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AND9423/D

NCV7748 LIN Communication Using Virtual Nodes

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APPLICATION NOTE

Communication speeds are not always fast. LIN protocol allows operation at relatively slow speeds. The NCV7748 allows operation at 10.417 kBit/sec or 19.2 kBit/sec. With wave shaping and these low bit rates, emissions are kept at a minimum.

While low bit rates have low emissions, low bit rates also have their detriment. Latency times would seemingly prohibit the use at low bit rates when controlling multiple nodes required to switch concurrently. Multiple command times would take too long.

The LIN network dynamics also limit the use at 15 nodes and 1 master node. This boundary sets the maximum number of actuator loads at 16 per system time constant limitations. This can be extended with dedicated design focus but is risky.

The use of a LIN virtual node in the NCV7748 expands the number of nodes by a factor of 4. With 8 relay drivers integrated into the NCV7748 and the virtual node implementation, one node can control 32 relay drivers. And since the NCV7748 Output Control Command linked to SAEJ2602 defines 7 Node Address (NAD) locations, system design can support 7 x 32 = 224 relay drivers.

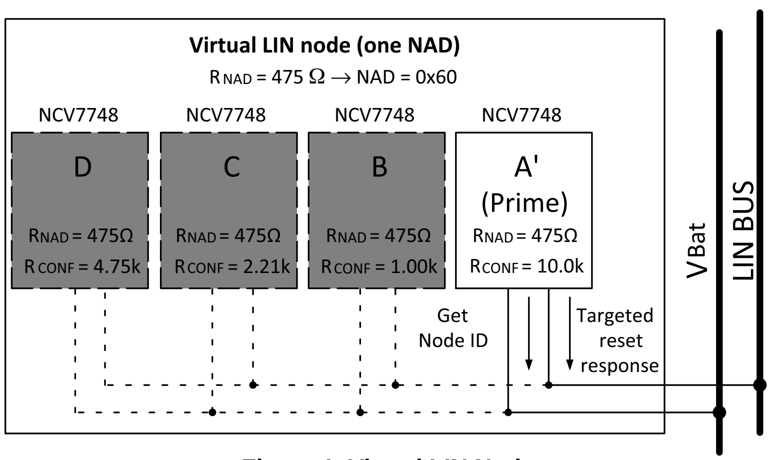

Figure 1. Virtual LIN Node

Figure 1 highlights the concept of a Virtual LIN node used in the NCV7748. The gray box is representative of one slave node on the LIN bus. As you can see there are 4 separate components labeled A’, B, C, & D connected directly to the LIN BUS and to the battery (Vbat) located within the node on the LIN BUS.

The programming resistor values listed in Table 1 and Table 2 are the programming values required by the NCV7748 describing their location on the BUS. These programming resistors (R_{NAD} and R_{CONF}) are directly connected on the NAD and CONF pins of the NCV7748 devices to ground. Their sole purpose is to identify the NAD and the location on the NAD (the config [CONF]).

Slave location via these programming resistors is read during the first 10 ms of power−up in the initialization mode by the NCV7748 device (T_init of the datasheet).

Table 1. VIRTUAL SLAVE NODE ADDRESS (NAD)

NAD	0x60	0x62	0x64	0x66	0x68	0x6A	0x6C
R_{NAD}	475 Ω	1.00 kΩ	2.21 kΩ	4.75 kΩ	10.0 kΩ	22.1 kΩ	47.5 kΩ

Table 2. VIRTUAL SLAVE NODE CONFIGURATION (CONF)

Slave	A	B	C	D	A’	B’	C’	D’
RConfig	475 Ω	1.00 kΩ	2.21 kΩ	4.75 kΩ	10.0 kΩ	22.1 kΩ	47.5 kΩ	100.0 kΩ

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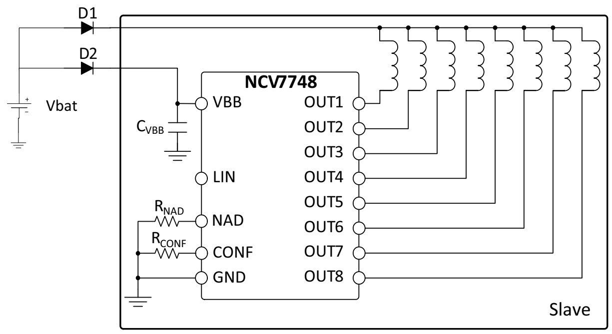

Figure 2. Device Setup

Output Control Frame

Table 3 illustrates the data structure of the Output Control Frame. Prime nodes are included, but not specified in the A, B, C, D labels. To turn outputs on or off, one must simply use the logic as given in Table 4 putting the data into the boxes and sending a LIN command with this information.

Table 3. OUTPUT CONTROL FRAME

	Byte	Content	Structure							
			Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Master	0	Identifier	PID							
	1	Data 1	OUT4_A		OUT3_A		OUT2_A		OUT1_A	
	2	Data 2	OUT8_A		OUT7_A		OUT6_A		OUT5_A	
	3	Data 3	OUT4_B		OUT3_B		OUT2_B		OUT1_B	
	4	Data 4	OUT8_B		OUT7_B		OUT6_B		OUT5_B	
	5	Data 5	OUT4_C		OUT3_C		OUT2_C		OUT1_C	
	6	Data 6	OUT8_C		OUT7_C		OUT6_C		OUT5_C	
	7	Data 7	OUT4_D		OUT3_D		OUT2_D		OUT1_D	
	8	Data 8	OUT8_D		OUT7_D		OUT6_D		OUT5_D	
	9	Checksum	Enhanced Checksum							

Table 4. OUTPUT DECODING

OUTx_A[1]	OUTx_A[0]	Output
0	0	No change
0	1	OUTx Off
1	0	OUTx On
1	1	No change

Figure 3 shows what a typical LIN Output Controls Frame would look like. Data for Dev A – OUT 1−4 and Dev OUT 5−8 specify the output state or state change. Special care should be taken when identifying and specifying the LSB and MSB information. It is not intuitive. In this case OUT1,2,3,6, & 8 are commanded on.

The data for OUT1−4 where OUT1,2,& 3 are commanded on (MSB → LSB 01101010 in the table looks like a mirror image LSB → MSB 01010110 in the waveform) is highlighted in red.

Note OUT1 is 1st in the waveform and last in the table.

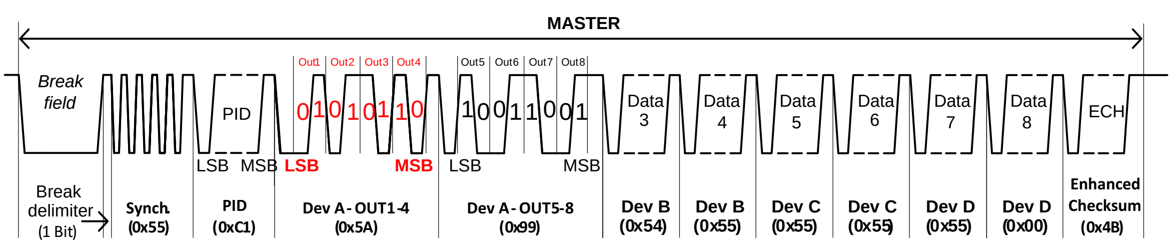

Figure 3. LIN Output Control Frame

Prime Nodes

This virtual node concept works because all potential conflicts have been considered and resolved. Without a device branded as prime, there would be conflicts with commands Get Node ID and Targeted Reset. Without a prime, multiple devices on the same node would respond. In this case only the Prime device responds. To avoid impedance issues, only the prime device connects an internal 33k pull−up resistor from LIN to VBB. No pullup up is connected for non−prime devices.

Output Status

Each individual IC on the virtual node still responds to its own GET STATUS command for reporting of errors and APPINFO. Error fields are cleared after a read and reported individually. Multiple errors may be retrieved by multiple GET STATUS commands. Reporting of error states are reported from highest priority to lowest priority as shown in Table 5.

Table 5. J2602−1 ERROR FIELD

ERR2	ERR1	ERR0	Error States	Priority
0	0	0	No Error	0 (lowest)
0	0	1	Reset	1
0	1	0	Reserved	2
0	1	1	Reserved	3
1	0	0	Data Error	4
1	0	1	Data Checksum	5
1	1	0	Byte Field Framing Error	6
1	1	1	ID Parity Error	7 (highest)

Virtual Node Error Detection Considerations

There may be multiple detections of a single error within a virtual node.

a. Example − Reset status will be reported by all devices on a node after a reset command.

b. Example – Every device on a node will report a checksum error (in status byte) from corrupted checksum and must be cleared individually.

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