LISr-ISP SoC

SPI Protocol

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[Reference]

[**Revision History**]

|  |  |  |  |
| --- | --- | --- | --- |
| Ver | Date | Description | Editor |
| 0.1 | 2023-08-14 | Create | TF |
| 0.2 | 2023-09-08 | Update message fields from uint32 to uint16 | LiuTie |
| 0.3 | 2024-09-03 | Change to English | TF |

# **Overview**

This document describes the communication protocol between the Host and LiSoC in the LISr ISP system. The Host sends the parameters and system control commands required for image processing to LiSoC through the SPI interface. In communication, Host acts as SPI master and LiSoC acts as SPI slave.

In order to synchronize the parameters on both sides, after the Host initiates a connection request, LiSoC needs to send all parameters to the Host

The Overview of Host🡪LiSoC communication sequence is shown in the following figure:

Synchronization parameter request, synchronization parameter response

(System control parameters, image processing parameters)

Connection request, connection confirmation

Connection status refresh request (periodically sent), connection status confirmation

Change parameter request, change parameter response

(System control parameters, image processing parameters)

Connection status refresh request (periodically sent), connection status confirmation

。。。

Figure 1 Overview of Host->LiSoC Communication Sequence

# **Communication Protocol**

## Communication establishment and monitoring

■Communication Retry

Host's communication connection requirements for LiSoC require a retry (RETRY) if the communication connection fails. If the maximum of 3 retries still fail, give up.

■Communication monitoring

When LiSoc does not send data to the Host, the Host sends a Link Alive Check Command to LiSoC at regular intervals (tentatively 1 second). If there is no response, it indicates a system malfunction. Host performs a reset operation on LiSoC. (Can Host reset LiSoCLiSoc)

## Communication Sequence

LiSoC (SPI slave)

Host (SPI master)

Connect Req

Connect Resp

Read SYS param Req

Read SYS param Resp

Read ISP param Req

Read ISP param Resp

Alive check Req

Alive check Resp

**……**

Write all SYS param Req

Write all SYS param Resp

Write all ISP param Req

Write all ISP param Resp

Write 1 SYS/ISP param Req

Write 1 SYS/ISP param Resp

Alive check Req

Alive check Resp

**……**

Figure 2 Communication Sequence between Host and LiSoC

## Data transmission content

When the Host sends data to LiSoC through the SPI interface, the Host is SPI master and LiSoC is SPI slave.

The data sent by Host to LiSoC through SPI interface can be divided into the following situations:

(1) When the Host starts, it will synchronize all parameters of LiSoC;

(2) Host image parameter changes, Host sends the changed image parameters to LiSoC;

(3) Host system parameter changes, Host will send the changed system parameters to LiSoC;

### Host startup

Table 1 Host needs to synchronize LiSoC data(RCC\_CTL)

|  |  |  |
| --- | --- | --- |
| Params | Data Type | Remark |
| RCC\_CR | UINT32 |  |
| RCC\_DATPLLCFGR | UINT32 |  |
| RCC\_SYSPLLCFGR | UINT32 |  |
| RCC\_SYSCFGR | UINT32 |  |
| RCC\_SYSENR | UINT32 |  |
| RCC\_PERENR | UINT32 |  |
| RCC\_DPENR | UINT32 |  |
| RCC\_SYSBLKRSTR | UINT32 |  |
| RCC\_DPBLKRSTR | UINT32 |  |
| RCC\_DCXO\_CTRL0 | UINT32 |  |
| RCC\_DCXO\_CTRL1 | UINT32 |  |
| RCC\_DATPLLCTRL | UINT32 |  |
| RCC\_SYSPLLCTRL | UINT32 |  |
| RCC\_RTC32KCTRL | UINT32 |  |
| RCC\_TRIMCTRL | UINT32 |  |
| RCC\_ANATEST | UINT32 |  |
| RCC\_DEBUGRO | UINT32 |  |
| Total: |  | 34 16-bit words |

Note: Each UINT32 data is transmitted on SPI with the big end first (MSB first, LSB last)

Table 2 Host requires synchronized LiSoC data (ISP\_CTL)

|  |  |  |
| --- | --- | --- |
| Params | Data Type | Remark |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
| Total: |  | N 16-bit words |

Note: Each UINT32 data is transmitted on SPI with the big end first (MSB first, LSB last)

### Host system parameter changes

When the parameters of the Host system change, the parameter content passed by the Host to LiSoC is detailed in Table 1.

### Host image parameter changes

When the Host image processing parameters are changed, the parameter content transmitted by the Host to LiSoC is detailed in Table 2.

## Data transmission format

The purpose of defining data transmission formats is to:

(1) Interpretation method for data between the sender and receiver.

(2) Define verification methods to prevent setting errors caused by data transmission errors;

(3) How to segment and transmit large blocks of data;

(4) Handshake protocol and request retransmission in case of transmission errors;

(5)Alive Check；

Different message formats are used for downlink data (host ->LiSoC) and uplink data (LiSoC ->host).

For downstream data (host ->LiSoC), the host can send up to 256 16 bit words at a time, and at least 3 16 bit words need to be sent. The message format is defined as follows:

Table 3 Message Format for data transfer for Host🡪LiSoC

| Field | TYPE | Content |
| --- | --- | --- |
| Length | Uint16 | Valid Payload length (command + parameters) in 16-bit word unit.  Min = 1  Max = 254 |
| Command | Uint16 | Command/Data indicator  This is the beginning of message payload |
| Param 0 | Uint16 | Word0 |
| …… | Uint16 | …… |
| Param N-1 | Uint16 | Word N-1  This is the end of message payload.  Max value of N is 253. |
| Checksum | Uint16 | CRC 16 using CCITT polynomial 0x1021:  x^16+x^12+x^5+x^0  Calculated on the data range starting from “length field” and ending at Param N-1. |

Note: The transmission of each Uint16 data on SPI is initiated by the big end first (MSB followed by LSB)

Note: When calculating CRC16, discharge the data according to the small end storage format before proceeding with the calculation.

For uplink data (LiSoChost), LiSoC can send up to 255 16 bit words at a time, and at least 2 16 bit words need to be sent. The length of the parameters carried by each Response command must be agreed upon in advance between the Host and LiSoc. The message format is defined as follows:

Table 4 Message Format for data transfer for LiSoC🡪Host

| Field | TYPE | Content |
| --- | --- | --- |
| Response | Uint16 | Response/Data indicator  This is the beginning of message payload |
| Param 0 | Uint16 | Word0 |
| …… | Uint16 | …… |
| Param N-1 | Uint16 | Word N-1  This is the end of message payload.  Max value of N is 253. |
| Checksum | Uint16 | CRC 16 using CCITT polynomial 0x1021:  x^16+x^12+x^5+x^0  Calculated on the data range starting from “Response field” and ending at Param N-1. |

Note: The transmission of each Uint16 data on SPI is initiated by the big end first (MSB followed by LSB)

Note: When calculating CRC16, discharge the data according to the small end storage format before proceeding with the calculation.

# **Message Details**

## Message Type Summary

Table 5 Message Types

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Direction | Command Type | MSG cmd ID | Cmd+Param  length | Description |
| Host->LiSoC | Connection request | 0x0100 | 1 |  |
| LiSoc->Host | Connection response | 0x0101 | 1 |  |
| Host->LiSoC | Alive check request | 0x1000 | 1 |  |
| LiSoc->Host | Alive check response | 0x1001 | 1 |  |
|  |  |  |  |  |
| Host->LiSoC | Read SYS param request | 0x0200 | 1 |  |
| LiSoc->Host | Read SYS param response | 0x0201 | 35 |  |
| Host->LiSoC | Read ISP param request | 0x0300 | 1 |  |
| LiSoc->Host | Read ISP param response | 0x0301 | 2N+1 |  |
|  |  |  |  |  |
| Host->LiSoC | Write all SYS param request | 0x2000 | 35 |  |
| LiSoc->Host | Write all SYS param response | 0x2001 | 1 |  |
| Host->LiSoC | Write all ISP param request | 0x3000 | 2N+1 |  |
| LiSoc->Host | Write all ISP param response | 0x3001 | 1 |  |
|  |  |  |  |  |
| Host->LiSoC | Write 1 SYS/ISP param request | 0x4000 | 5 |  |
| LiSoc->Host | Write 1 SYS/ISP param response | 0x4001 | 1 |  |
| LiSoc->Host | Generic error response | 0x9999 | 3 |  |

## Message 0x0100/0x0101 Connection Request/ Response

Table 6 Message 0x0100 Connection Request

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Length | 1 | 1-word | Data length |
| Command | 0x0100 | 1-word | Connection Request |
| Checksum | - | 1-word | CRC for length field + command field |

Table 7 Message 0x0101 Connection Response

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Response | 0x0101 | 1-word | Connection Response |
| Checksum | - | 1-word | CRC for response field |

## Message 0x1000/0x1001 Alive Check Request/Response

Table 8 Message 0x1000 Alive Check

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Length | 1 | 1-word | Data length |
| Command | 0x1000 | 1-word | Alive Check Request |
| Checksum | - | 1-word | CRC for length field + command field |

Table 9 Message 0x1001 Alive Check Response

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Response | 0x1001 | 1-word | Alive Check Response |
| Checksum | - | 1-word | CRC for response field |

## Message 0x0200/0x0201 Read SYS Param Request/Response

Table 10 Message 0x0200 Read SYS Param Request

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Length | 1 | 1-word | Data length |
| Command | 0x0200 | 1-word | Read SYS Param Request |
| Checksum | - | 1-word | CRC for length field + command field |

Table 11 Message 0x0201 Read SYS Param Response

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Response | 0x0201 | 1-word | Read SYS Param Response |
| Param | - | 34-word | 17 SYS control register values (32-bit each, big endian) |
| Checksum | - | 1-word | CRC for response + param field |

## Message 0x0300/0x0301 Read ISP Param Request/Response

Table 12 Message 0x0300 Read ISP Param Request

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Length | 1 | 1-word | Data length |
| Command | 0x0300 | 1-word | Read ISP Param Request |
| Checksum | - | 1-word | CRC for length field + command field |

Table 13 Message 0x0301 Read ISP Param Response

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Response | 0x0301 | 1-word | Read SYS Param Response |
| Param | - | 2N-word | N SYS control register values (32-bit each, big endian) |
| Checksum | - | 1-word | CRC for response + param field |

## Message 0x2000/0x2001 Write All SYS Param Request/Response

Table 14 Message 0x2000 Write All SYS Param Request

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Length | 35 | 1-word | Data length |
| Command | 0x2000 | 1-word | Write All SYS Param Request |
| Param | - | 34-word | 17 SYS control register values (32-bit each, big endian) |
| Checksum | - | 1-word | CRC for length field + command + param field |

Table 15 Message 0x2001 Write All SYS Param Response

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Response | 0x2001 | 1-word | Write All SYS Param Response |
| Checksum | - | 1-word | CRC for response field |

## Message 0x3000/0x3001 Write All ISP Param Request/Response

Table 16 Message 0x3000 Write All ISP Param Request

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Length | 2N+1 | 1-word | Data length |
| Command | 0x3000 | 1-word | Write All ISP Param Request |
| Param | - | 2N-word | N SYS control register values (32-bit each, big endian) |
| Checksum | - | 1-word | CRC for length field + command + param field |

Table 17 Message 0x3001 Write All ISP Param Response

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Response | 0x3001 | 1-word | Write All SYS Param Response |
| Checksum | - | 1-word | CRC for response field |

## Message 0x4000/0x4001 Write 1 SYS/ISP Param Request/Response

Table 18 Message 0x4000 Write 1 SYS/ISP Param Request

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Length | 5 | 1-word | Data length |
| Command | 0x2000 | 1-word | Write 1 Param Request |
| Param | - | 2-word | SYS/ISP control register address (32-bit, big endian) |
| Param | - | 2-word | SYS/ISP control register value (32-bit, big endian) |
| Checksum | - | 1-word | CRC for length + command + param field |

Table 19 Message 0x4001 Write 1 SYS/ISP Param Response

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Response | 0x2001 | 1-word | Write 1 SYS/ISP Param Response |
| Checksum | - | 1-word | CRC for response field |

## Message 0x9999 Generic Error Response

Table 20 Message 0x9999 Generic Error Response

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Response | 0x9999 | 1-word | Generic Error Response |
| Request | - | 1-word | Corresponding request that causes this error |
| Error Code | - | 1-word | Error code |
| Checksum | - | 1-word | CRC for response + param field |

## Message 0xFFFF CRC Error Response

Table 19 Message 0xFFFF CRC ERR Response

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Response | 0xFFFF | 1-word | CRC ERR Response |
| Checksum | - | 1-word | CRC for response field |

## Message 0xFFFE LEN Error Response

Table 19 Message 0xFFFE LEN ERR Response

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Response | 0xFFFE | 1-word | LEN ERR Response |
| Checksum | - | 1-word | CRC for response field |

## Message 0xFFFF FIFO Error Response

Table 19 Message 0xFFFD FIFO ERR Response

| Field | Value | Size | Content |
| --- | --- | --- | --- |
| Response | 0xFFFD | 1-word | FIFO ERR Response |
| Checksum | - | 1-word | CRC for response field |