YAMAR
Operation Manual

DC-BUS EVB Tester board

1. General

The DC-BUS Tester board is a versatile tool for testing DC-BUS evaluation boards (EVB) containing Yamar's new family of devices for DC power line communication. An optional DC Powerline Attenuator allows performing communication tests over-controlled attenuated DC powerline channels.

This manual describes the DC-BUS EVB Tester board.

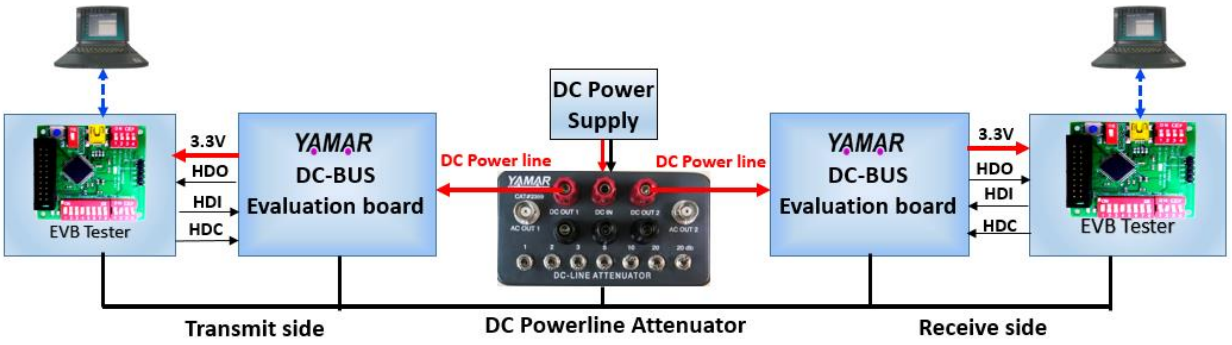

Figure 1 – Typical DC-BUS Test environment

EVB Tester Main Features

- ***On-board switches allowing quick configuration of the device's operating parameters (frequency, bit rate, modes)***
- ***Stand-alone mode enables auto TX and RX BER of powerline test messages.***
- ***Auto Tx Sweep mode enables sequentially transmission of Test pattern on all carrier frequencies for fast powerline TX signal assessment.***
- ***Sweep BER mode enables auto peer to peer Communication test on all carrier frequencies.***
- ***Transceiver mode enables a seamless interface with the existence of CAN/LIN BUS.***
- ***PC mode enables USB connection with Yamar's DC-BUS PC Test SW.***

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2. EVB Tester board

The EVB Tester board is interfacing directly with Yamar's SIG10x/DCAN500/DCB1M/DMX250 EVBs, allowing plug & play powerline communication test environment solution.

The Tester board consists of PIC18F45K0, configuration switches, reset button, USB interface, and onboard CAN/LIN/RS485 transceivers (For direct interface with CAN, LIN BUS, and DMX512/RDM BUS).

The EVB-Tester board 3.3V supply is provided from the connected DC-BUS evaluation board. A 20 wires ribbon cable connects between the DC-BUS EVB and the EVB Tester. The USB connector provides the voltage for the USB interface only. The attached DC-BUS EVB must be connected to the powerline for the EVB-Tester board to be supplied with 3.3V properly. Figure 2 and Figure 3 show the board and describe its building blocks.

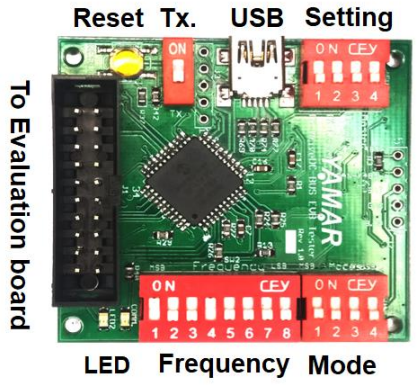

Figure 2 - EVB Tester board

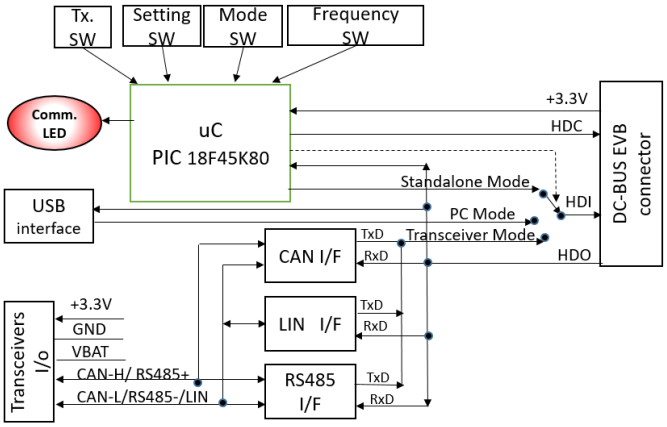

Figure 3 - EVB Tester building blocks

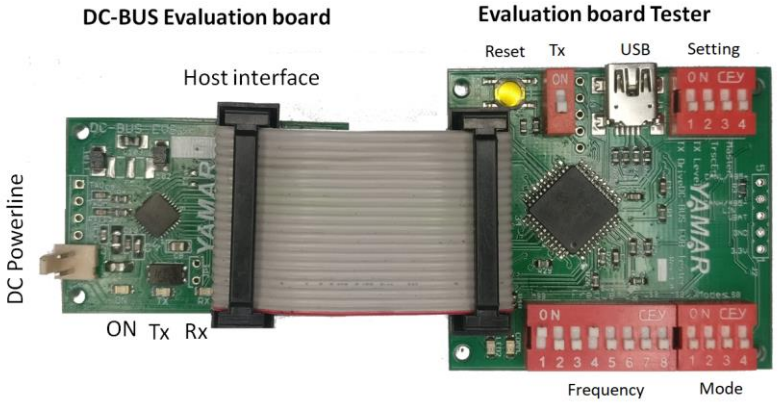

Figure 4 - EVB Tester connected to tested EVB

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2.1 Switches setting

The on-board switches configure the EVB operation upon power-up, reset, or on-change event [1].

Frequency – Configures the EVB operating carrier frequency.

Mode – Configures the Operation mode.

Setting – Configures the attached DC-BUS EVB output driver.

Tx. – Activates Test message transmission in Standalone mode.

Reset – Push button that resets the attached DC-BUS EVB and the Tester board.

[1] When the EVB-Tester board is connected to the DC-BUS PC SW (Comm. Port is opened), all switches state is forward once to the PC SW GUI, which takes control of the DC-BUS EVB configuration. The switch's state will not be read while the PC SW GUI is active.

2.1.1 Frequency switch

Users can define carrier frequency from 5MHz to 30MHz with a spacing of 100 kHz (A total of 251 selectable carriers). The active carrier frequency selection is made by configuring the Frequency switch. The new carrier is configured upon switch change or after pressing the EVB Tester reset button.

The Frequency switch [1:8] (represented in binary, SW[1] is MSB), value is calculated as given in the following Formula:

Switch value = (Carrier Freq. [MHz] - 5) * 10

ON = '1', OFF='0'.

For example, switch setting for carrier 19.4MHz:

Switch Value = (19.4-5) * 10 = 144 (0x90).

SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
ON	OFF	OFF	ON	OFF	OFF	OFF	OFF

See Annex 1 - DC-BUS frequencies binary table.

2.1.2 *Mode* switch

Table 1 defines the Modes selection. The mode switch functionality depends on the connected DC-BUS EVB device.

Table 1- modes selection per chip

Mode	SIG100/ SIG102	DCB1M	DCB1M with DMX Interface	DCAN500	DMX250
S1	N/A	CODE_SEL_1 [1]	N/A	N/A	N/A
S2	BR_SEL_2 [1]	CODE_SEL_0 [1]	RS485 RDM mode Enable[3]	N/A	RS485 RDM mode Enable[3]
S3	BR_SEL_1 [1]	IF_MODE_1 [2]	ON	BR_SEL_1 [2]	N/A
S4	BR_SEL_0 [1]	IF_MODE_0 [2]	OFF	BR_SEL_0 [2]	RS485 TX/RX Enable [2]

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[1] Switch is read on-the-fly.

[2] Switch is read once after power-up or reset.

[3] Switch ON when interfacing with an RDM controller.

2.1.2.1 Mode selection with SIG100/SIG102

Table 2 describes the SIG10x bitrate selection using SW[2:4], SW[1] is N/A.
ON = '1', OFF='0'.

Table 2- SIG100/SIG102 bitrate selection

[S2:S3:S4]	BR_SEL[2:0]
000	9.6 kbit/s
001	10.417 kbit/s
010	19.2 kbit/s
011	38.4 kbit/s
100	57.6 kbit/s
101	115.2 kbit/s
110	N/A
111	N/A

2.1.2.2 Mode selection with DCB1M and DCAN500

Table 3 describes the SW[1:2] code selection in DCB1M.
ON = '1', OFF='0'.

Table 3 – SW[1:2] selection

[S1:S2]	COODE_SEL[1:0]	Max powerline bitrate (Mbit/s)
00	Code 0	1.4
01	Code1	1
10	Code 2	0.5
11	Code 3	0.225

Table 4 describes S3:S4 Interface selection when using DCB1M, DCAN500. In this case switches [S3:S4] are read once after power-up/reset.
ON = '1', OFF='0'.

Table 4 – SW[3:4] selection

[S3:S4]	DCB1M IF_MODE[1:0]	DCAN500 BR_SEL[1:0]
00	UART	1Mbit/s
01	DMX/RDM	125 kbit/s
10	SPI	250 kbit/s
11	I2C	500 kbit/s

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2.1.2.1 Mode selection with DMX250

Table 5 describe the SW[4] RS485 TX/RX enable (switch is read once after power-up/reset)

Table 5 - Mode SW[4] & SW[2] selection

Switch	Switch State	Description
[S4]	ON	RS485 RX enabled.
	OFF	RS485 TX enabled.
[S2]	ON	Auto RS485 TX/RX control is enabled. Use this when interfacing with an RDM controller. **Applies also when interfacing DCB1M EVB in DMX/RDM interface mode.**
	OFF	RS485 TX/RX is controlled manually according to [S4] state.

2.1.3 *Setting* switch

The Setting switch determines the TX driver control and transceiver selection.
Table 6 describes the switches S1:S4 settings.
ON = '1', OFF='0'.

Table 6 – Setting switch

Setting	Name	Description
S1	TXO Driver	ON - drive 66mA, OFF – drive 33mA
S2	TXO TX level	ON - 1Vpp, OFF - 2Vpp
S3	TRANCS_EN	ON - Enable use of onboard transceiver. OFF - Disabled use of onboard transceiver [1]
S4	LIN_MASTER	ON - LIN transceiver as A master, OFF - LIN transceiver as Slave [2]

[1] S3 TRANCS_EN selection is read after the power-up/reset event once. When ON indicating, that the user is interfacing to LIN/CAN/RS485 transceiver (if installed on the board).

[2] S4 is a dedicated switch for the LIN interface. When ON, the LIN Transceiver operates as a Master. When OFF, the LIN transceiver operates as a Slave.

2.1.4 *Tx* Switch

When the Tx switch is ON, the onboard uC acts as the EVB Host, transferring a cyclic pre-defined test message A2Z ('ABC..Z') according to the selected host interface.
When the Tx switch is OFF, the EVB is in RX mode. The uC waits to receive test messages from other TX EVB. If such a message is detected, the uC analyzes the received data and toggle the Comm. LED accordingly (see 2.2).
The received A2Z message is transferred also through the connected transceiver (if installed).

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2.2 Comm. LED

The Comm. LED indicates the communication performance during the stand-alone mode. When there are no errors, the LED is ON. Whenever an error is detected, the LED is OFF for short period. If the LED is OFF, no communication is detected.

When the USB interface is connected to a PC, The LED indicates that the PC detected the USB interface. The PC Program controls the EVB operation regardless of the switch's setting (see 3.3).

3. Operation

Upon power-up or reset, the EVB Tester board is initializing with auto-detection of the attached DC-BUS EVB type (SIG10x/DCAN500/DCB1M/DMX250). During initializing the DC-BUS EVB is being configured according to the current state of the EVB Tester board switches.

The EVB Tester board has three modes of operation;

3.1 Stand-alone mode

Stand-alone mode is defined when the EVB Tester board is not connected to the PC SW (i.e. USB cable is not connected).

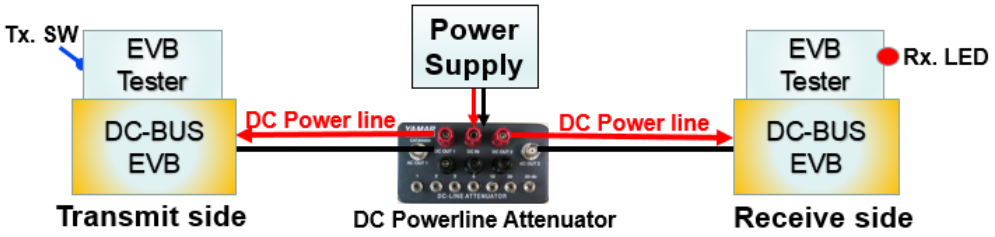

Figure 5 - Standalone connectivity

In this mode, all switches are read on-change event and configure the DC-BUS EVB on-the-fly (expect from Table 4 switches which are read once after power-up or reset).

User can select the following stand-alone modes of operations:

- **Auto Tx -** When the TX switch is ON, The tester generates continuous test messages to the connected EVB according to the switch's positions (i.e. bitrate selection, carrier frequency, protocol interface, TX signal level). During transmission, Comm. LED is ON. Other EVBs connected to the DC-BUS test software can detect the test messages over the powerline and perform BER analysis.

- **Auto Rx -** When the TX switch is OFF the EVB Tester board waits for valid test messages over the powerline from other TX EVB, analyzes it, and turns ON the Comm. LED if the Rx data is without errors, blinks when an error is detected, or turns LED OFF if no data detected.

- **TX-Sweep -** When the Tx switch is ON and the Frequency switch is **0xFF** (all switches are ON), test messages are transmitted for a period of ~250ms on each frequency starting from 5MHz up to 30MHz with 0.1MHz spacing (cyclic). During the frequency change period, the Comm. LED is OFF. This mode allows the user a quick assessment of its powerline channel frequency response (RX signal level-wise) within device carrier frequency selection full

range (i.e. user can observe the powerline full range carrier frequency level using an oscilloscope or spectrum-analyzer in various optional nodes located along the powerline).

- **BER-Sweep –** This mode allows a full carrier frequency Sweep BER measurement over the powerline. This test is under the control of a TX EVB connected to a PC running the DC-BUS Test SW. Only the RX EVB is in Standalone mode. The RX EVB Tester responds to test messages from the TX EVB Tester with data errors information for each carrier frequency between 5MHz to 30MHz, 100kHz spacing.

Setting the BER-Sweep Test step by step:

1. Before the start of the Sweep-BER test, the user must set the BASE TEST FREQUENCY. The BASE TEST FREQUENCY is defined as a carrier frequency that was tested to be a flawless communication channel over the powerline.
2. For instance, assuming 19.4MHz is the BASE TEST FREQUENCY; the user must set this frequency using the frequency switch with the value of 0x90 (SW1 and SW4 ON, the reset are OFF).
3. Click the reset button on the TX and RX EVB Tester boards as shown in Figure 6.

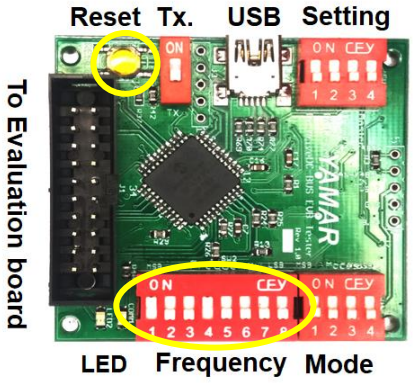

Figure 6 – EVB Tester board 19.4MHz carrier frequency setting example

4. At this point, both TX and RX EVB Tester are set to the BASE TEST FREQUENCY.

5. At the RX side, set the Frequency switch to **0xFE** (all switches are ON, aside from SW 8).
6. Click the **Reset** button again. The RX EVB Tester automatically enters the Sweep BER Mode.
7. At the TX side (which is connected to the PC PROGRAM), click on the Sweeper BER Test Tab. The TX device automatically enters the Sweep BER Mode.

8. The Sweep BER Test tab includes a real-time updated BER measurement table per carrier frequency, and a test frequency range settings as shown in Figure 7. Set the Sweeper Start Freq. and End Freq., and then click on the Start Sweep Test button.

9. The Sweep BER Test starts with transmitting the ABCD…Z pattern @ Start Freq. retrieves from the RX device the number of received bytes, error bytes, and miss bytes, then it will move to Start Freq. + 0.1MHz spacing, retrieve the BER results, and so on… until reaching the End Freq. The Test will continue a cyclic transmission from Start Freq. to End Freq. until the user stops the Test by clicking the Stop Sweep Test button as shown in Figure 7.
10. Click on the 'Clear Data' button to clear the Table content.
11. Set the test description under the 'Test Name' text box.
12. Click on the 'Save Sweep Log' button to save the current test into the .csv file.
13. Check the 'Append Tests' check box to append current tests to open the log CSV. file.

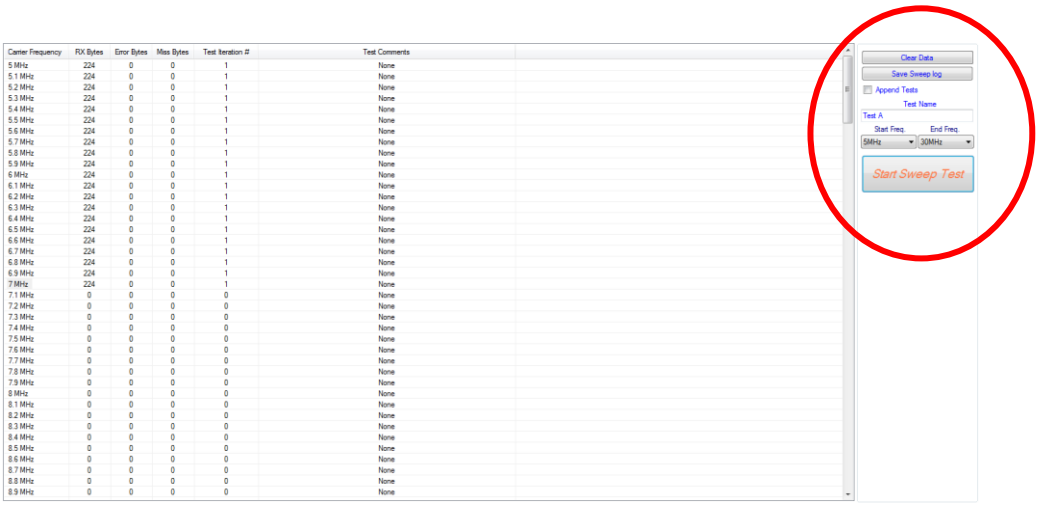

Figure 7 – Sweep BER Test TAB in the process

3.2 Transceiver mode (Optional)

Transceiver mode is enabled by setting switch S3 (TRANCS_EN) ON. Upon reset or power-up, the EVB Tester board configures the connected DC-BUS EVB according to its switch position (Frequency, Mode, Setting) and then switch for direct communication between the connected DC-BUS EVB and the user's installed transceiver (CAN/ LIN/ RS485). The EVB Tester has an option to install **one** of the following transceivers for direct communication between the user's bus and the connected EVB. Upon reset or power-up, the EVB Tester configures the EVB.

- CAN – SN65HVD232D (SO8)
- LIN – TJA1020T/N1,112 (SO8)
- RS485 – SN65HVD1781 (SO8)

Table 7 – Transc. J2 connector pinout

J2 Pin	Description
1	3.3V
2	GND
3	VBAT (LIN) / RS485 TX/RX control [1]
4	CANH/485-/LIN
5	CANL/485+

[1] User external manual control - RS485 RX enabled - 0V, RS485 TX enabled - 3.3V

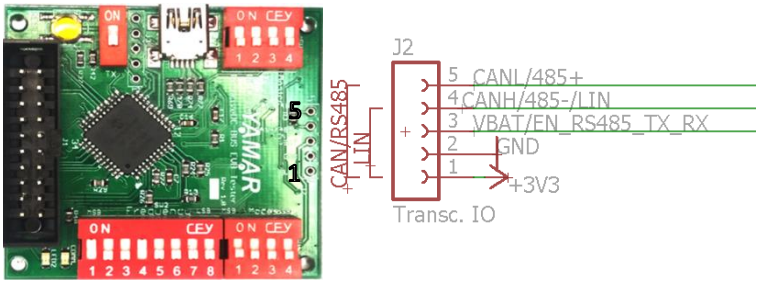

Figure 8 - Transceiver I/O connector

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3.3 PC operation Mode

When a USB cable is connected[1] between the EVB Tester and the PC Test SW, the EVB Tester board is under the control of the PC Test SW, that is, the on-board switches state are not read, and configuration of the attaches DC-BUS EVB is done only through the PC SW GUI. The Comm. LED is ON, indicating that the communication between the EVB Tester and the PC is established. Users can connect both TX and RX EVBs to the PC, or connected only the RX EVB to the PC and operate the TX EVB in stand-alone in TX mode (see Figure 9 and Figure 10).

See PC Test Program operation manual.

[1] The USB connector provides the voltage for the USB interface only. The attached DC-BUS EVB must be connected to the powerline for the EVB-Tester board to be supplied with 3.3V properly.

I.PC to PC communication via the powerline using the USB interface built in the EVB tester.

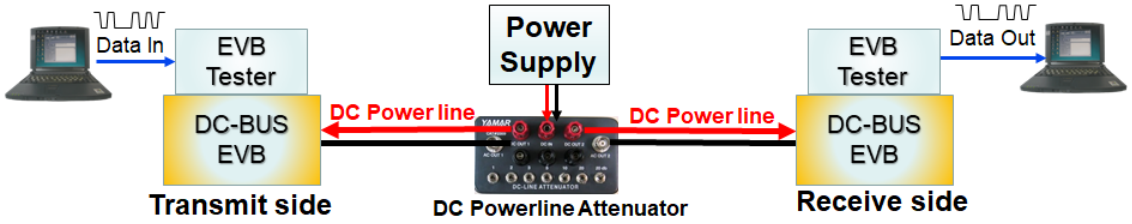

Figure 9 - PC to PC testing

II.TX test messages transmission from the EVB tester to a PC with a test program via the powerline.

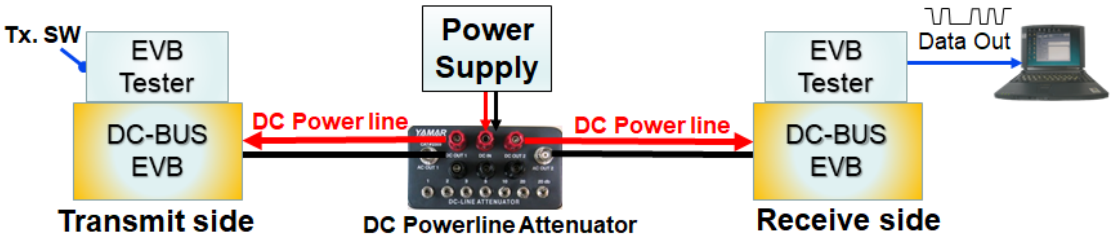

Figure 10 – EVB Tester (Tx mode) to PC (RX mode) testing

This set-up allows the user to test the full utilization of powerline bitrate.

1. TX side is in stand-alone mode (Not connected to a PC).
2. RX side is connected to the DC-BUS PC SW.
3. On the TX side, turn ON TX. switch. A2Z test pattern is continuously sent over the powerline to the RX side.
4. On the RX side, set BER mode, and observe the received A2Z test pattern including BER statistics analysis. The powerline bitrate is shown in the real-time graph.
   For the DCB1M, the user can change on-the-fly the codec selection pins using Mode SW[1:2] (see Table 3) on the TX side and observed the corresponded powerline bitrate changing in RX side real-time graph.

Annex 1 - DC-BUS frequencies binary table

Freq. Switch	Freq. MHz		Freq. Switch	Freq. MHz		Freq. Switch	Freq. MHz		Freq. Switch	Freq. MHz
00000000	5.0		01000000	11.4		10000000	17.8		11000000	24.2
00000001	5.1		01000001	11.5		10000001	17.9		11000001	24.3
00000010	5.2		01000010	11.6		10000010	18.0		11000010	24.4
00000011	5.3		01000011	11.7		10000011	18.1		11000011	24.5
00000100	5.4		01000100	11.8		10000100	18.2		11000100	24.6
00000101	5.5		01000101	11.9		10000101	18.3		11000101	24.7
00000110	5.6		01000110	12.0		10000110	18.4		11000110	24.8
00000111	5.7		01000111	12.1		10000111	18.5		11000111	24.9
00001000	5.8		01001000	12.2		10001000	18.6		11001000	25.0
00001001	5.9		01001001	12.3		10001001	18.7		11001001	25.1
00001010	6.0		01001010	12.4		10001010	18.8		11001010	25.2
00001011	6.1		01001011	12.5		10001011	18.9		11001011	25.3
00001100	6.2		01001100	12.6		10001100	19.0		11001100	25.4
00001101	6.3		01001101	12.7		10001101	19.1		11001101	25.5
00001110	6.4		01001110	12.8		10001110	19.2		11001110	25.6
00001111	6.5		01001111	12.9		10001111	19.3		11001111	25.7
00010000	6.6		01010000	13.0		10010000	19.4		11010000	25.8
00010001	6.7		01010001	13.1		10010001	19.5		11010001	25.9
00010010	6.8		01010010	13.2		10010010	19.6		11010010	26.0
00010011	6.9		01010011	13.3		10010011	19.7		11010011	26.1
00010100	7.0		01010100	13.4		10010100	19.8		11010100	26.2
00010101	7.1		01010101	13.5		10010101	19.9		11010101	26.3
00010110	7.2		01010110	13.6		10010110	20.0		11010110	26.4
00010111	7.3		01010111	13.7		10010111	20.1		11010111	26.5
00011000	7.4		01011000	13.8		10011000	20.2		11011000	26.6
00011001	7.5		01011001	13.9		10011001	20.3		11011001	26.7
00011010	7.6		01011010	14.0		10011010	20.4		11011010	26.8
00011011	7.7		01011011	14.1		10011011	20.5		11011011	26.9
00011100	7.8		01011100	14.2		10011100	20.6		11011100	27.0
00011101	7.9		01011101	14.3		10011101	20.7		11011101	27.1
00011110	8.0		01011110	14.4		10011110	20.8		11011110	27.2
00011111	8.1		01011111	14.5		10011111	20.9		11011111	27.3
00100000	8.2		01100000	14.6		10100000	21.0		11100000	27.4
00100001	8.3		01100001	14.7		10100001	21.1		11100001	27.5
00100010	8.4		01100010	14.8		10100010	21.2		11100010	27.6
00100011	8.5		01100011	14.9		10100011	21.3		11100011	27.7
00100100	8.6		01100100	15.0		10100100	21.4		11100100	27.8
00100101	8.7		01100101	15.1		10100101	21.5		11100101	27.9
00100110	8.8		01100110	15.2		10100110	21.6		11100110	28.0
00100111	8.9		01100111	15.3		10100111	21.7		11100111	28.1
00101000	9.0		01101000	15.4		10101000	21.8		11101000	28.2
00101001	9.1		01101001	15.5		10101001	21.9		11101001	28.3
00101010	9.2		01101010	15.6		10101010	22.0		11101010	28.4
00101011	9.3		01101011	15.7		10101011	22.1		11101011	28.5
00101100	9.4		01101100	15.8		10101100	22.2		11101100	28.6
00101101	9.5		01101101	15.9		10101101	22.3		11101101	28.7
00101110	9.6		01101110	16.0		10101110	22.4		11101110	28.8
00101111	9.7		01101111	16.1		10101111	22.5		11101111	28.9
00110000	9.8		01110000	16.2		10110000	22.6		11110000	29.0
00110001	9.9		01110001	16.3		10110001	22.7		11110001	29.1
00110010	10.0		01110010	16.4		10110010	22.8		11110010	29.2
00110011	10.1		01110011	16.5		10110011	22.9		11110011	29.3
00110100	10.2		01110100	16.6		10110100	23.0		11110100	29.4
00110101	10.3		01110101	16.7		10110101	23.1		11110101	29.5
00110110	10.4		01110110	16.8		10110110	23.2		11110110	29.6
00110111	10.5		01110111	16.9		10110111	23.3		11110111	29.7
00111000	10.6		01111000	17.0		10111000	23.4		11111000	29.8
00111001	10.7		01111001	17.1		10111001	23.5		11111001	29.9
00111010	10.8		01111010	17.2		10111010	23.6		11111010	30.0
00111011	10.9		01111011	17.3		10111011	23.7		11111011	
00111100	11.0		01111100	17.4		10111100	23.8		11111100	
00111101	11.1		01111101	17.5		10111101	23.9		11111101	
00111110	11.2		01111110	17.6		10111110	24.0		11111110	BER-Sweep
00111111	11.3		01111111	17.7		10111111	24.1		11111111	TX-Sweep

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