



1. Purpose of this specification

This specification describes the output of serial data, which has to be generated by SX-main units¹⁾.

2. Explanations

- SX-data-packet is a defined set of bits as described in NEM 680 (the track-signal).
- The SX-data-packet consists of a specified number of bit groups.
- Each bit groups consist of 12 bits. They are named either “synchronization”- or “data”-bit-groups (also called channels).

3. Format of a SX-data-packet

The subsequently described components of a data packet define the generally valid composition of the SX-data-packet to activate the decoders.²⁾ The SX-data-packet consists from following parts:

1. Start synchronize-bit-group (S): The **Synchronization (Sync)** activates the decoder and consists of a combination of bits, which do not occur in normal operation. Additionally, the Sync contains the so-called “**base address**” (**BA**).
2. 7 successive data-bit-groups, the so-called “**channels**” (**K6..K0**). The channel numbers combined with the base addresses (BA) are the addresses of the locomotives.
3. End synchronize-bit-group: (see 1. Perhaps with a different BA which could also be used as the synchronize-bit-group of the following data bit groups.

Sync+BA K6 K5 K4 K3 K2 K1 K0 Sync+BA?

4. SX-Synchronize bit group

4.1 Synchronizing and transmission of the base address (BA)

Format of the synchronize-bit-group (Sync+BA):

0 0 0 1 Z 1 BA3 BA2 1 BA1 BA0 1

The bits contain the following information

- 0 0 0** Sync with 3 times „0“
- 1** Separation bits, to prevent the occurrence of “000” anywhere else than in the Sync-bit-group.
- BA0..BA3** The base address (BA),
BA3 = MSB (most significant bit), valence 8
BA0 = LSB (least significant bit), valence 1
- Z** Condition-bit of the command-station („0“ = off, „1“ = on)

¹⁾ In the most cases the SX-main unit contains an amplifier, which delivers the necessary energy for the locomotives. If that is not sufficient, more amplifiers could be used.

²⁾ For the decoder it is also allowed to accept other command-formats in addition to the SX-format (e. g. DCC in accordance with NEM 671).

4.2 Determination of the decoder-addresses

The base-address (BA) is transmitted in inverted format, f. i. the bits of the base-address have to be inverted to calculate the decoder address.

BA = 0 0 0 0	BAinv = 1 1 1 1	decimal = 15
BA = 0 0 0 1	BAinv = 1 1 1 0	decimal = 14
BA = 0 0 1 0	BAinv = 1 1 0 1	decimal = 13 etc.

The address of the decoder is calculated as:

$$\text{Loco-address} = 16 \cdot (K?) + \text{BAinv}$$

Example:

BA = 0100 (equals BAinv = 1011), channel number 4 (? = 4) :

$$\text{Locomotive-address} = (16 \cdot 4) + 11 = 75$$

4.3 The SX-data-bit-group controlling of speed, direction, light and addition-functions

Format of the data-bit-group:

S0 S1 1 S2 S3 1 S4 D 1 L F 1

The bits have the following meaning

- 1** Separation-bits, to prevent same combination of bits in the data-bit-group as in the Sync-bit-group.
- S0..S4** Speed (S0 = LSB, least significant bit - S4 = MSB most significant bit). With 5 bits, there are $2^5 = 32$ possible values (31 speed steps and 00000 = full stop)

S4	S3	S2	S1	S0	Speed level step
0	0	0	0	0	0 (full stop)
0	0	0	0	1	1
...					...
1	1	1	1	0	30
1	1	1	1	1	31

- D** Direction
„0“ means forward.³⁾
„1“ means backwards.
- L** Light. The two decoder-outputs for the light have to be combined with the direction bit D (front light / back light).
- F** Bit for the additional-function F1 (e.g. smoke generator).
„0“ means, the additional-function is switched off.
„1“ means, the additional-function is switched on.

³⁾ Forward means, that vehicle end 1 is in front of direction of motion.

5. Repetition of the SX-data packets

The SX-data packets can be repeated in any order, but it is however recommended to transmit all 16 possible base-addresses in consecutive order. Mixing with digital signals of other control systems is possible as long as the rules for building the data packets are obeyed (see 3.)

6. Decoder behaviour with automatic recognition of different commands control-systems

Decoders with automatic recognition of control-commands any other systems (multi-system-decoder), including the NEM-DCC-System (NEM 670 / NEM 671), should have the ability to switch it off. If switched on, the decoder has to keep its current status until a known and correct control command of any other control system is recognized (especially important for the address of the locomotive).