

## DCC commands

This description of DCC control orders is organized in 2 parts.

First an overview of the structure of the orders with a brief/short description of the byte and bit content. This include the total set of bits in a message.

Then we leave out the PreAmp, Separators and the XOR byte concentrating on a deeper explanation of the remaining bytes and bits.

The 2 parts are connected through the **RED TEXT**, which act as a kind of index. Bit Values in **Bold** indicate key values for that Byte, i.e. the interpretation of the remaining bits depend upon this key.

This document is based upon Jens Klarskovs text to the Embedded C-Programming course at KEA (Copenhagens School of Design and Technology). A text which is based upon :

General Packet Format :

<https://www.nmra.org/sites/default/files/s-92-2004-07.pdf>

Extended Package Format :

[https://www.nmra.org/sites/default/files/s-9.2.1\\_2012\\_07.pdf](https://www.nmra.org/sites/default/files/s-9.2.1_2012_07.pdf)

both kept at the National Model Railroad Associations, Inc. homepage.

Loco * Small Address * Speed						
	Bit number	Byte number	Name	Bit value		Short Explanation Text in blue : see Glossary
	0		PREAMBLE	1		A sequence of at least 10 bits set to 1. 16 is a good choice.
	1			1		
	2			1		
	3			1		
	4			1		
	5			1		
	6			1		
	7			1		
	8			1		
	9			1		
	10			1		
	11			1		
	12			0		Separating bit
	13	BYTE 1	ADDRESSBYTE	0		0 means 7 bit short address
	14			A7		Short loco address (7 bit) A7 A6 A5 A4 A3 A2 A1 1 <= value <= 127 0 is NOT allowed
	15			A6		
	16			A5		
	17			A4		
	18			A3		
	19			A2		
	20			A1		
	21			0		Separating bit
	22	BYTE 2	COMMAND	0	0	0 means speed & direction command
	23			1	1	
	24			D		D = 0 backward = 1 forward
	25			C = S1		C = 0 (see Speed below)
	26			S5		Loco speed : S5 S4 S3 S2 S1 Easy version : 4 bits = 16 speed values 0 S4 S3 S2 S1
	27			S4		
	28			S3		
	29			S2		
	30			0		Separating bit
	31	BYTE 3	ERROR DETECTION BYTE	X8		All bits are binary XOR : <b>BYTE 1 XOR BYTE 2</b>
	32			X7		
	33			X6		
	34			X5		
	35			X4		
	36			X3		
	37			X2		
	38			X1		
	39			1		End of message bit

Loco * Small Address * Light & Sound				
Bit number	Byte number	Name	Bit value	Short Explanation Text in blue : see Glossary
0		PREAMBLE	1	A sequence of at least 10 bits set to 1. 16 is a good choice.  Identical to Loco * Small Address *Speed
1			1	
2			1	
3			1	
4			1	
5			1	
6			1	
7			1	
8			1	
9			1	
10			1	
11			1	
12			0	Separating bit
13		ADDRESS BYTE	0	0 means 7 bit (short) address
14	BYTE 1		A7	
15			A6	Short loco address (7 bit)
16			A5	A7 A6 A5 A4 A3 A2 A1
17			A4	1 <= value <= 127
18			A3	0 is NOT allowed.
19			A2	Identical to Loco * Small Address *Speed
20			A1	
21				0
22		COMMAND BYTE	T4	
23	BYTE 2		T3	Tn bits shows which
24			T2	set of Functions are on or off
25			T1 / U5	
26			U4	F0 - F4; F8 - F5; F12-F9; F16-F13
27			U3	
28			U2	
29			U1	
30				0
31		ERROR DETECTION BYTE	X8	
32	BYTE 3		X7	
33			X6	
34			X5	All bits are binary XOR :
35			X4	BYTE 1 XOR BYTE 2
36			X3	
37			X2	
38			X1	
39				1

## Accessory \* Signal \* Switch

Bit number	Byte number	Name	Bit value	Explanation Text in blue : see Glossary
0			1	
1			1	
2			1	
3			1	
4			1	
5			1	
6			1	
7			1	
8			1	
9			1	
10			1	
11			1	
12			0	Separating bit
13			1	10 means short 9 bit accessory address
14			0	
15			A6	
16			A5	
17			A4	
18			A3	
19			A2	
20			A1	
21			0	Separating bit
22			1	
23			$\wedge A9$	NOTE :
24			$\wedge A8$	$\wedge A9 \wedge A8 \wedge A7$
25			$\wedge A7$	1 complement to the values used above
26			C	0 off 1 on
27			D1	
28			D2	local register address
29			E	== 0 turn / red == 1 straight / green
30			0	Separating bit
31			X8	
32			X7	
33			X6	
34			X5	
35			X4	
36			X3	
37			X2	
38			X1	
39			1	End of message bit

## GLOSSARY

Index		Bit number	Bit value		
Loco * Small Address * Speed & Registers					
BYTE 1	ADDRESS	8	0		0 means 7 bit short address
		7	A7		A7 A6 A5 A4 A3 A2 A1  127 >= value >= 1 0 is NOT allowed.
		6	A6		
		5	A5		
		4	A4		
		3	A3		
		2	A2		
		1	A1		
Loco * Small Address * Speed					
BYTE 2	COMMAND	8	0		0
		7	1		1 means Speed and Direction
		6	D		D = 0 backward = 1 forward
		5	C = S1		
		4	S5		Easy Speed is 16 possible steps using S5 S4 S3 S2 and let S1=0. S5 S4 S3 S2 S1 0 0 0 0 0 = stop 0 0 0 1 0 = emergency stop
		3	S4		
		2	S3		
		1	S2		
Loco * Small Address * Registers					
BYTE 2	COMMAND	8	1		1
		7	0		0 means F registers
		6	0		
		5	F0		Light : 0 = off 1 = on
		4	F4		Bell : 0 = off 1 = on
		3	F3		Horn2 : 0 = off 1 = on
		2	F2		Horn1 : 0 = off 1 = on
		1	F1		Sound : 0 = off 1 = on

Index		Bit number	Bit value											
Loco * Small Address * Light & Sound														
BYTE 1	ADDRESS	8	0		0 means 7 bit (short) loco address									
		7	A7											
		6	A6											
		5	A5		A7 A6 A5 A4 A3 A2 A1									
		4	A4											
		3	A3		127 >= value >= 1									
		2	A2		0 is NOT allowed.									
		1	A1		Identical to Loco * Small Address *Speed									
Loco * Small Address * Light & Sound														
BYTE 2	COMMAND	8	T4			1	1	1	1					
		7	T3			0	0	0	1					
		6	T2			0	1	1	0					
		5	T1 / U5			F0	1	0	1					
		4	U4			F4	F8	F12	F16					
		3	U3			F3	F7	F11	F15					
		2	U2			F2	F6	F10	F14					
		1	U1			F1	F5	F9	F13					
F0 is Light on / off F1 . . . F15 are functionalities in the sound decoder														

Index		Bit number	Bit value	
Accessory * Signal * Switch				
BYTE 1	ADDRESS	8	1	<div>layoutAddr is the address (number), that is defined in the track layout</div> <div>(AccAdr : Accessory Address A9 A8 A7 A6 A5 A4 A3 A2 A1) = ( (layoutAddr / 4) + 1) &amp; 63,</div> <div>Where / is an integer division (i.e. without remainder)</div>
		7	0	
		6	A6	
		5	A5	
		4	A4	
		3	A3	
		2	A2	
		1	A1	
Accessory * Signal * Switch				
BYTE 2	COMMAND & ADDRESS2	8	1	
		7	~A9	<div>~A9 ~A8 ~A7</div> <div>Is the complementary values to the bits in AccAdr</div>
		6	~A8	
		5	~A7	
		4	C	
		3	D2	<div>RegAdr : Register Address D2 D1 ) = ( layoutAddr % 4) - 1</div> <div>RegAdr &lt; 0 is NOT allowed    If ( RegAdr &lt; 0 ) then { RegAdr = 3 ; AccAdr--}</div>
		2	D1	
		1	E	if switch ( == 0 turn    == 1 straight )    if signal ( == 0 red    == 1 green )