# Easy BER measurements for long PRBS

The R&S<sup>®</sup>FSW signal and spectrum analyzer is a high-performance instrument capable of measuring many key system and component parameters. Using the bit error rate (BER) functionality of the R&S<sup>®</sup>FSW-K70P option, the raw data error performance of a component or system can be accurately determined.



## Your task

Developers of components and communications systems are interested in the modulation signal quality provided by their device. This has a direct relationship to the quality of the data that is being sent. Bad quality can result in poor voice call quality and low data throughput due to data being transmitted incorrectly.

Each bit in a communications system is transmitted in a data symbol. Modulation accuracy measures the deviation of each received symbol from its ideal symbol position in its constellation diagram. This measurement is called error vector magnitude (EVM).

Although this measurement is useful, it says nothing about the impact on data errors in the system since it is possible to have a bad EVM in a system with zero bit errors.



Signal with excellent EVM (i.e. high modulation accuracy)



The same signal with strong distortion. It has poor modulation quality, but it is clear that no symbols would fall in an adjacent quadrant.

Bit errors occur when a data symbol appears in the wrong area (quadrant for QPSK) of the constellation diagram. This is called a symbol decision error. They occur because the data symbol was distorted during transmission by amplitude, phase, timing or additive noise. When this happens, bit errors occur because our wanted data has been corrupted and received incorrectly.





## Rohde&Schwarz solution

Bit errors can be measured using both one-port and twoport test setups.

## Typical one-port and two-port test setups

In a one-port test setup, the DUT itself produces both the data patterns and the modulation format to be measured. A transmitter chipset or a modem are examples for this setup.

In the past, measuring BER was time-consuming and complex. Now, the process has been made simple and almost instantaneous, even for very long and complex data patterns such as PRBS23 which has more than 8 million possible combinations that have to be calculated in advance.

# Configuring the R&S<sup>®</sup>FSW-K70P

First, the R&S<sup>®</sup>FSW must know the type of modulation it is expecting, e.g. QAM or QPSK. Then, the R&S<sup>®</sup>FSW must know how the data is mapped to each constellation point. Whenever an R&S<sup>®</sup>SMx vector signal generator is used, the mapping can simply be set to "SMx", which will always match the default mapping of the generator regardless of the modulation.

	Signal Description	🖹 😒 k? 💡		۲	×
ctrum 💌 🗸	Modulation	Signal Structure	Frame Structure	Known	Data
Mot Freq 3.41 GHz Res	Modulation Set				
ef)	Туре •1	QAM			Peak
	Order	256QAM	•		1.18 3.35 38.53
	Mapping	SMx	- Park		29.51 1.02 -14.52
	Symbol Rate	DOCSIS			-134.23
	Transmit Filter	DVB-C	2		0.999 859
	Туре	GRAY			-53.62 -56.74 0.02
****	Alpha/BT	0.2			0.05 0.000 010 -9.65
•)	Const I/Q(Mea	as&Ref)	• 1M Clrw		(Hexad
a a mana anitara da di ta mada a	le l			+ 9 + 9 50 EC A 9 15 31 F	3 4E 7D 0B 8 9 E8 93 07

• Next, we need to tell the R&S<sup>®</sup>FSW that it will use "Known Data" for its demodulation process and select the data source and type.

	Signal Description	🔳 🖏 kg 💈		
Spectrum	Modulation	Signal Structure	Frame Structure	Known Data
odBm 10 dB <b>Freq</b> 3.41 GHz	Mod Res en 2000	R. Solo MHz		
eas&Ref)	Known Data can be used f	is needed for the BER or fine synchronizatio	measurement and n (see "Demodulatior	" dialog)
-++++++++++++++++++++++++++++++++++++++	- <u>+ - + - + - + - +</u>			
	Known			
	Source		PRBS	• -1
	PRBS Type		23	1
	Generator f	Polynomial	Auto 23; 5; 0	
	Negate Fee	dback Path	Auto On	
	Pattern Syn		Auto On	
Buffer)	and a subsection design			
damentation direct international	all the second store a balle	0 63		

### Rohde & Schwarz GmbH & Co. KG

Europe, Africa, Middle East | +49 89 4129 12345 North America | 1 888 TEST RSA (1 888 837 87 72) Latin America | +1 410 910 79 88 Asia Pacific | +65 65 13 04 88 China | +86 800 810 82 28 | +86 400 650 58 96 www.rohde-schwarz.com customersupport@rohde-schwarz.com It is also possible to manually change the polynomial or negate the feedback path in this step.

• Finally, the bit error rate results need to be displayed. This can be done under "Window Config" for the "Modulation Accuracy" measurement.

• 1	M Clrw	3 Bit Error Rate Bit Error Rate Total # of Errors	Current 0.00e+00 16 000	Accumulative 0.00e+00 0
ĺ	Window	Config	10,000	x
	Signal	Source:	Modulation A	ccuracy -
	Resu	lt Type Result Summary		
	2.48	Bit Error Rate		(Hexadecimal)

#### **Summary**

With basic knowledge of the PRBS polynomial and data mapping, BER can be easily measured in the R&S<sup>®</sup>FSW for any PRBS sequence, no matter how long.

As an additional benefit, the known data approach delivers highly accurate EVM results, even for low SNR environments.

		a 🗤 🥐				ite	ме	as Config
MultiView # Spectrum X VSA Ref Level 0.00 dBm Mod 256 Att 10 dB Free 3.41 GHz Bes Len 2	AM SR	50.0 MHz			SGL Stat	• Gount 4	· le	Signal escription
YIG Bypess 1 Const I/Q(Meas&Ref)	• 1M Clrw	2 Result Summa	ary				•1	Input/ Frontend
\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$		EVM MER	RMS Peak RMS	Current 2.64 6.81 31.44	Peak 2.72 8.21 31.32	Unit % % dB	Ē	Signal Capture
A		Phase Error Magnitude Error	Peak RMS Peak RMS	23.2 2.1 -29.1 1.8	21.71 2.16 -29.14 1.89	dB deg deg %	·	Pattern Config
	(	Carrier Frequenc Symbol Rate Erro	Peak y Error or	-6.0	6.65 -135.68	% Hz ppm z	•	Burst/ Pattern Search
		Rho I/Q Offset I/Q Imbalance		0.999 28- -53.01 -66.31	0.999.263 -53.08 -63.06	88 88 5	÷	Range Settings
-2.48	7 48	Quadrature Error Amplitude Droop Power		-0.000 00 -0.000 00 -29.9	0.000 0.000 002 -29.84	deg dB/sym dB/m	÷	Demod/ leas Filter
3 Bit Error Rate Current Ac Bit Error Rate 0.00e+00	cumulative	4 Symbols + 1	+ 3 + 5	+ 7 + 9	(Hexa + 11 + 13	decimal) + 15 •	÷	Window Config
Total # of Errors 0 Total # of Bits 16 000	64 000	16 66 88 1 32 20 82 1 48 A5 87 2	FA 8C 76 A9 F0 C8 26 2C 21 D5 39 C9	FA B8 D2 A4 66 38 BE BD 1B FE 2B 37	BA F3 98 36 A1 2D EC F6 89 64 72 B4	FE C2 DF 18 28 87	Ţ	Display Config
		80 E3 C1 ( 96 AC 9E E 112 37 EB / 128 F2 E4 144 A5 16 I	77 94 20 P3 D6 C8 3C 40 ED 81 79 44 A4 6A C1 AD 10 A3 33 P6 E5 F0 6B 48	60 97 67 16 A3 5C 5E 6E 9A 17 C2 4E 75 65 8E 4C 05 FB 6E 84	00 F7 08 D3 50 D8 F7 08 D3 50 D8 B7 68 20 E8 EB 84 57 70 72 8D 52 80 55 FA	D3 1C 63 4B 14 C9 03 B9 E8	و جا	l+ + verview
				R	ady 📶		20 1	3.08.2018

### See also

- www.rohde-schwarz.com/product/fsw
- www.rohde-schwarz.com/product/fswk70
- https://www.rohde-schwarz.com/us/manual/r-s-fswk70-measuring-unknown-signals-application-sheetmanuals-gb1\_78701-286988.html

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