSL_Open function. It is called when an HDSLn_SP interrupt is generated. This interrupt shows that the safety position registers have been updated. This function is the context of the interrupt handler. To ensure interrupt responsiveness, return immediately. The function name is an example and can be set freely.
Argument	p_safety1[ ] : Safety status, safe position, and CRC If the safety channel 1 interface register access is enabled. the array pointed by p_safety1 holds vertical channel data. vertical channel data contains safety status (SAFE_SUM) register data, safe position (VPOS4 to VPOS0) register data, and safe position CRC (VPOSCRC_H, VPOSCRC_L) register data. If the safety channel 1 interface register access is disabled, p_safety1 holds NULL pointer. The value of this argument is only valid within this function.
Return value	None

4.5.4 hfdsl_int_mrcv_callback

hfdsl_int_mrcv_callback	
Synopsis	Indicating that the HDSLn_INT interrupt by the FREL bit in the EVENT_L register has occurred.
Header	-
Declaration	void hfdsl_int_mrcv_callback(uint8_t* msg_data);
Description	This callback function is registered with the R_HFDSL_Control (R_HFDSL_CMD_MSG) function. It is called when the HDSLn_INT interrupt by the FREL bit in the EVENT_L register occurs, and data storage of the received message is completed. This function is the context of the interrupt handler. To ensure interrupt responsiveness, return immediately. The function name is an example and can be set freely.
Argument	msg_data[] : Message address and PC_BUFF register values (long messages) Two bytes of the message address (PC_ADD_H, PC_ADD_L) and the values of the PC_BUF0 to PC_BUF7 registers (long messages) are stored. The fifth bit LOFF of the message address PC_ADD_H holds the message reception error flag. The value of this argument remains valid until the next HDSLn_INT interrupt caused by the FREL bit is generated.
Return value	None

4.5.5 hfdsl_int_smrcv_callback

hfdsl_int_smrcv_callback	
Synopsis	Indicating that the HDSLn_INTS interrupt by the FRES bit in the EVENT_S register has occurred.
Header	-
Declaration	void hfdsl_int_smrcv_callback(uint8_t* msg_data);
Description	This callback function is registered with the R_HFDSL_Control(R_HFDSL_CMD_SMSG) function. It is called when the HDSLn_INTS interrupt by the FRES bit in the EVENT_S register occurs, and data storage of the received message is completed. This function is the context of the interrupt handler. To ensure interrupt responsiveness, return immediately. The function name is an example and can be set freely.
Argument	msg_data[] : PC_DATA register value PC_DATA register value (as short messages) is stored. The value of this argument remains valid until the next HDSLn_INTS interrupt caused by the FRES bit is generated.
Return value	None

4.6 Interrupt Handler

4.6.1 hfdsl_int_isr_ch0

hfdsl_int_isr_ch0	
Synopsis	Interrupt handler for the HDSL0_INT
Header	-
Declaration	static void hfdsl_int_isr_ch0(void);
Description	An interrupt handler for the HDSL0_INT interrupt. If the source of an interrupt is the FREL bit of the EVENT_L register, function hfdsl_int_mrcv_callback is called as a callback function. If the source of an interrupt is other bits of the EVENT_H register and the EVENT_L register, function hfdsl_int_err_callback is called as a callback function.
Argument	None
Return value	None

4.6.2 hfdsl_int_isr_ch1

hfdsl_int_isr_ch1	
Synopsis	Interrrupt handler for the HDSL1_INT
Header	-
Declaration	static void hfdsl_int_isr_ch1(void);
Description	An interrupt handler for the HDSL1_INT interrupt. If the source of an interrupt is the FREL bit of the EVENT_L register, function hfdsl_int_mrcv_callback is called as a callback function. If the source of an interrupt is other bits of the EVENT_H register and the EVENT_L register, function hfdsl_int_err_callback is called as a callback function.
Argument	None
Return value	None

4.6.3 hfdsl_ints_isr_ch0

hfdsl_ints_isr_ch0	
Synopsis	Interrrupt handler for the HDSL0_INTS
Header	-
Declaration	static void hfdsl_ints_isr_ch0(void);
Description	An interrupt handler for the HDSL0_INTS interrupt. If the source of an interrupt is the FRES bit of the EVENT_S register, function hfdsl_int_smrcv_callback is called as a callback function.
Argument	None
Return value	None

4.6.4 hfdsl_ints_isr_ch1

hfdsl_ints_isr_ch1	
Synopsis	Interrrupt handler for the HDSL1_INTS
Header	-
Declaration	static void hfdsl_ints_isr_ch1(void);
Description	An interrupt handler for the HDSL1_INTS interrupt. If the source of an interrupt is the FRES bit of the EVENT_S register, function hfdsl_int_smrcv_callback is called as a callback function.
Argument	None
Return value	None

4.6.5 hfdsl_fpr_isr_ch0

hfdsl_fpr_isr_ch0	
Synopsis	Interrupt handler for the HDSL0_FPR
Header	-
Declaration	static void hfdsl_fpr_isr_ch0(void);
Description	An interrupt handler for the HDSL0_FPR interrupt. If the interrupt is generated, function hfdsl_int_nml_callback is called as a callback function.
Argument	None
Return value	None

4.6.6 hfdsl_fpr_isr_ch1

hfdsl_fpr_isr_ch1	
Synopsis	Interrupt handler for the HDSL1_FPR
Header	-
Declaration	static void hfdsl_fpr_isr_ch1(void);
Description	An interrupt handler for the HDSL1_FPR interrupt. If the interrupt is generated, function hfdsl_int_nml_callback is called as a callback function.
Argument	None
Return value	None

4.6.7 hfdsl_sp_isr_ch0

hfdsl_sp_isr_ch0	
Synopsis	Interrupt handler for the HDSL0_SP
Header	-
Declaration	static void hfdsl_sp_isr_ch0(void);
Description	An interrupt handler for the HDSL0_SP interrupt. If the interrupt is generated, function hfdsl_int_safety_callback is called as a callback function.
Argument	None
Return value	None

4.6.8 hfdsl_sp_isr_ch1

hfdsl_sp_isr_ch1	
Synopsis	Interrupt handler for the HDSL1_SP
Header	-
Declaration	static void hfdsl_sp_isr_ch1(void);
Description	An interrupt handler for the HDSL1_SP interrupt. If the interrupt is generated, function hfdsl_int_safety_callback is called as a callback function.
Argument	None
Return value	None

4.6.9 hfdsl_err_isr

hfdsl_err_isr	
Synopsis	Interrupt handler for the PERI_ERR0
Header	-
Declaration	static void hfdsl_err_isr(void);
Description	An interrupt handler for the PERI_ERR0 interrupt. If the interrupt is generated, this function reads error events from PERIERR_STAT3 register and clear interrupt.
Argument	None
Return value	None

4.7 Interrupts

Table 4.2 lists the interrupts for the HFDSL driver.

Table 4.2 Interrupts for the HFDSL Driver

Interrupts	ID	Outline
HDSL0_INT	263	Generated when the value of any bit in the ch0 EVENT_L, EVENT_H registers is updated to 1.
HDSL0_INTS	264	Generated when the short message of the ch0 is received.
HDSL1_INT	265	Generated when the value of any bit in the ch1 EVENT_L, EVENT_H registers is updated to 1.
HDSL1_INTS	266	Generated when the short message of the ch1 is received.
HDSL0_FPR	273	Generated when the fast position value of the ch0 is ready to read.
HDSL1_FPR	274	Generated when the fast position value of the ch1 is ready to read.
HDSL0_SP	275	Generated when the safety position value of the ch0 is ready to read.
HDSL1_SP	276	Generated when the safety position value of the ch1 is ready to read.
PERI_ERR0	388	Generated when the value of any bit indicating HDLS ch0 or ch1 error in the PERIERR_STAT3 register is updated to 1.

4.8 Constants and Error Codes

The tables below list the constants and error codes. For the definitions, see the respective tables.

Table 4.3 User-defined Constants for the HFDSL Driver (r_hfdsl_rzt2_config.h)

Constant Name	Setting	Description
R_HFDSL_SYNC_CTRL	3	Setting of the SYNC_CTRL register
R_HFDSL_ACC_ERR	31	Setting of the ACC_ERR register
R_HFDSL_MASK_H	4Bh	Setting of the MASK_H register *1
R_HFDSL_MASK_L	36h	Setting of the MASK_L register *1

Note 1. To change R_HFDSL_MASK_H and R_HFDSL_MASK_L, change processing of the hfdsl_int_isr_ch0 function, hfdsl_int_isr_ch1 function in accord with the settings in the R_HFDSL_MASK_H and R_HFDSL_MASK_L.

Table 4.4 Error Codes

Constant Name	Setting	Description
R_HFDSL_SUCCESS	0	Normal termination
R_HFDSL_ERR_INVALID_ARG	-1	Argument error
R_HFDSL_ERR_ACCESS	-2	API execution order error, register access error
R_HFDSL_ERR_INIT	-3	Failure in initialization of the HFDSL controller and encoder

Table 4.5 Interface Mode Codes for the Safe Interface

Constant Name	Setting	Description
R_HFDSL_INTERNAL_BUS_MODE	0	Internal bus mode
R_HFDSL_SPI_MODE	1	SPI mode

4.9 Fixed-width Integers

Table 4.6 lists the fixed-width integers for the sample code. The fixed-width integers used in the sample code are defined in the standard library.

Table 4.6 Fixed-width Integers for the Sample Code

Symbols	Description
int8_t	8-bit signed integer
int16_t	16-bit signed integer
int32_t	32-bit signed integer
int64_t	64-bit signed integer
uint8_t	8-bit unsigned integer
uint16_t	16-bit unsigned integer
uint32_t	32-bit unsigned integer
uint64_t	64-bit unsigned integer

4.10 Structures, Unions, and Enumerated Types

The major structures, unions, and enumerated types are listed below.

4.10.1 Structures

(1) r_hfdsl_info_t

Information on initialization of the HFDSL driver

```
typedef struct
{
    uint8_t                 safe1_if_mode;  Select the interface mode for safety channel 1 interface.
                                            (0: Internal bus mode, 1: SPI mode) *1
    uint8_t                 safe2_if_mode;  Select the interface mode for safety channel 2 interface. *2
    r_hfdsl_int_nml_cb_t    p_cb_nml;       Pointer to the callback function to be called when an
                                            HDSLn_FPR interrupt is generated.
                                            For details, see section “4.5.1, hfdsl_int_nml_callback”. *3
                                            *4
    r_hfdsl_int_err_cb_t    p_cb_err;       Pointer to the callback function to be called when an
                                            HDSLn_INT interrupt is generated.
                                            For details, see section “4.5.2, hfdsl_int_err_callback”.  *3
    r_hfdsl_int_safety_cb_t p_cb_safety;    Pointer to the callback function to be called when an
                                            HDSLn_SP interrupt is generated.
                                            For details, see section “4.5.3, hfdsl_int_safety_callback”.
                                            *3
} r_hfdsl_info_t
```

Note: 1. If the SPI mode is selected for safety channel 1 interface, access to the safety channel 1 interface registers from sample program is disabled. SPI mode is used to access the safety channel 1 registers by external CPU via SPI interface.
2. Safety channel 2 interface is always SPI mode for the RZ/T2L. Setting value of this parameter is not used by the RZ/T2L.
3. This function is not called if NULL is specified.
4. This function is not called when an HDSLn_INT interrupt is generated in response to the FREL bit in the EVENT_L register being set to 1.

(2) r_hfdsl_pos_t

For storing fast position

```
typedef struct
{
    bool        all;    Enables the member variable posh.
                        (true: The member variable posh is enabled,
                         false: The member variable is disabled)
    uint8_t     posh;   Holds bits [39:32] of the fast position.
                        The value is updated when the member variable all is true.
    uint32_t    pos;    Holds bits [31:0] of the fast position.
} r_hfdsl_pos_t
```

(3) r_hfdsl_vpos_t

For storing the safe position

```
typedef struct
{
    uint8_t     vposh;    Holds bits [39:32] of the safe position.
    uint32_t    vpos;     Holds bits [31:0] of the safe position.
    uint16_t    crc;      Holds the CRC of the vertical channel
} r_hfdsl_vpos_t
```

(4) r_hfdsl_send_msg_t

For storing message data for transmission.

```
typedef struct
{
    uint8_t         *pdata;     Pointer to the array which holds message data for transmission.
                                In the case of using with R_HFDSL_CMD_MSG control
                                command, set the pointer to the array which holds message data
                                for transmission.
                                In reading case with R_HFDSL_CMD_SMSG command, set the
                                pointer to the array which holds R_HFDSL_SMSG_READ and
                                address to read. In writing case with R_HFDSL_CMD_SMSG
                                command, set the pointer to the array which holds
                                R_HFDSL_SMSG_WRITE, address, and data to write.
    r_hfdsl_msg_cb_t    p_cb_msg;   Pointer to the callback function to be called when a message is
                                received.
                                For details, see sections “4.5.4, hfdsl_int_mrcv_callback” and
                                “4.5.5 hfdsl_int_smrcv_callback”.
                                Be sure to set the address of hfdsl_int_mrcv_callback in case of
                                using with R_HFDSL_CMD_MSG control command. Set the
                                address of hfdsl_int_smrcv_callback in reading case with
                                R_HFDSL_CMD_SMSG control command.
                                In writing case with R_HFDSL_CMD_SMSG control command,
                                no callback operation is generated. Set NULL for p_cb_msg.
} r_hfdsl_send_msg_t
```

4.10.2 Unions

Not used.

4.10.3 Enumerated Types

Not used.

4.11 Description of the Sample Program

4.11.1 Outline of Operations

This sample program supports the encoder (EDM35-2KF0A020A from SICK AG) compliant with the HIPERFACE DSL communications protocols specification. It handles the following processing.

1) Indicates the following information by using a command input from the console.
   A) Fast and safe positions
   B) Rotational velocity of the motor
   C) Results of transmission and reception of long messages (the type of encoder from resources)
   D) Vertical channel data
   E) Received status (ENC_ST0) by short message
2) Runs in SYNC mode.
3) This sample program ends by detecting a protocol reset.

(1) System Block Diagram

Figure 4.1 shows a block diagram of the system.

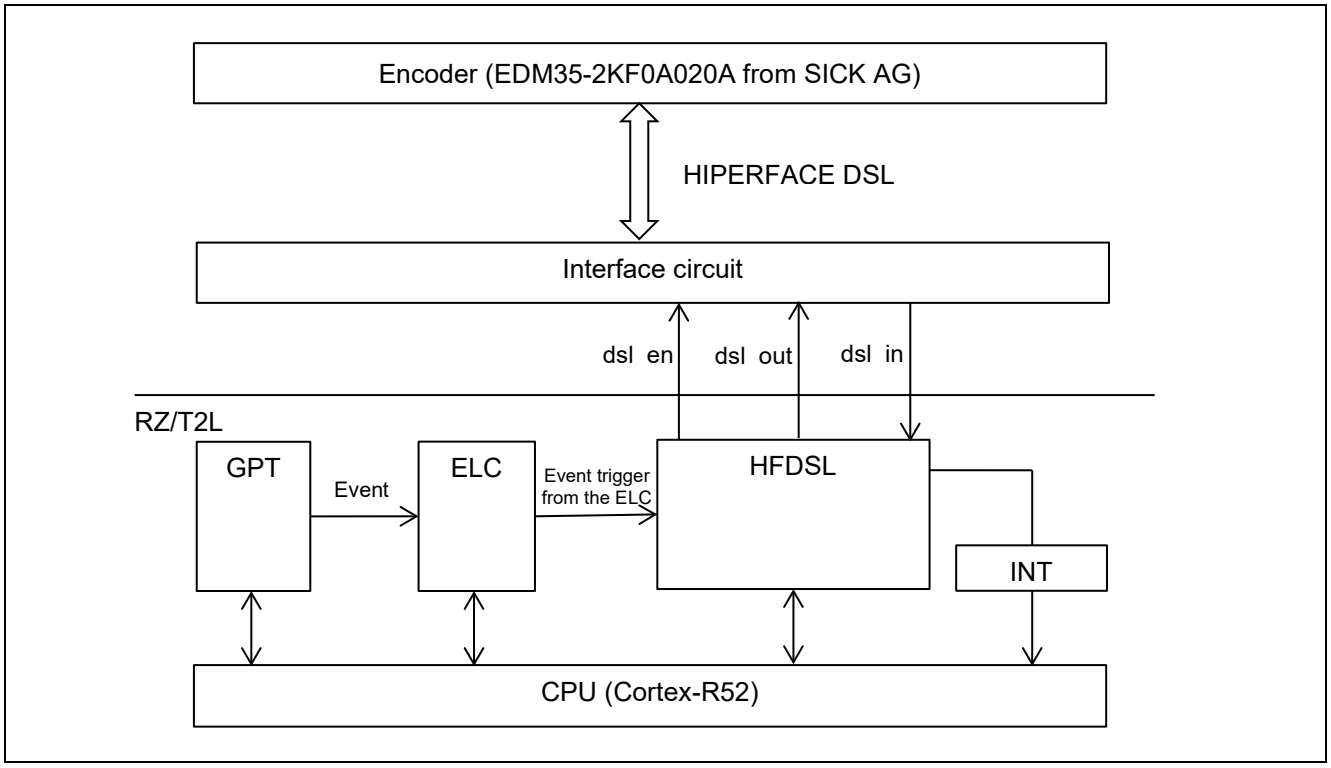

Figure 4.1 System Block Diagram

(2) Software Configuration

Figure 4.2 is a block diagram of the software.

The HFDSL driver has six sections: the opening process part configured of function R_HFDSL_Open, the closing process part configured of function R_HFDSL_Close, the protocol initialization, positional value acquisition, and message transmission parts configured of function R_HFDSL_Control, and the data reception part (interrupt handler) configured of the callback function.

The HFDSL driver controller section of the sample program controls the HFDSL driver, acquires the positional value, and sends messages. The results indication section (callback) displays the results of data reception.

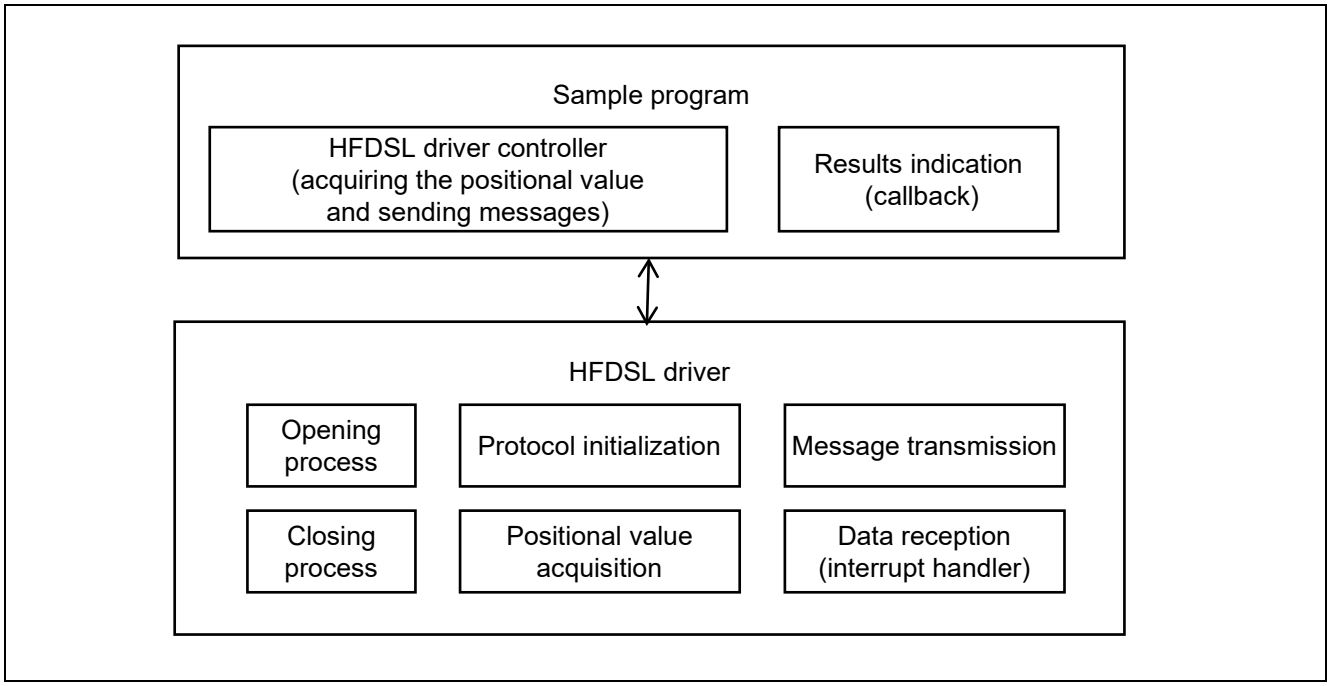

Figure 4.2 Software Configuration

4.11.2 Variables for the Sample Program

Table 4.7 lists the major static variables.

Table 4.7 Major Static Variables

Type	Variable Name	Description
bool	mrcv_flg	Message transfer completed flag (true: Transfer of messages has been completed false: Transfer of messages is in progress)
bool	prst_found	Protocol reset warning detection flag (true: Protocol reset warning is detected false: Protocol reset warning is not detected)
uint32_t	err_info	Holds the HDSLn_INT interrupt source.
uint32_t	pos_rot	Holds the number of rotations with the fast position.
uint32_t	pos_res	Holds the angle of the fast position.
bool	vpos_valid	Holds result of the safe position is valid or not.
uint32_t	vpos_rot	Holds the number of rotations with the safe positions.
uint32_t	vpos_res	Holds the angle of the safe position.
uint32_t	vel	Holds the rotational velocity of the motor.
uint8_t	lmsg_recv[LMSG_RECV_SIZE]	Holds received data in long messages.
uint8_t	smsg_recv	Holds received short message data.
bool	safety1_valid	Holds result of the vertical channel data is valid or not.
uint8_t	safety1[SAFETY_CNT_MAX]	Holds the received data including vertical channel data.

4.11.3 Constants for the Sample Program

Table 4.8 lists the major constants for the sample program.

Table 4.8 Major Constants

Constant Name	Setting	Description
ENC_ID	00000153h	Encoder ID of EDM35-2KF0A020A *1 *2
RES_BIT	0	Position of the least significant bit of the positional information in the POS4 to 0 registers *1
RES_MASK	000FFFFFh	Masking of the positional information in the POS3 to 0 registers *1
RES_MASK_H	00000000h	Masking of the positional information in the POS4 register *1
ROT_BIT	20	Position of the least significant bit of the rotational information in the POS4 to 0 registers *1
ROT_MASK	00000FFFh	Masking of the number of rotations in the POS3 to 0 registers *1
ROT_MASK_H	00000000h	Masking of the number of rotations in the POS4 register *1
LMSG_RECV_SIZE	10	Maximum size of received data in long messages
SAFETY_CNT_MAX	8	Vertical channel data size
TIMEOUT_UNIT	1000	Setting of timeout unit (1 ms)
TIMEOUT_COUNT	1000	Setting of timeout (1 ms x 1000)
INIT_RETRY_COUNT	10	Retry times of initialization error

Note: 1. To run the sample program with an encoder other than an EDM35-2KF0A020A, change the settings to suit the specifications of the connected encoder.
2. Refer to the “HIPERFACE DSL® MASTER Safety Integration Manual” for details.

The figure below shows the mechanism for storing the positional and rotational information.

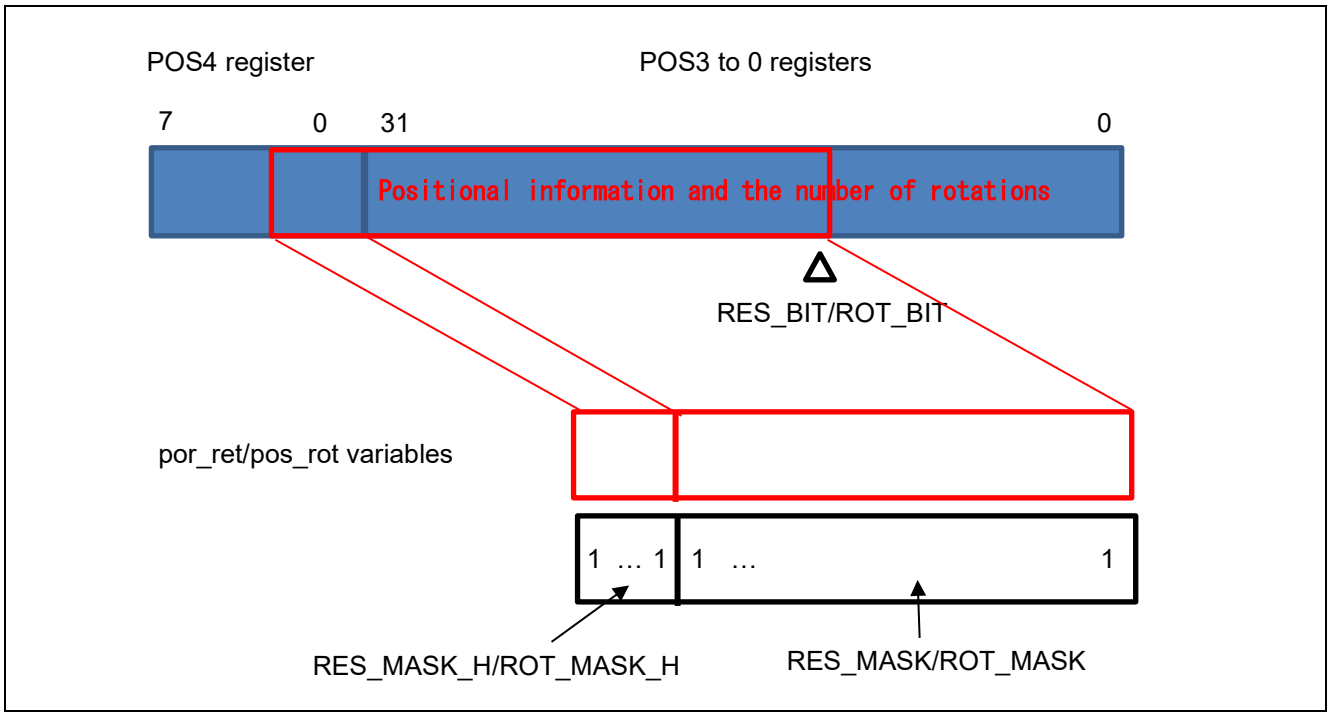

Figure 4.3 Mechanism for Storing the Positional and Rotational Information

4.11.4 Flowchart of Main Processing

The flowchart below shows processing by the main function.

Processing marked with * in the figure is shown separately in a subsequent flowchart.

(1) Flowchart of enc_main

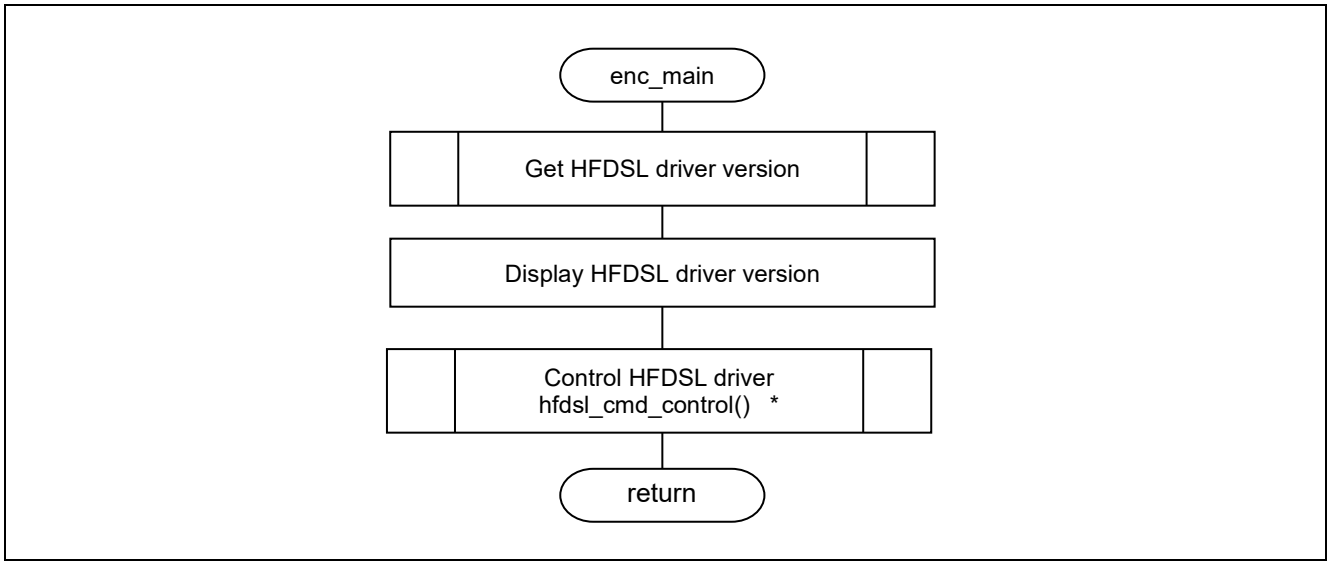

Figure 4.4 Flowchart of the enc_main Function

(2) Flowchart of hfdsl_cmd_control

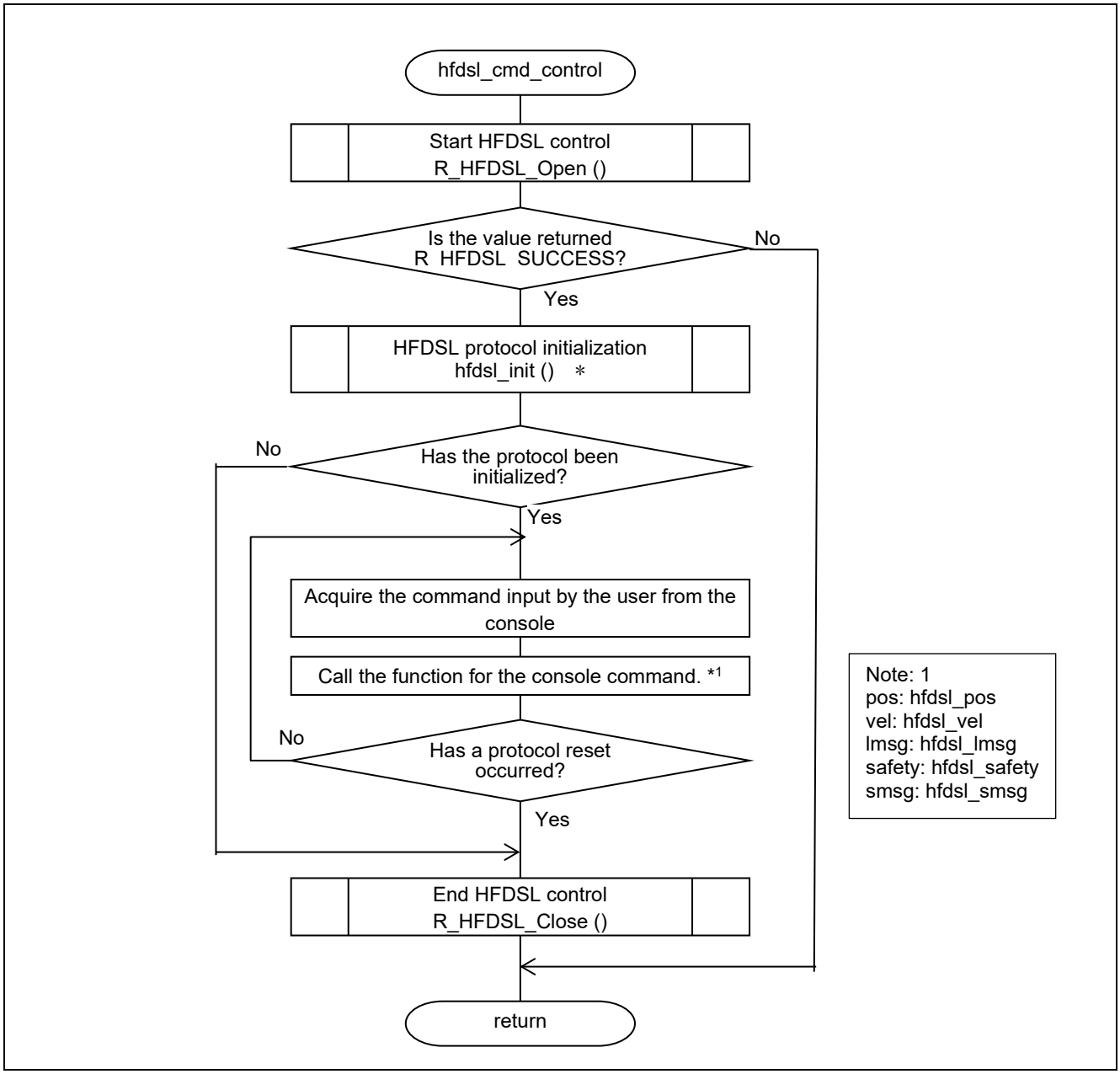

Figure 4.5 Flowchart of the hfdsl_cmd_control

(3) Flowchart of hfdsl_init

This function initializes the protocol.

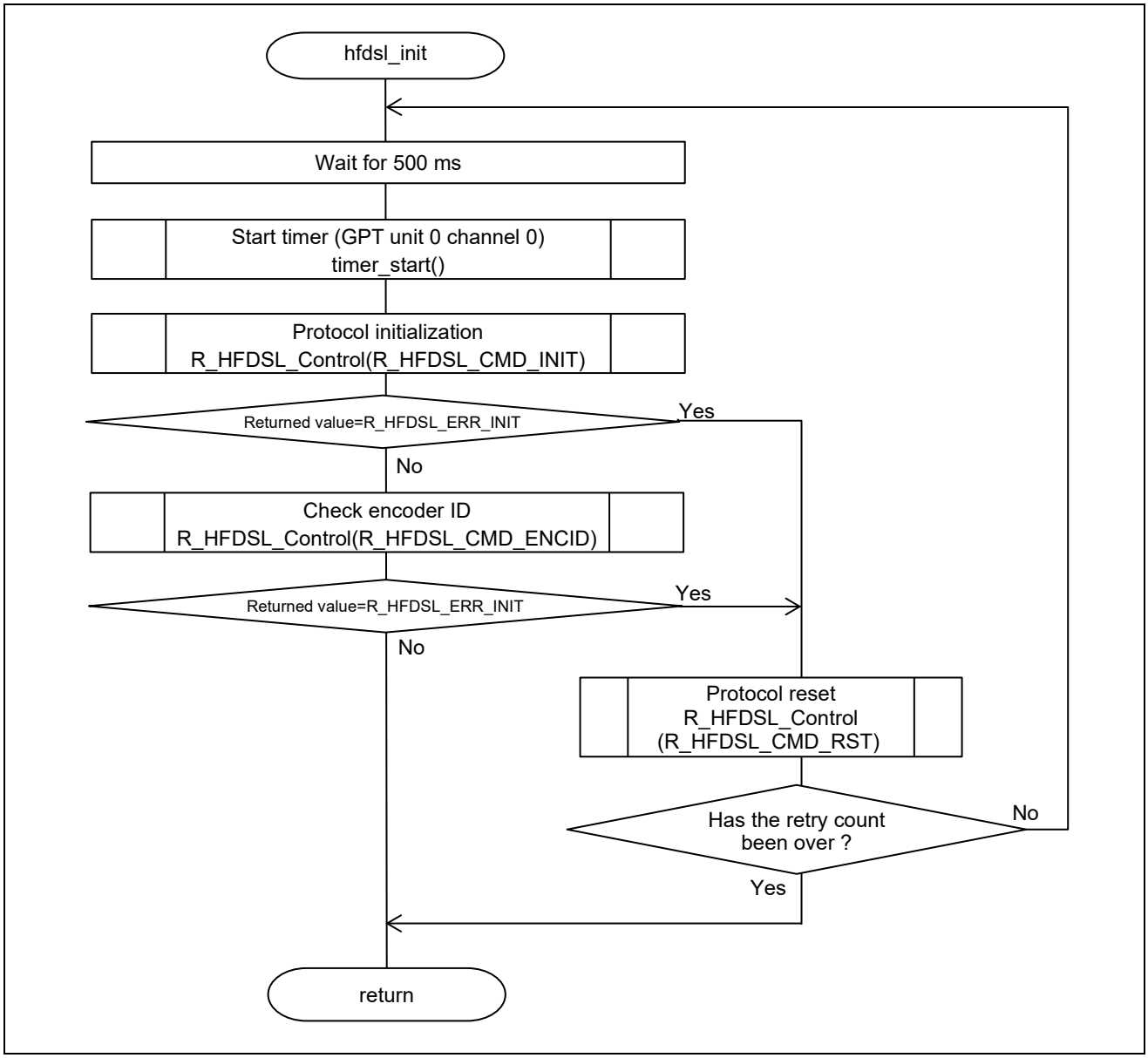

Figure 4.6 Flowchart of the hfdsl_init

(4) Flowchart of hfdsl_pos, hfdsl_vel, hfdsl_safety

These functions are executed in response to input of the console commands “pos”, “vel” and “safety”, and indicate the acquired data. The functions corresponding to the respective console commands and details of the items displayed are below.

Table 4.9 Functions Corresponding to the Console Commands “pos”, “vel”, “safety”

Console Command	Corresponding Function	Items Displayed
pos	hfdsl_pos	pos_rot, pos_res vpos_rot, vpos_res err_info
vel	hfdsl_vel	vel, err_info
safety	hfdsl_safety	safety1

Since the procedures for processing of the hfdsl_pos, hfdsl_vel and hfdsl_safety functions are similar, they are shown in the same flowchart.

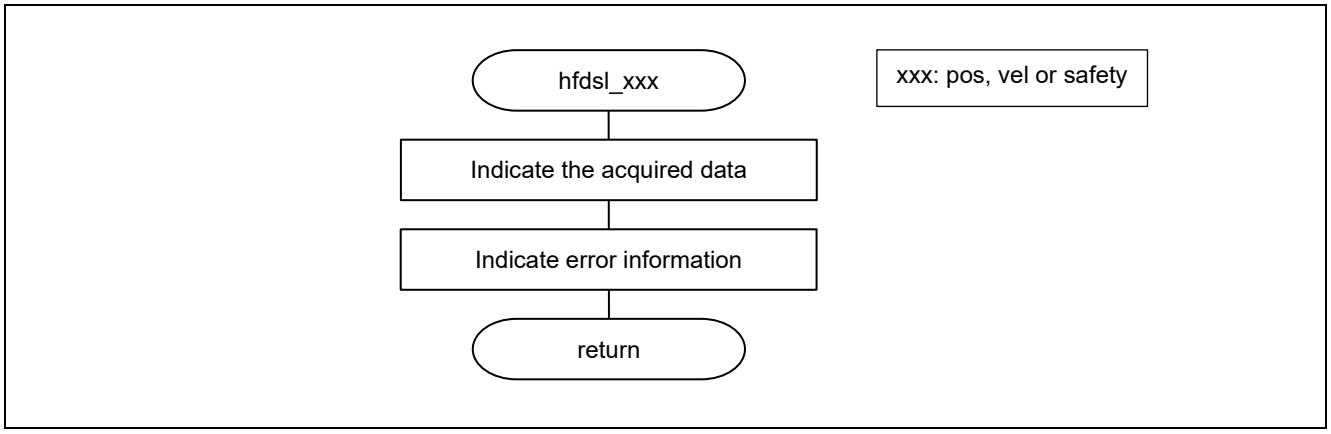

Figure 4.7 Flowchart of the hfdsl_pos, hfdsl_vel, hfdsl_safety

(5) Flowchart of hfdsl_lmsg

This function is executed in response to input of the console command “lmsg”.

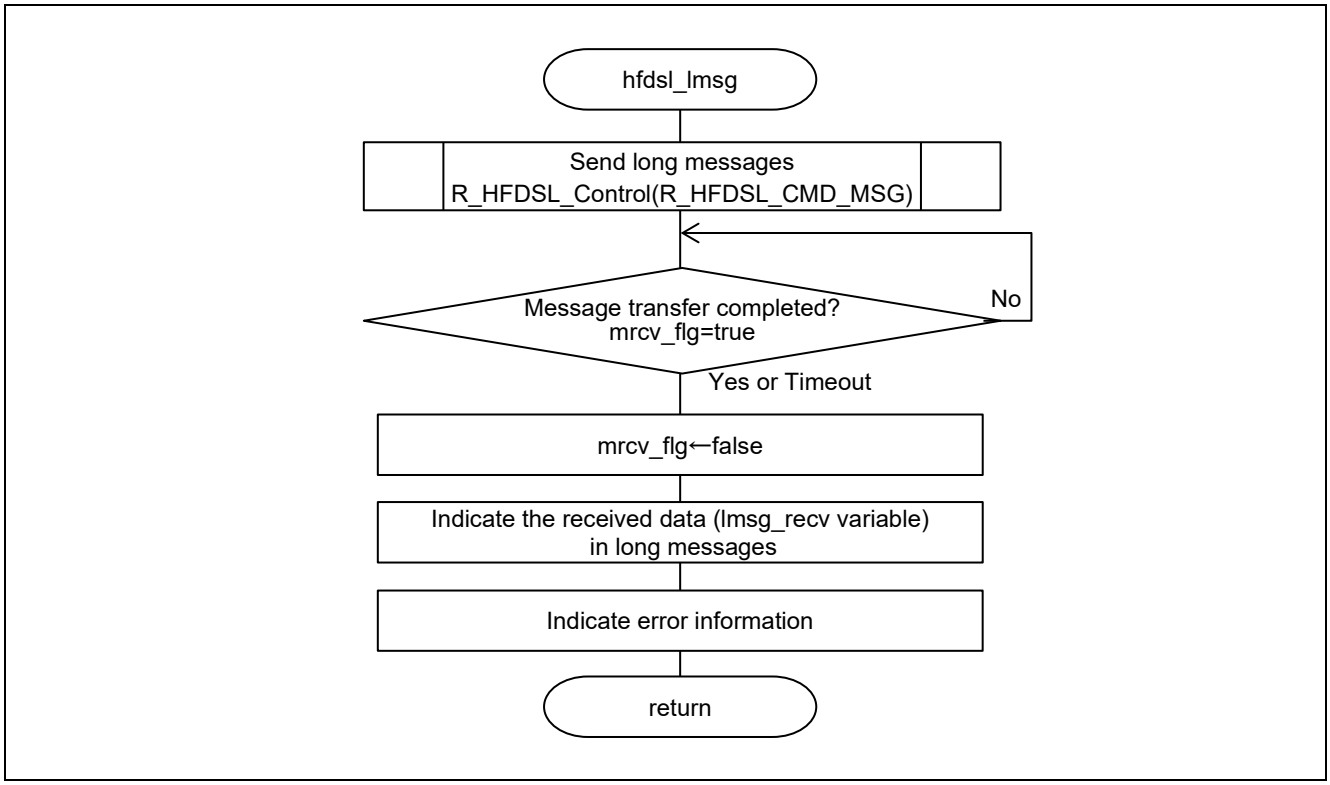

Figure 4.8 Flowchart of the hfdsl_lmsg

(6) Flowchart of hfdsl_smsg

This function is executed in response to input of the console command “smsg”.

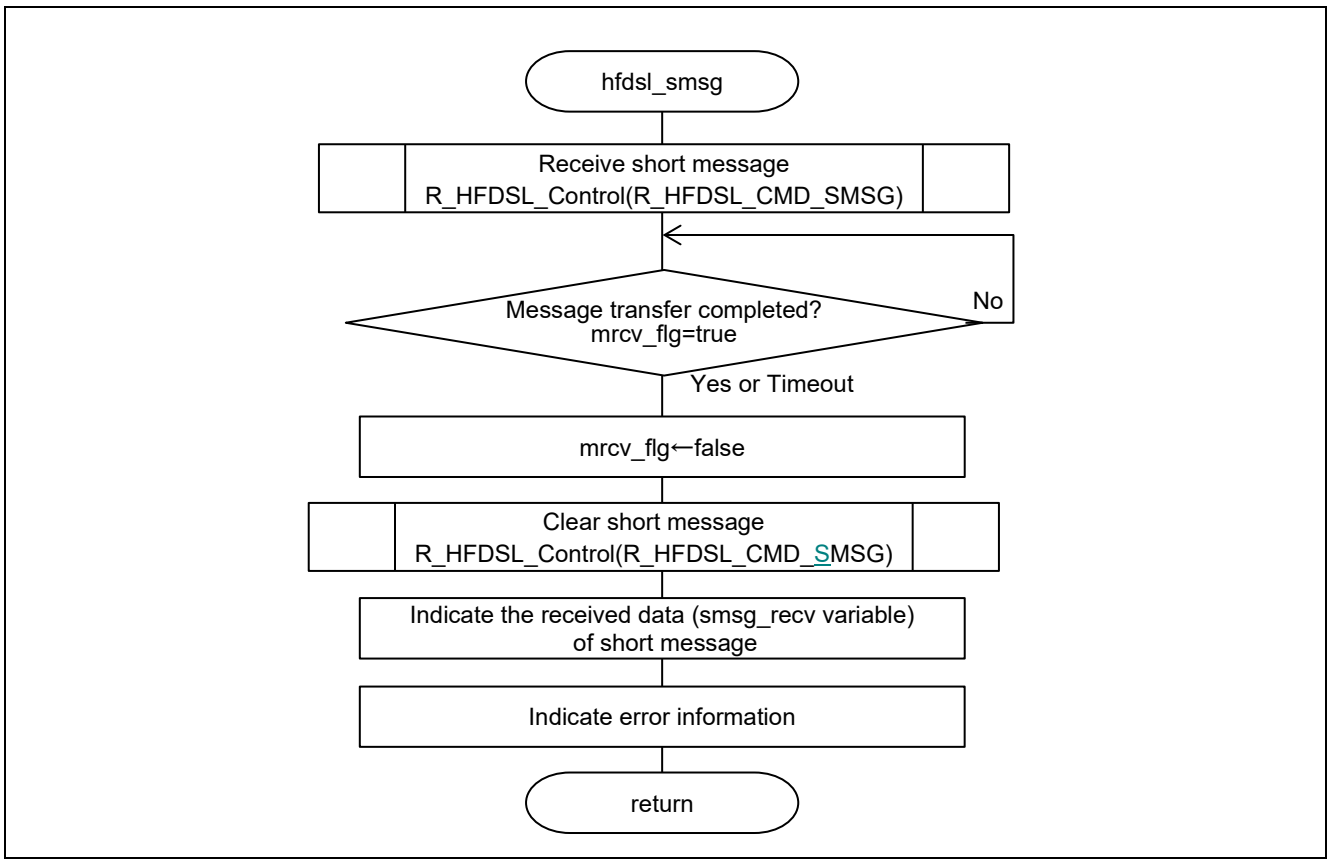

Figure 4.9 Flowchart of the hfdsl_smsg

(7) Flowchart of hfdsl_int_nml_callback

This callback function is called in response to generation of an HDSLn_FPR interrupt.

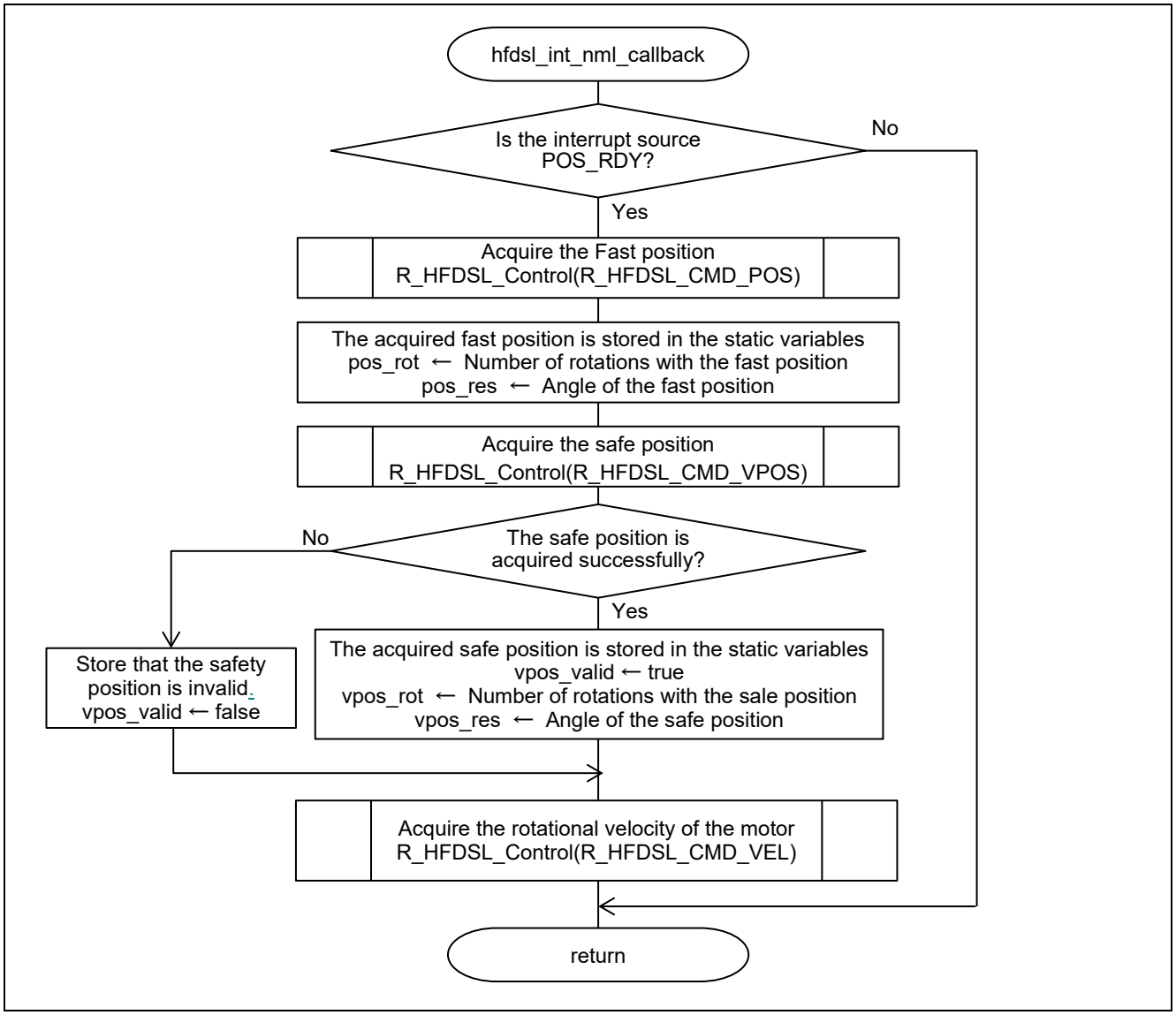

Figure 4.10 Flowchart of the hfdsl_int_nml_callback

(8) Flowchart of hfdsl_int_err_callback

This callback function is called in response to generation of an HDSLn_INT interrupt.

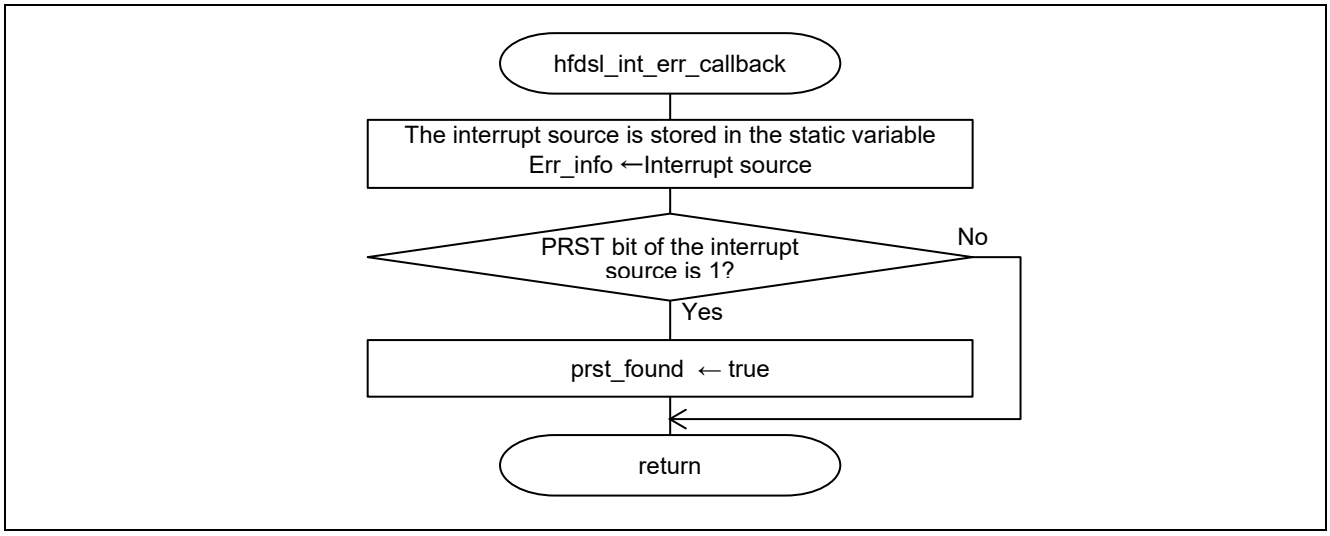

Figure 4.11 Flowchart of the hfdsl_int_err_callback

(9) Flowchart of hfdsl_int_safety_callback

This callback function is called in response to generation of an HDSLn_SP interrupt.

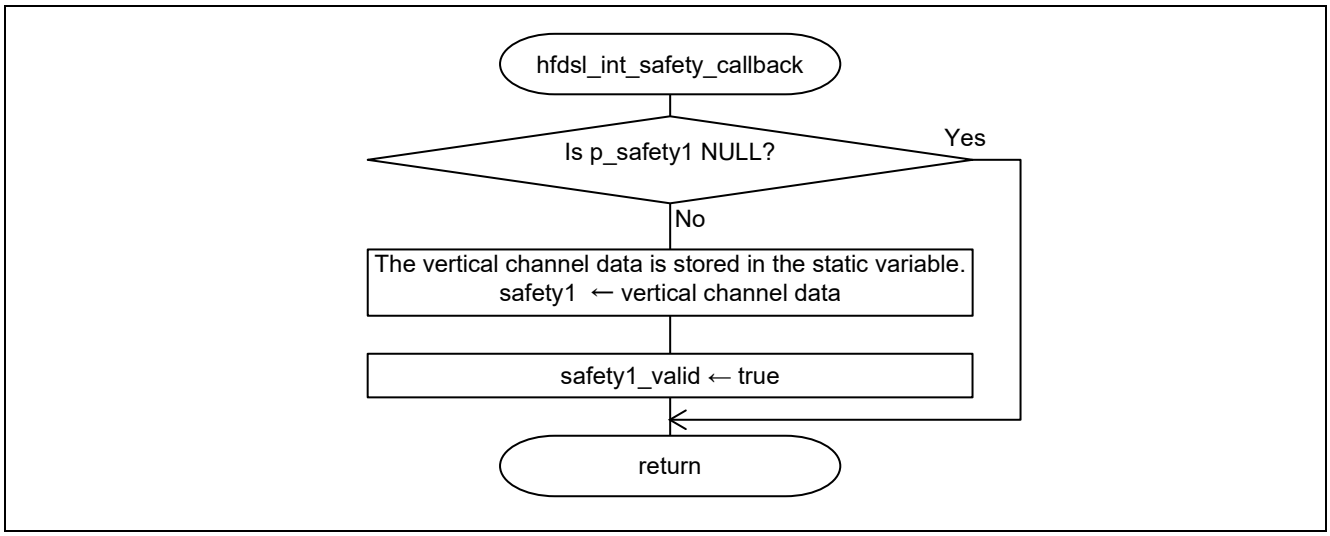

Figure 4.12 Flowchart of the hfdsl_int_safety_callback

(10) Flowchart of hfdsl_int_mrcv_callback

This callback function is called when the HDSLn_INT interrupt by the EVENT_L register FREL bit occurs and data storage of the received message is completed.

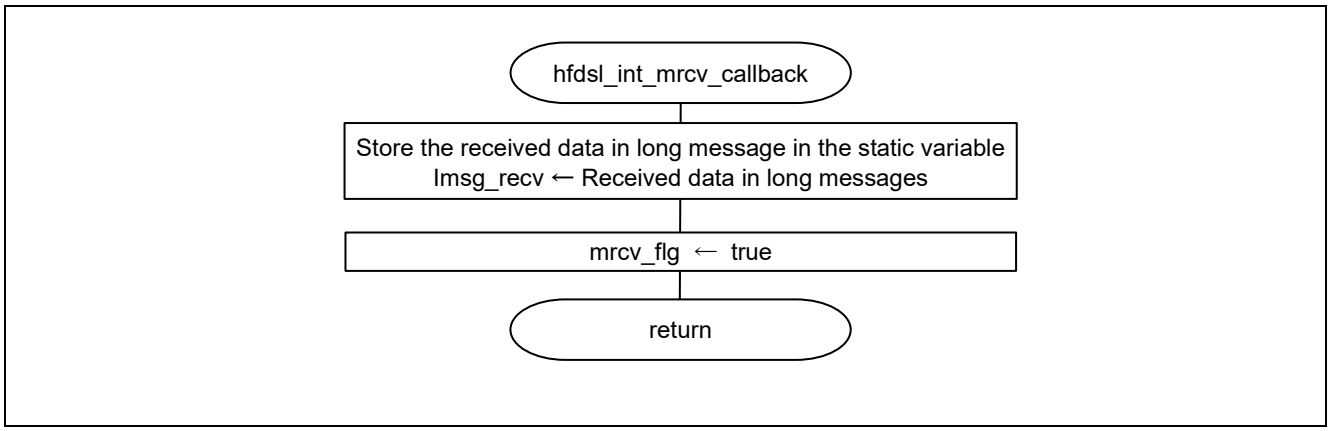

Figure 4.13 Flowchart of the hfdsl_int_mrcv_callback

(11) Flowchart of hfdsl_int_smrcv_callback

This callback function is called when the HDSLn_INTS interrupt by the EVENT_S register FRES bit occurs and data storage of the received message is completed.

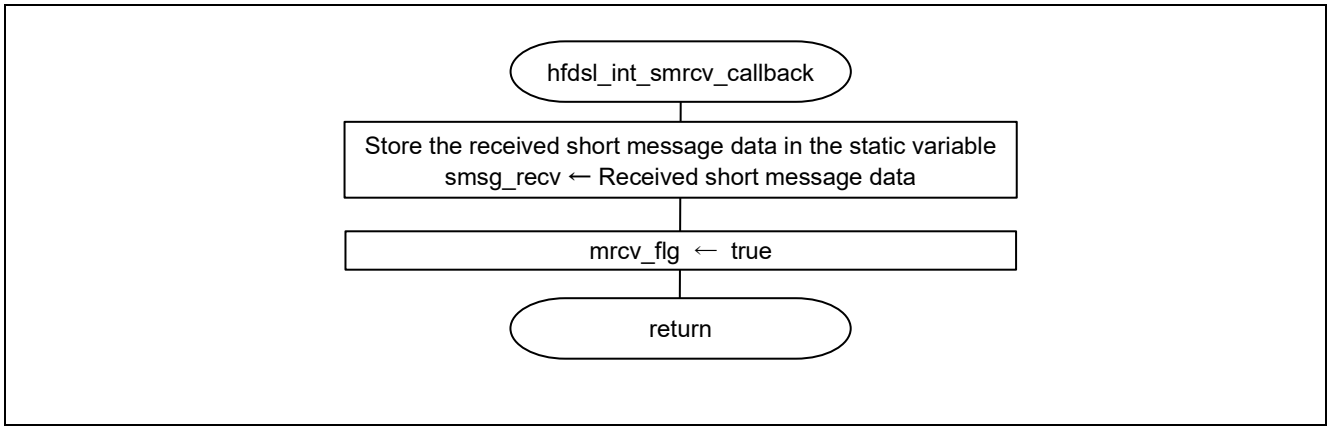

Figure 4.14 Flowchart of the hfdsl_int_smrcv_callback

4.11.5 Operation Sequence

(1) Startup Sequence

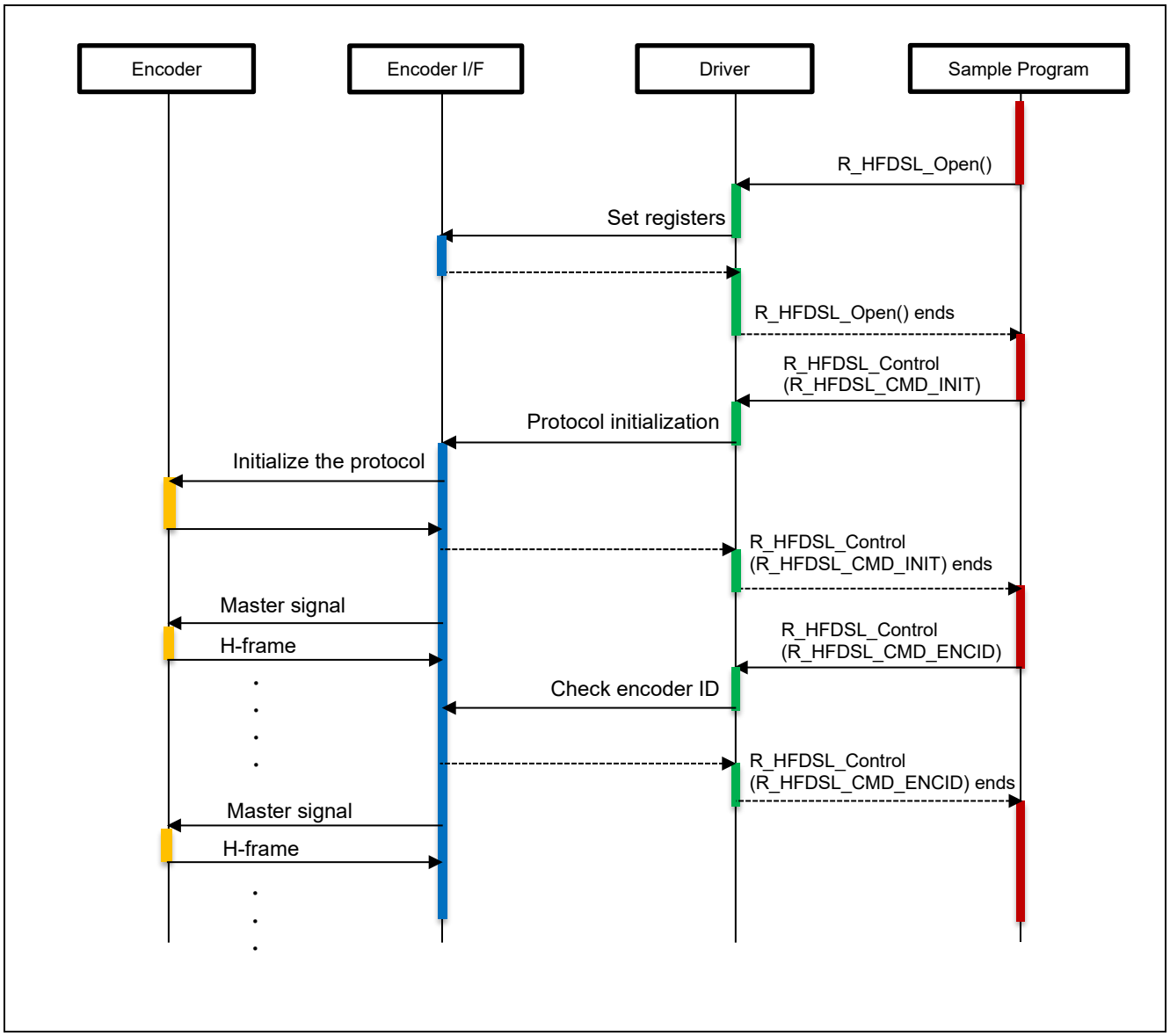

Figure 4.15 Startup Sequence Diagram

(2) Fast Position in SYNC Mode Acquisition Sequence

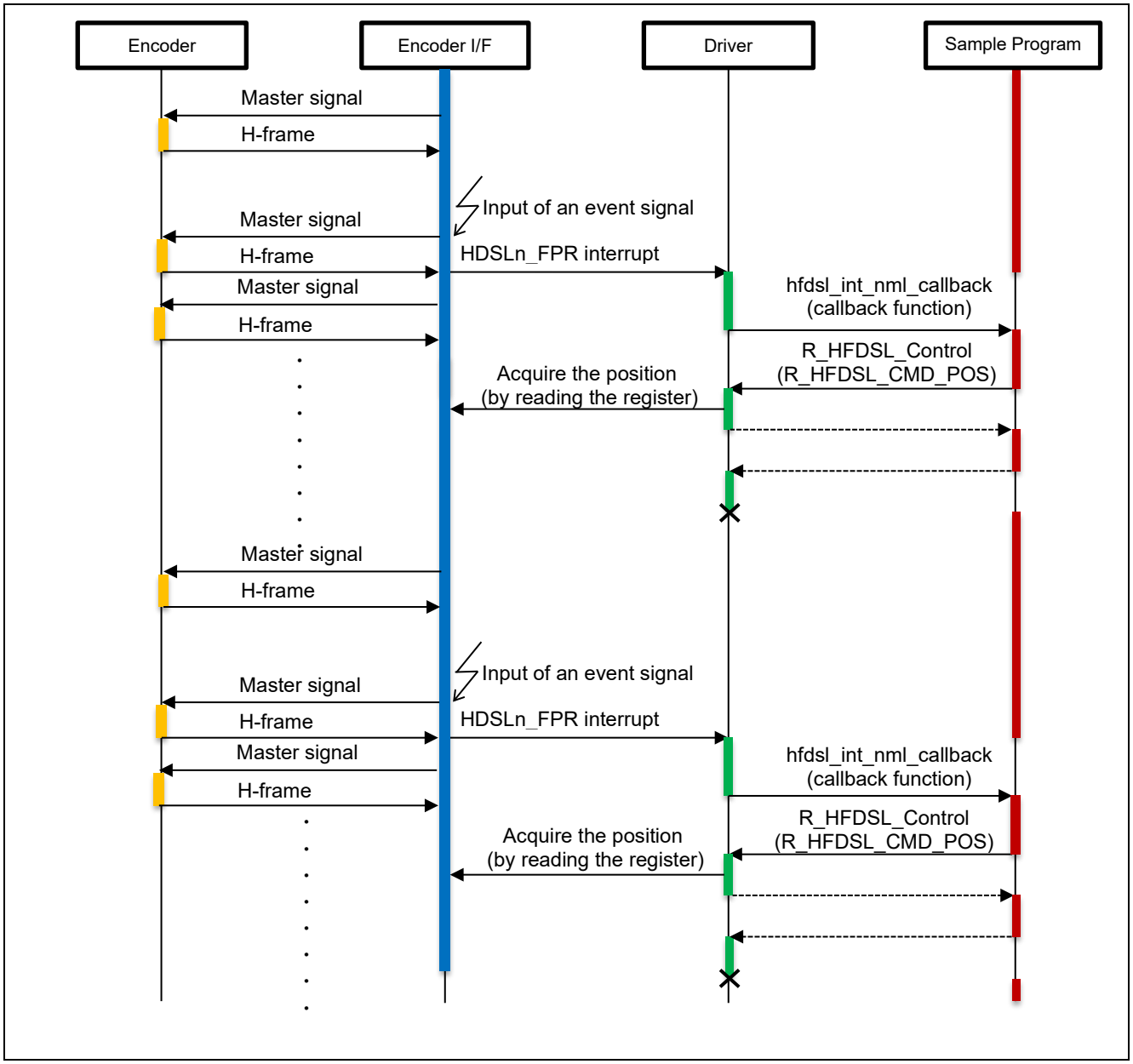

Figure 4.16 Fast Position in SYNC Mode Acquisition Sequence Diagram

(3) Vertical Channel Data Acquisition Sequence

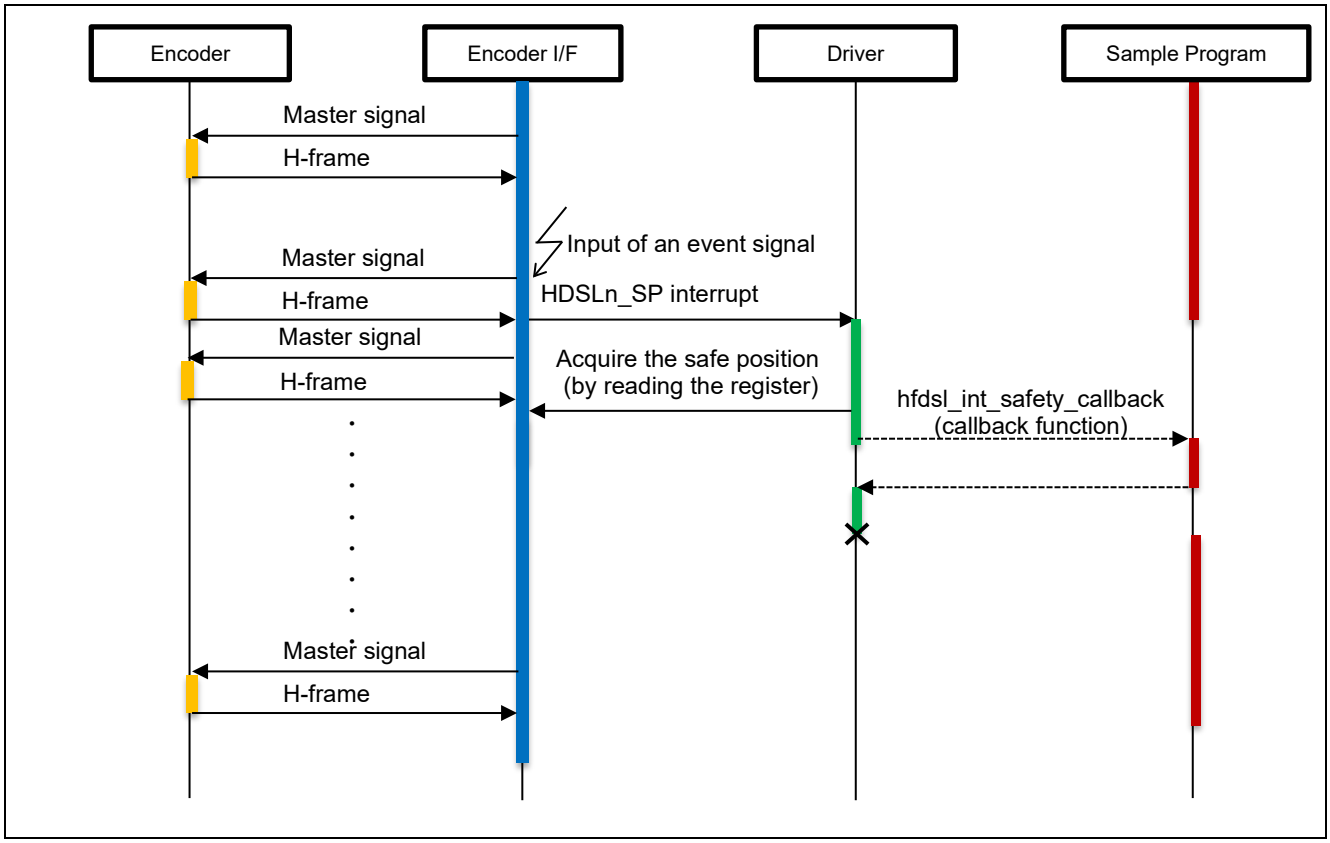

Figure 4.17 Vertical Channel Data Acquisition Sequence Diagram

(4) Message Transfer Sequence

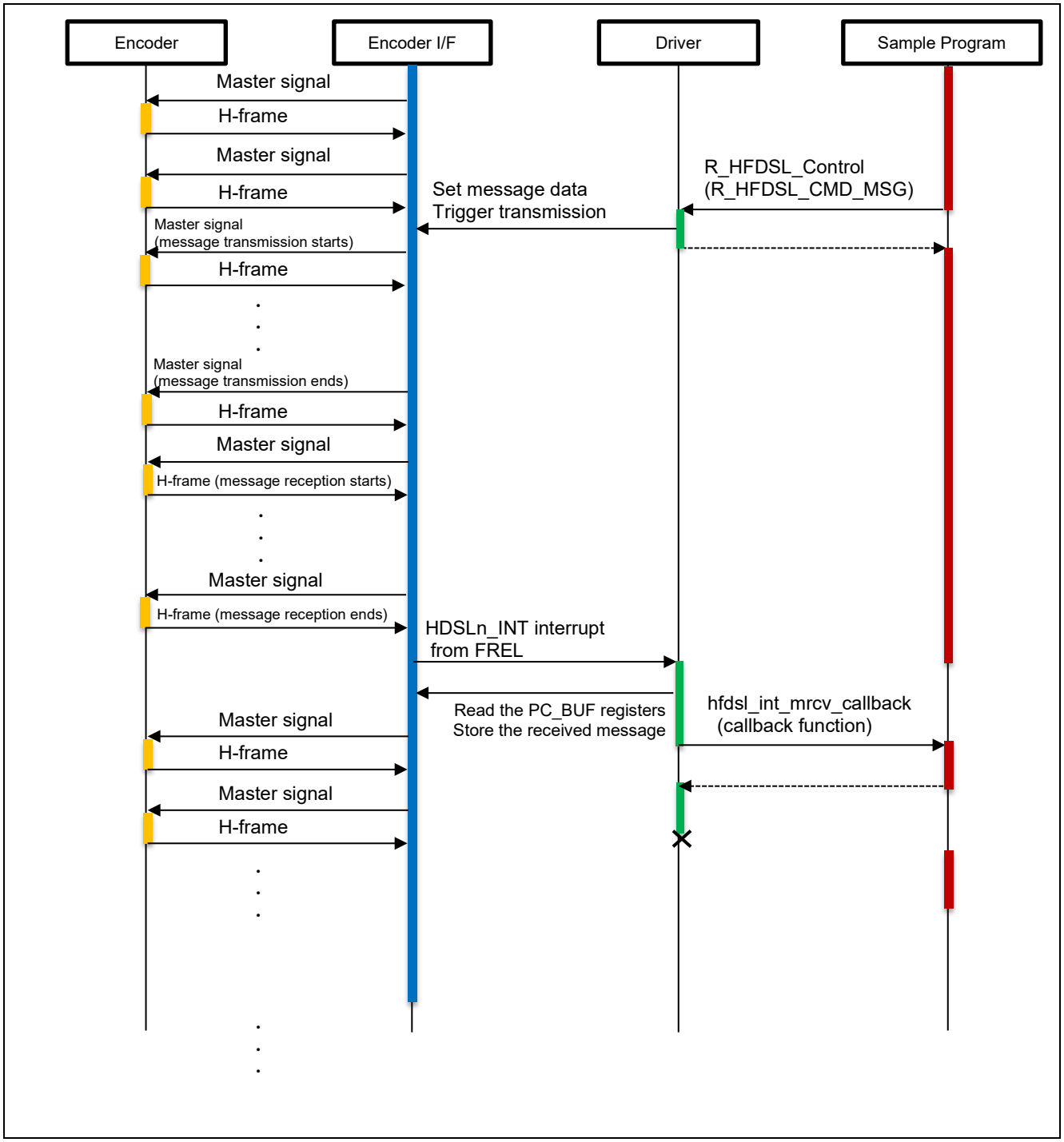

Figure 4.18 Message Transfer Sequence Diagram

(5) Stop Sequence

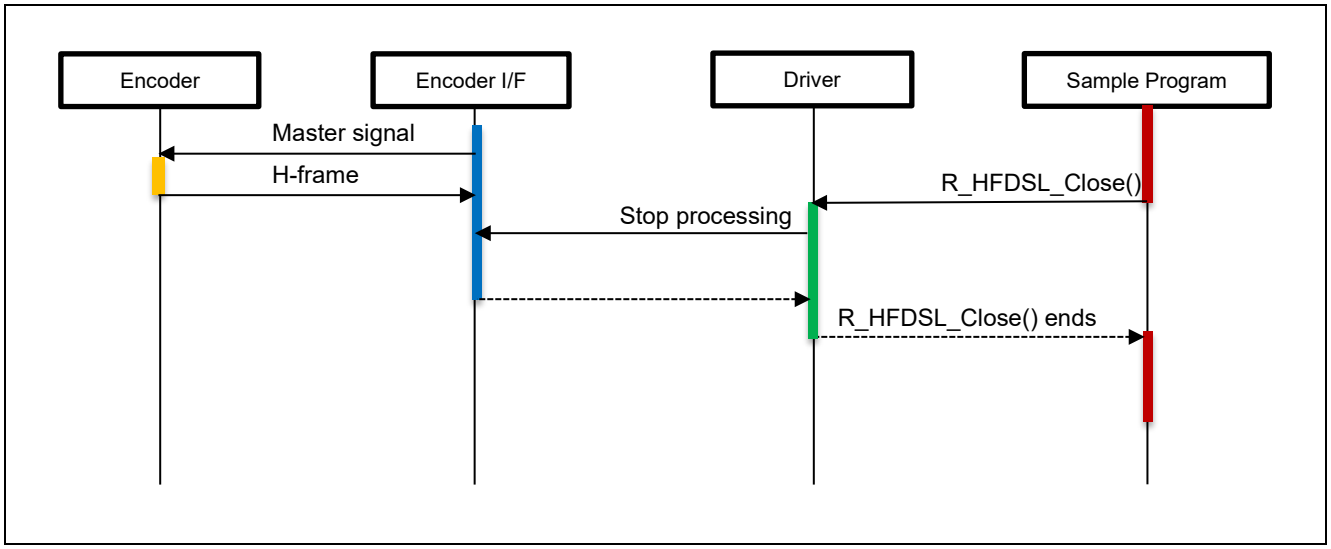

Figure 4.19 Stop Sequence Diagram

4.11.6 Console Commands

The commands available for input from the console are listed below.

Table 4.10 Console Commands

Command	Description
pos	Indicates the fast and safe positions
vel	Indicates the rotational velocity of the motor.
lmsg	Among the encoder resources, acquire the type of the encoder as a long message.
safety	Displays received data of vertical channel.
smsg	Acquire encoder status ENC_ST0 by short message and clear the status.

(1) Result of Running

After running, it will display the command prompt following the version. Enter the command after “hfdsl>”.

```
HFDSL Safety sample program start
R_HFDSL_GetVersion = 4.0


hfdsl >
```

(2) pos Command

Fast position: The result of R_HFDSL_CMD_POS in the hfdsl_int_nml_callback function is displayed.

Safe position: The result of R_HFDSL_CMD_VPOS in the hfdsl_int_nml_callback function is displayed. *

Error information: The result of the hfdsl_int_err_callback function is displayed.

```
hfdsl >pos
Fast position
   Rotations    : 0x000002E1
   Angle        : 0x0002D564
Safe position
   Rotations    : 0x000002E1
   Angle        : 0x0002D564
Error information
   EVENT_ERR    : 0x00000000
```

Note: If the SPI mode is selected for safety channel 1 interface mode by the argument p_info of the R_HFDSL_Open function, access to the safety channel 1 interface registers is disabled. Values for the safe position are shown as “–".

(3) vel Command

Motor rotation speed: The result of R_HFDSL_CMD_VEL in the hfdsl_int_nml_callback function is displayed.

Error information: The result of the hfdsl_int_err_callback function is displayed.

```
hfdsl >vel
Motor rotation speed
   Speed       : 0x00000026
Error information
   EVENT_ERR   : 0x00000000
```

(4) lmsg Command

Message address: The message address of the long message is displayed.

Motor rotation speed: The result of the hfdsl_int_mrcv_callback function is displayed.

Error information: The result of the hfdsl_int_err_callback function is displayed.

```
hfdsl >lmsg
Message address
   PC_ADD_H : 0x54
   PC_ADD_L : 0x80
Received data
   PCBUF[0] : 0x00
   PCBUF[1] : 0x02
Error information
   EVENT_ERR   : 0x00000000
```

(5) safety Command

SAFETY POSITION 1 data: The result of the hfdsl_int_safety_callback function is displayed. *

The “data” are register data, “Rotations” and “Angle” are the values after conversion.

SAFETY POSITION 2 data: Safety position 2 is not accessible from this sample program, Values are displayed as “—“.

```
hfdsl >safety
SAFETY POSITION 1 data
   Rotations   : 0x000002E1
   Angle       : 0x000F055D
   data : 0x05 0x00 0x2E 0x1F 0x05 0x5D 0x79 0x7F
SAFETY POSITION 2 data
   Rotations   : --
   Angle       : --
   data : -- -- -- -- -- -- -- --
```

Note: If the SPI mode is selected for safety channel 1 interface mode by the argument p_info of the R_HFDSL_Open function, access to the safety channel 1 interface registers is disabled. Values for the SAFETY POSITION 1 are shown as “–", too.

(6) smsg Command

Message address: The message address and the recived data of the short message are displayed.

Error information: The result of the hfdsl_int_err_callback function is displayed.

```
hfdsl >smsg
Message address
   ENC_STn      : 0x40
   S_PC_DATA    : 0x01
Error information
   EVENT_ERR    : 0x00000000
```

5. Sample Code

The sample code can be downloaded from the Renesas Electronics website.

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	May 31.23	-	First Edition issued.
2.00	May 24.24	5 20	Update description of the board name. Remove description about location of integer type definition.
3.00	Oct 3.25	1, 4, 5 4, 25 8, 15 7, 13, 15, 16, 18, 21, 22 31, 34 40, 42	Change description for trademarks. Update notes of HIPERFACE DSL MASTER Safety Integration Manual. Revise to unify description for functions. Update user-defined function, control command, interrupt handler by supporting short message. Update list of interrupts, outline of operations. Add flowchart of functions hfdsl_smsg and hfdsl_int_smrcv_callback for processing short message. Add smsg command.
4.00	Apr 17.26	8 to 14, 20 13 to 15	Change prefix of pointer variables to “p_”. Revise header column of the specifications of user-defined functions.

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)
   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on
   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state
   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins
   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals
   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin
   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
7. Prohibition of access to reserved addresses
   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products
   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

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