LIN
Switch
Slave Node Position Detection

Revision 1.0

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REVISION HISTORY

Issue	Date	Remark
Revision 1.0	2012-07-24	1st Release

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1 SCOPE

This document is intended to describe one method for the detection of the position of a particular slave node in a LIN network with equal built slaves. This does not limit the use of position detection to the method described here.

The document covers the LIN switch method (LSM).

1.1 REFERENCE

[1] LIN Specification Package, Revision 2.1, Nov-24, 2006

2 REQUIREMENTS

The specified methods must provide a means to assign a slave node with a unique node address within the particular LIN network, which can be used to configure the nodes according to LIN 2.1.

Any Slave Node Position Detection method should not violate the LIN Specification. In case an SNPD method violates the LIN Specification, these violations are described in the following chapters with the respective method descriptions. The behaviour is described in the chapter “Limitations in Use” of the respective method description.

3 LIN SWITCH METHOD (LSM)

3.1 PRINCIPLE

In Figure 3-1 a typical LIN bus topology with LSM slave nodes is illustrated. The LSM slaves are arranged as daisy chain network. The LIN signal is routed through the LSM slave via a LIN switch.

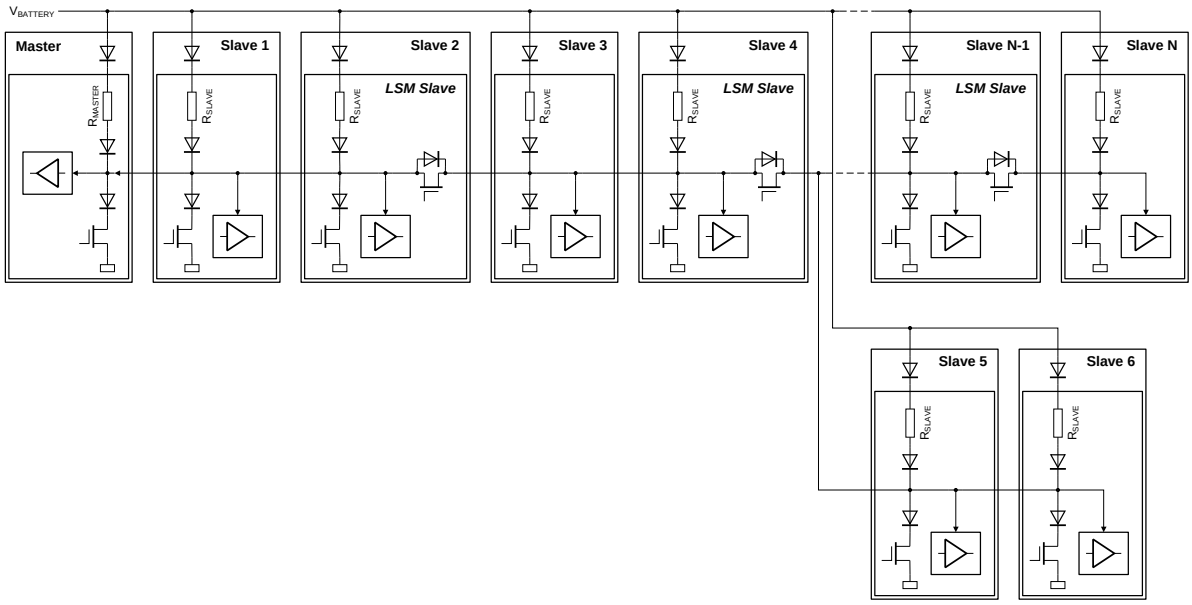

Figure 3-1: Typical LIN bus topology with LSM slaves

The default state of the LIN switch is the closed state. Only during the SNPD process of LSM slaves the LIN switch of slaves with unassigned NAD is open. At the beginning of the SNPD process all LIN switches are open. Then the NAD of the first LSM slave in the daisy chain can be assigned. After the NAD assignment the LIN switch is closed in order to enable the next LSM slave for NAD assignment. This continues until the last LSM slave is assigned with a new NAD and all LIN switches are closed again. Thus the SNPD process is completed.

Standard LIN nodes can be added to a LSM slave daisy chain network in any order; also as network stub, e.g. slave 5 and slave 6 in Figure 3-1. In most instances LSM slaves can also be mixed with other SNPD LIN slaves as long as the LSM slaves are still arranged as daisy chain.

3.2 PHYSICAL LAYER

A LSM slave is basically a standard LIN slave, but with an additional LIN switch. The LIN signal is routed through the LSM slave via the LIN switch. Thus a LSM slave has two LIN bus pins. In Figure 3.2 a block diagram of a typical LSM slave is shown.

The LIN switch of a LSM slave is typically a transistor. Nevertheless any kind of switch can be considered, e.g. a relay.

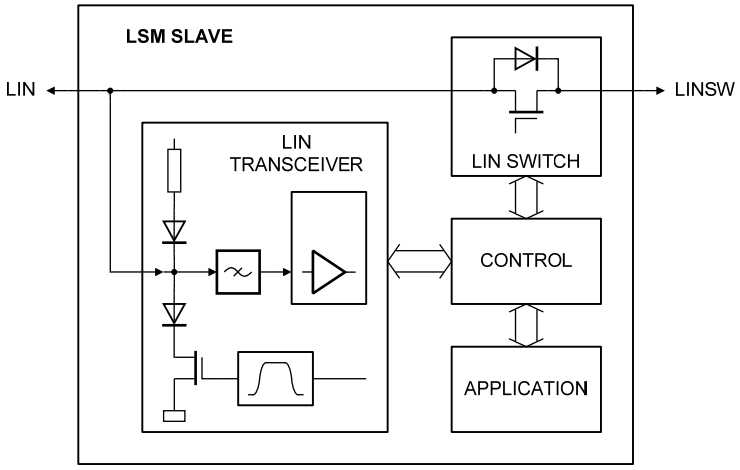

Figure 3-2: LSM block diagram

Note: Often transistor implementations have a parasitic diode between drain and source. In order to provide the capability to block the LIN communication to the following LSM slaves it is mandatory to connect the anode to the LIN transceiver of the LSM slave, i.e. as shown in Figure 3-2.

In addition to the LIN physical layer specification [1] the electrical parameter in Table 3-1 shall be observed.

In Table 3-1 all voltages are defined with respect to ground; values are given for V_{SUP} operation range; unless otherwise specified.

no.	symbol	parameter	min.	typ.	max.	unit	condition
1	$V_{LIN(dom)}$	Dominant LIN output voltage			1.4	V	V_{SUP} = 7V Bus load = 500Ω
					2	V	V_{SUP} = 18V Bus load = 500Ω
2	R_{ON}	LIN switch ON resistance		1	2	Ω	V_{LIN} = 1V
3	t_{pd_switch}	Propagation delay: time from end of LIN frame until LIN switch is turned ON/OFF			150	µs	See Figure 4-3

Table 3-1: Electrical Parameter of LSM slave

In Figure 3-3 the propagation delay of the LIN switch is illustrated in a timing diagram.

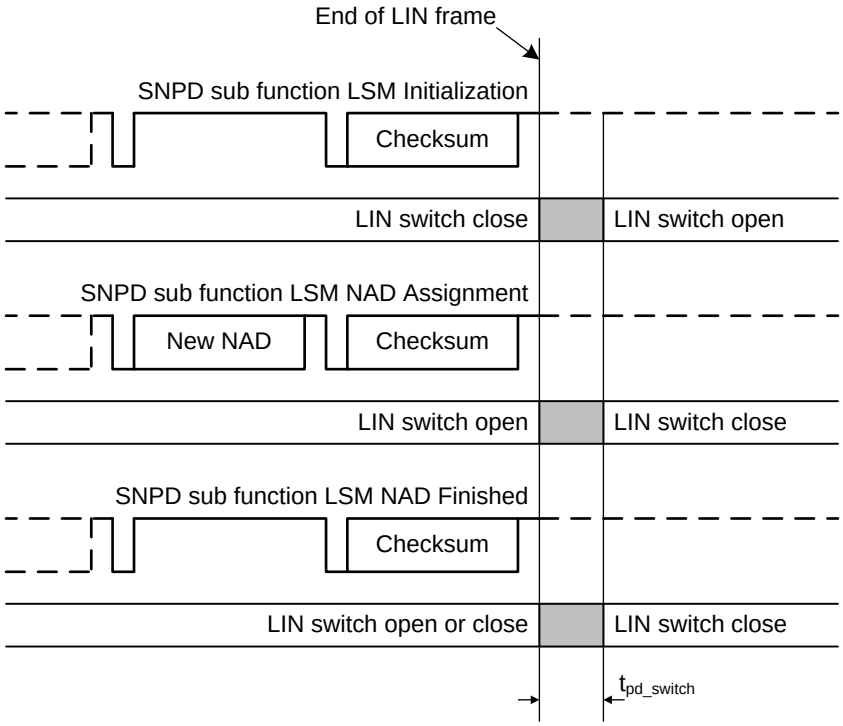

Figure 3-3: Timing diagram of LIN switch propagation delay

3.3 SUB FUNCTIONS

The mandatory SNPD sub function IDs for the LIN switch method (LSM) are summarized in Table 3-2.

SNPD sub function	SNPD sub function ID
LSM Initialization	0x01
LSM NAD Assignment	0x02
LSM Finished	0x03

Table 3-2: SNPD sub function ID of LSM

The SNPD sub functions LSM Initialization and LSM Finished inform all slaves (incl. non-LSM slaves) about the start respectively the end of a LSM configuration.

For the SNPD sub function LSM NAD Assignment a positive SNPD response shall be provided. The positive SNPD response shall be send only, when the last LIN Master Request frame has been a valid LSM NAD Assignment request and subsequently the assigned LSM slave has accepted and stored the New NAD and closed the LIN switch. The call of a positive SNPD response is optional.

Note: The SNPD sub functions LSM Initialization and LSM Finished shall not provide a positive SNPD response.

3.4 CONFIGURATION FLOW

The SNPD configuration flow of the LSM (see Figure 3-4) shall start with the SNPD sub function LSM Initialization. After the reception of the LSM Initialization all LSM slaves shall reset their NAD and open their LIN switch.

As consequence only the first LSM slave in the daisy chain is left, which can receive LIN frames from the LIN master. Once a valid SNPD sub function LSM NAD Assignment is received the first LSM slave shall accept and store the New NAD and close its LIN switch. After the LSM NAD Assignment the LIN master can optionally send a Slave Response Header to get a positive SNPD response from the last assigned LSM slave.

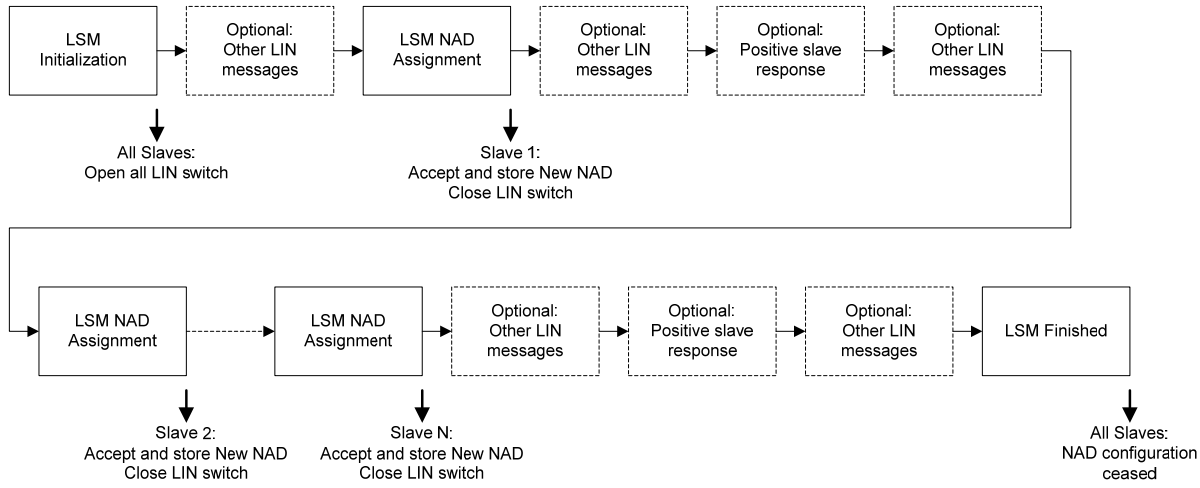

Figure 3-4: LSM configuration flow

During LSM configuration the SNPD sub function LSM NAD Assignment shall be accepted from unassigned LSM slaves only, i.e. all LSM slaves with assigned New NAD will ignore this SNPD sub function. Thus the first LSM slave has closed the LIN switch and shall ignore any further LSM NAD Assignment and the second LSM slave can receive LIN frames from the LIN master and shall accept a valid LSM NAD Assignment. After successful assignment of New NAD the second LSM slave shall also close its LIN switch and consequently enable the next LSM slave in the daisy chain for NAD assignment.

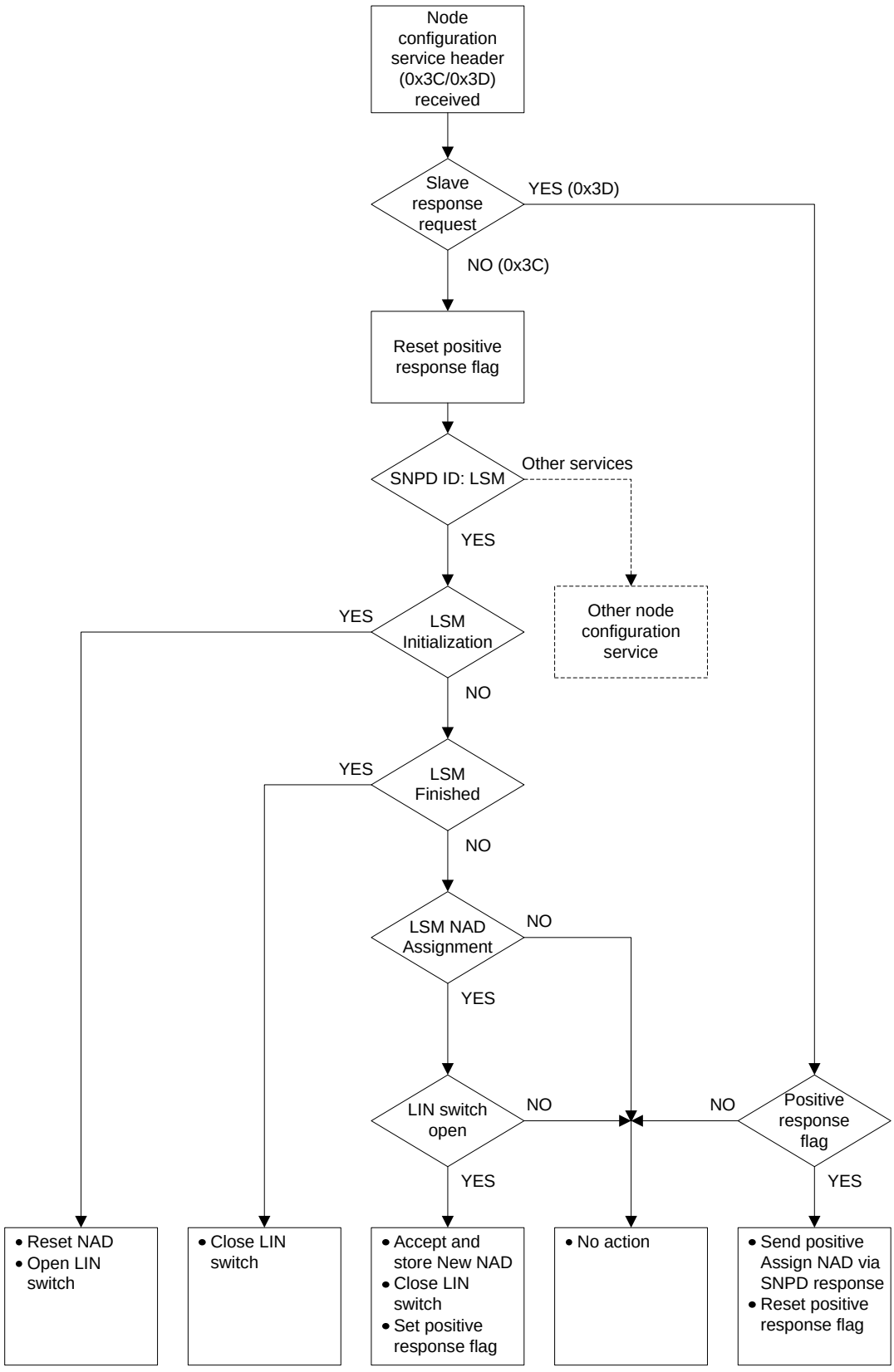

Figure 3-5: Typical LSM slave flow chart

With this configuration flow each LSM slave will be assigned one by one with a New NAD. When all LSM slaves have a New NAD assigned, the LIN master shall signal this by sending the SNPD sub function LSM Finished. LSM slaves shall close their LIN switch when the SNPD sub function LSM Finished is received, no matter whether a New NAD is assigned or not. In case the configuration was unsuccessful the SNPD sub function LSM Finished might be send repeatedly in order to close the LIN switch of unassigned LSM slaves.

Note: The SNPD process for all LSM slaves (from reception of LSM Initialization until reception of LSM Finished) shall be completed within 4 s, because when LIN bus inactivity is detected [1] a LSM slave shall close the LIN switch and enter bus sleep mode.

In Figure 3-5 a typical LSM slave flow chart is shown.

3.4.1 LSM Setup Flow in Detail

LSM Initialization

Assign NAD via SNPD Request

Header 0x3C	+	NAD	PCI	SID	D1	D2	D3	D4	D5
		Initial NAD			Supplier ID LSB	Supplier ID MSB	Function ID LSB	Function ID MSB	unused
		0x7f	0x06	0xb5	0xff	0x7f	0x01	0x03	0xff

All SNPD slaves with LSM function:
- Open all LIN switch

Optional: other (standard) LIN Messages

LSM NAD Assignment to slave 1

Assign NAD via SNPD Request

Header 0x3C	+	NAD	PCI	SID	D1	D2	D3	D4	D5
		Initial NAD			Supplier ID LSB	Supplier ID MSB	Function ID LSB	Function ID MSB	New NAD
		0x7f	0x06	0xb5	0xff	0x7f	0x02	0x03	New NAD for Slave 1

LSM slave 1:
- Accept and store New NAD, because only this LSM slave 1 can receive this LSM request
- Close LIN switch

Optional: Positive Slave Response and/or other (standard) LIN Messages

LSM NAD Assignment to slave 2

Assign NAD via SNPD Request

Header 0x3C	+	NAD	PCI	SID	D1	D2	D3	D4	D5
		Initial NAD			Supplier ID LSB	Supplier ID MSB	Function ID LSB	Function ID MSB	New NAD
		0x7f	0x06	0xb5	0xff	0x7f	0x02	0x03	New NAD for Slave 2

LSM slave 2:
- Accept and store New NAD, because only this LSM slave has no assigned NAD and can receive this LSM request
- Close LIN switch

Optional: Positive Slave Response and/or other (standard) LIN Messages

. . .

LSM NAD Assignment to slave N

Assign NAD via SNPD Request

Header 0x3C	+	NAD	PCI	SID	D1	D2	D3	D4	D5
		Initial NAD			Supplier ID LSB	Supplier ID MSB	Function ID LSB	Function ID MSB	New NAD
		0x7f	0x06	0xb5	0xff	0x7f	0x02	0x03	New NAD for Slave N

LSM slave N:
- Accept and store New NAD, because only this LSM slave has no assigned NAD and can receive this LSM request
- Close LIN switch

Optional: Positive Slave Response and/or other (standard) LIN Messages

LSM Finished

Assign NAD via SNPD Request

Header 0x3C	+	NAD	PCI	SID	D1	D2	D3	D4	D5
		Initial NAD			Supplier ID LSB	Supplier ID MSB	Function ID LSB	Function ID MSB	unused
		0x7f	0x06	0xb5	0xff	0x7f	0x03	0x03	0xff

SNPD slaves with LSM function:
- NAD configuration ceased
- Close LIN switch

3.4.2 SNPD Response

Optional: other (standard) LIN Messages

Positive assign NAD response of last assigned LSM slave

Assign NAD via SNPD Request

Header 0x3D	+	NAD	PCI	RSID	D1	D2	D3	D4	D5
		Initial NAD			unused				
		0x7f	0x01	0xf5	0xff	0xff	0xff	0xff	0xff

A SNPD slave with LSM function responds on this header when the last 0x3C-Command was a valid "LSM NAD Assignment" request for this LSM slave.

3.5 LIMITATION IN USE

The LIN switch of LSM slaves adds a serial resistance, which reduces the overall tolerance of ground shift. The worst case scenario is when the last LSM slave in the daisy chain transmits and the LIN master receives. In Table 4-3 the worst case impact on ground shift as function of the number of LSM slaves is listed. The battery shift tolerance is as specified in the LIN physical layer specification [1].

Number of LSM slaves	GND shift tolerance [%V_{BAT}]
1	11,50
2	11,40
3	11,30
4	11,20
5	11,08
6	10,96
7	10,83
8	10,70
9	10,56
10	10,42
11	10,26
12	10,10
13	9,94
14	9,77
15	9,59

Table 3-3: Worst case impact on ground shift tolerance

Hint: The impact of the LIN switch, as listed in Table 4-3, can be reduced, or even compensated, with a positive temperature coefficient for the LIN switch ON resistance and a low dominant LIN output voltage.