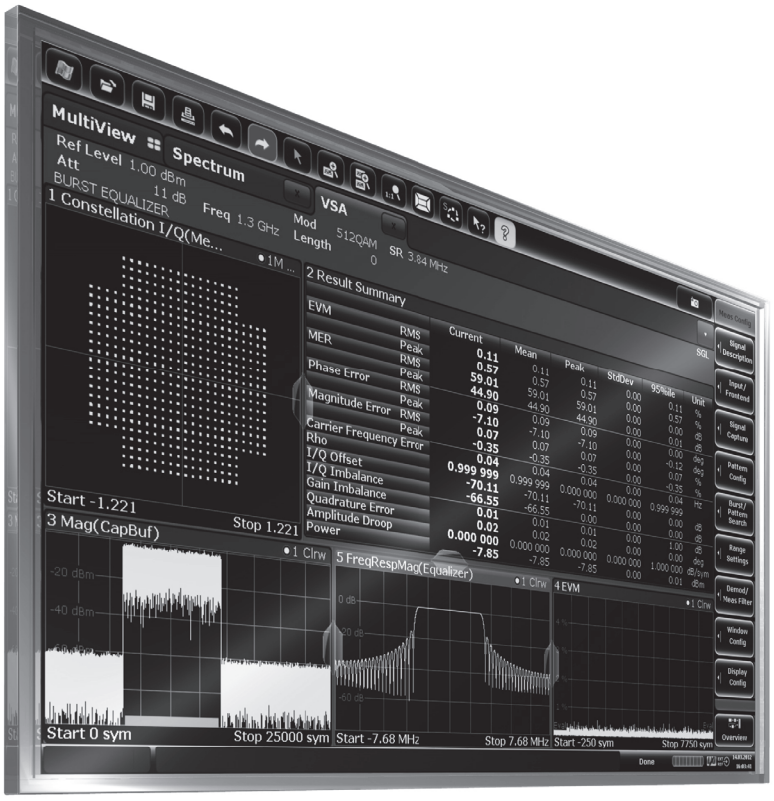
R&S®FSW-K70
Vector signal analysis
Specifications



ROHDE&SCHWARZ

Test & Measurement

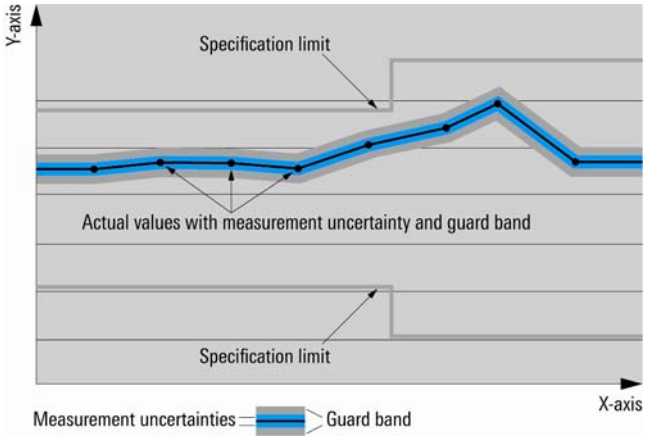
Data Sheet | 02.00

Definitions

General
Product data applies under the following conditions:

- Three hours storage at ambient temperature followed by 30 minutes warm-up operation
- Specified environmental conditions met
- Recommended calibration interval adhered to
- All internal automatic adjustments performed, if applicable

Specifications with limits
Represent warranted product performance by means of a range of values for the specified parameter. These specifications are marked with limiting symbols such as <, ≤, >, ≥, ±, or descriptions such as maximum, limit of, minimum. Compliance is ensured by testing or is derived from the design. Test limits are narrowed by guard bands to take into account measurement uncertainties, drift and aging, if applicable.



Specifications without limits
Represent warranted product performance for the specified parameter. These specifications are not specially marked and represent values with no or negligible deviations from the given value (e.g. dimensions or resolution of a setting parameter). Compliance is ensured by design.

Typical data (typ.)
Characterizes product performance by means of representative information for the given parameter. When marked with <, > or as a range, it represents the performance met by approximately 80 % of the instruments at production time. Otherwise, it represents the mean value.

Nominal values (nom.)
Characterize product performance by means of a representative value for the given parameter (e.g. nominal impedance). In contrast to typical data, a statistical evaluation does not take place and the parameter is not tested during production.

Measured values (meas.)
Characterize expected product performance by means of measurement results gained from individual samples.

Uncertainties
Represent limits of measurement uncertainty for a given measurand. Uncertainty is defined with a coverage factor of 2 and has been calculated in line with the rules of the Guide to the Expression of Uncertainty in Measurement (GUM), taking into account environmental conditions, aging, wear and tear.

Device settings and GUI parameters are designated with the format “parameter: value”.

Typical data as well as nominal and measured values are not warranted by Rohde & Schwarz.

Specifications

The specifications of the R&S®FSW-K70 vector signal analysis measurements are based on the specifications in the data sheet for the R&S®FSW signal and spectrum analyzer. They have not been checked separately and are not verified during instrument calibration. Measurement uncertainties are given as 95 % confidence intervals. They apply to the specified symbol rates. The specified level measurement errors do not take into account systematic errors due to reduced signal-to-noise ratio (S/N).

Inputs

RF input	frequency range same as R&S®FSW

Signal acquisition

Capture length	RF input	100 symbol to 64000 symbol
Result length		10 symbol to 64000 symbol, but not larger than capture length
Capture oversampling		4, 8, 16, 32 [1]
Triggering	RF input	free run
		external (positive or negative polarity)
		I/Q power
		IF power [2]
	checks captured data for power bursts and performs analysis only at detected burst	burst search
	checks captured data for patterns and performs analysis only at detected pattern	predefined patterns
		user-defined patterns

[1] For large symbol rates, restricted by the maximum sampling rate.

[2] Restricted IF overload, IF power trigger and auto level functionality depending on carrier frequency and bandwidth at carrier frequencies < 50 MHz.

Modulation formats

Type	Order	Mapping
FSK	2FSK	Natural
	4FSK	Natural, Gray, APCO25 C4FM, APCO25 Phase 2
	8FSK	Natural
MSK	MSK, including GMSK	Natural
	DMSK	GSM
PSK	BPSK	Natural
	QPSK	WCDMA, Natural, Gray, CDMA2000® forward, DVB-S2
	Offset QPSK	Gray
	DQPSK	Natural, Inmarsat
	π/4-DQPSK	TFTS, TETRA, PHS, PDC, Natural, NADC, APCO25, APCO25 Phase 2
	3π/4-QPSK	EDGE
	8PSK	Natural, Gray, DVB-S2
	D8PSK	Natural, Gray
	3π/8-8PSK	EDGE
	π/8-D8PSK	APCO25 Phase 2, TETRA
QAM	16QAM	Gray, DVB-C
	π/4-16QAM	EDGE
	32QAM	DVB-C
	–π/4-32QAM	EDGE
	64QAM	DVB-C
	128QAM	Gray
	256QAM	Gray
	512QAM	Gray
	1024QAM	Gray
ASK	2ASK	OOK
	4ASK	Natural
APSK	16APSK	DVB-S2 (for different code rates)
	32APSK	DVB-S2 (for different code rates)
User modulation (QAM, PSK) (with external MAPWIZ [3] tool)	static	user-definable constellation 2-ary, 4-ary, 8-ary, 16-ary, 32-ary, 64-ary, 128-ary, 256-ary
	differential	user-definable constellation 2-ary, 4-ary, 8-ary, 16-ary, 32-ary, 64-ary, 128-ary, 256-ary

[3] MAPWIZ is a free Rohde & Schwarz tool that can be downloaded at www.rohde-schwarz.com. It requires MATLAB®.

Predefined standards

Predefined standards can be loaded in order to preset the measurement parameters, filters and display format.
Predefined standards can be changed and resaved.

3GPP CDMA	QPSK	CPICH (without descrambling and despreading)
GSM, EDGE, EDGE Evolution	GMSK	normal burst
		access burst
		frequency correction burst
		synchronization burst
	3π/8-8PSK	normal burst
	3π/4-QPSK	higher symbol rate burst with narrow and wide pulse filter
	π/4-16QAM	normal burst
		higher symbol rate burst with narrow and wide pulse filter
	–π/4-32QAM	normal burst
		higher symbol rate burst with wide pulse filter
TETRA	π/4-DQPSK	discontinuous downlink
		continuous downlink
APCO25	QPSK	CQPSK
	4FSK	C4FM
	CPM	H-CPM
	DQPSK	H-DQPSK
Bluetooth®	2FSK	DH1
		DH3
		DH5
DECT	2FSK	P32, fixed part
		P32, portable part
DVB-S2	QPSK	
	8PSK	
	16APSK	only XFECFrame
	32APSK	only XFECFrame
CDMA2000®	QPSK	1× forward link (without descrambling and despreading)
	Offset QPSK	1× reverse link (without descrambling and despreading)
ZigBee (IEEE 802.15.4)	Offset QPSK	PHY for 2450 MHz band (without descrambling and despreading)
	BPSK	PHY for 915 MHz band (without descrambling and despreading)
		PHY for 868 MHz band (without descrambling and despreading)
User-definable standards		

Filtering

Filter types	transmit filter	RC (raised cosine)
		RRC (root raised cosine)
		Gaussian
		GMSK
		linearized GMSK
		EDGE narrow pulse shape
		EDGE wide pulse shape
		CDMA2000® 1x forward
		CDMA2000® 1x reverse
		APCO25 C4FM
		APCO25 H-CPM
		APCO25 H-DQPSK
		APCO25 H-D8PSK narrow
		APCO25 H-D8PSK wide
		half sine
		rectangular
		none
		user-definable filters designed with FILTWIZ [4]
	measurement filter	RRC
		EDGE NSR
		EDGE HSR (narrow pulse)
		EDGE HSR (wide pulse)
		rectangular
		low ISI measurement filter
		none
		user-definable filters designed with FILTWIZ [4]
	receive filter	R&S®FSW-K70 automatically selects appropriate receive filters
User-selectable filter parameters		
Alpha (rolloff factor)	for RC and RRC filters	0.1 to 1
B × T	for Gaussian and GMSK filters	0.1 to 1

[4] FILTWIZ is a free Rohde & Schwarz tool that can be downloaded at www.rohde-schwarz.com. It requires MATLAB®.

Measurement parameters

Sampling rate	RF input	
		100 Hz to 10 GHz
Symbol rate [5] [6] [7]	depends on capture oversampling	sampling rate/capture oversampling
Usable I/Q bandwidth	depends on set symbol rate	about 0.8 × capture oversampling × symbol rate
	max.	
	RF input	
	standard	10 MHz
	with R&S®FSW-B28 option	28 MHz [8]
	with R&S®FSW-B40 option	40 MHz [8]
	with R&S®FSW-B80 option	80 MHz [8]
	with R&S®FSW-B160 option	160 MHz [8]
	with R&S®FSW-B320 option	320 MHz [8]
Coarse synchronization		data (based on unknown data)
	only if a synchronization pattern is found	pattern (based on synchronization pattern)
Fine synchronization		detected data (based on detected data)
	only if a synchronization pattern is found	pattern (based on synchronization pattern)
	only if a file containing all valid transmit sequences is loaded (cf. requirements for BER measurement)	known data (based on detected transmit sequence)
EVM normalization	only for PSK, QAM, ASK and APSK	mean reference power
		max. reference power
		mean constellation power
		max. constellation power
Offset EVM	only for offset QPSK	on/off
Equalizer estimation	only for PSK, QAM, ASK, APSK and MSK	normal
		tracking
		averaging
		user-defined
Equalizer length	only for PSK, QAM, ASK, APSK and MSK	1 symbol to 256 symbol
Error compensation (optional)	PSK, QAM, ASK, APSK and MSK, measured signal	estimated I/Q offset
		estimated I/Q imbalance
		estimated amplitude droop
		estimated channel response
	FSK, measured signal	estimated carrier frequency drift
	FSK, reference signal	estimated FSK deviation error
Estimation points per symbol	samples per symbol used for fine synchronization and equalizer estimation	1, 2 or capture oversampling
Swap I/Q	captured signal	on/off

[5] RF input: the maximum symbol rate a measured signal is allowed to have is also limited by the analyzer's usable I/Q bandwidth, the actual bandwidth of the measured signal (depends e.g. on filter rolloff (alpha)), and any frequency offset (FO).
Example with raised cosine filter: [symbol rate x (1+alpha) + 2 x FO < usable I/Q bandwidth].

[6] Digital baseband input with R&S®FSW-B17 option: the maximum symbol rate a measured signal is allowed to have is also limited by the digital input sampling rate, the actual bandwidth of the measured signal (depends e.g. on filter rolloff (alpha), and any frequency offset (FO),
Example with raised cosine filter: [symbol rate x (1+alpha) + 2 x FO < 0.8 x digital input sampling rate/capture oversampling].

[7] Analog baseband input with R&S®FSW-B71 option: the maximum symbol rate a measured signal is allowed to have is also limited by the analyzer's frequency range, the actual bandwidth of the measured signal (depends e.g. on filter rolloff (alpha)), and any frequency offset (FO).
Example with raised cosine filter: [0.5 x symbol rate x (1+alpha) + FO < half frequency range].

[8] YIG preselector off for f ≥ 8 GHz.

Display formats versus time

The following display formats versus time are available.

For this display format, the number of displayed samples per symbols is fixed to the selected capture oversampling.

Captured signal		magnitude versus time
		I/Q versus time
		absolute frequency versus time

For these display formats, the parameter “display points per symbol” (1, 2, 4, 8, 16 or 32) sets the number of displayed samples per symbol.

Measured signal	filtered, carrier locked, symbol locked	absolute/relative magnitude versus time
		I/Q versus time
		wrapped/unwrapped phase versus time
		absolute/relative frequency versus time
Reference signal	ideal, calculated from detected symbols	absolute/relative magnitude versus time
		I/Q versus time
		wrapped/unwrapped phase versus time
		absolute/relative frequency versus time
Error vector signal	vector difference between measured signal and reference signal	EVM versus time (EVM normalization selectable)
		I/Q versus time
Error signal	difference between the measured signal’s magnitude/phase/frequency and the reference signal’s magnitude/phase/ frequency	magnitude error versus time
		phase error versus time
		absolute and relative frequency error versus time

For all the listed results, spectrum and statistics (probability density function (PDF), cumulative probability density function (CDF), 95th percentile) are also available.

Additional display formats

For this display format, the number of displayed samples per symbols is fixed to the selected capture oversampling.

I/Q vector	captured signal	polar diagram

For these display formats, only symbol times are displayed.

I/Q constellation	measured signal, reference signal	polar diagram
		I/Q samples
I/Q constellation (rotated)	measured signal, reference signal	polar diagram
		I/Q samples (only for rotated constellations, e.g. 3π/8-8PSK)
Frequency constellation	measured signal, reference signal	absolute frequency

For these display formats, the parameter “display points per symbol” (1, 2, 4, 8, 16 or 32) sets the number of displayed samples per symbol.

I/Q vector	measured signal, reference signal, error vector signal	polar diagram, display of trajectory between symbol times
Frequency vector	measured signal, reference signal	absolute frequency
Eye diagram	measured signal, reference signal	I eye diagram
		Q eye diagram
Eye diagram frequency	measured signal, reference signal	eye diagram of the absolute frequency

Display of modulation accuracy results

The tables show the scalar result values calculated for each measurement. Additionally, the following statistical measures (calculated over multiple measurements) are shown for each result value: mean, peak (worst value), standard deviation and 95th percentile.

Numerical limits can be set for the current, mean and peak value. Limits can only be set for the parameters EVM, magnitude error, phase error, carrier frequency error, waveform quality factor and I/Q offset.

The tables are modulation-specific.

Table for MSK, PSK, QAM, ASK and APSK
For the following results, the parameter “estimation points per symbol” can be set by the user. It can be set to 1 (only symbol times contribute to the result), 2 (two samples per symbol contribute to the result) or “capture oversampling” (all samples contribute to the result).

I/Q offset		R&S®FSW-K70 automatically selects calculation range
I/Q imbalance	not for BPSK, ASK	
Gain imbalance	not for BPSK, ASK	
Quadrature error	not for BPSK, ASK	
Amplitude droop		
Carrier frequency error		

For the following results, the parameter “display points per symbol” can be set by the user. It can be set to 1 (only symbol times contribute to the result), 2 (two samples per symbol contribute to the result) or “capture oversampling” (all samples contribute to the result). The estimated I/Q offset, amplitude droop, I/Q imbalance may be optionally compensated before calculating these values.

Error vector magnitude (EVM)	RMS and peak value of corresponding trace	user-settable calculation range (evaluation range)
Modulation error ratio (MER)	RMS and peak value of corresponding trace	
Magnitude error	RMS and peak value of corresponding trace	
Phase error	RMS and peak value of corresponding trace	
Mean power		
Waveform quality factor ρ (rho)		

Remark: for Offset-QPSK, the error vector magnitude (EVM) and modulation error ratio (MER) can be influenced by the parameter “Offset-EVM”.

Table for FSK
For the following results, the parameter “estimation points per symbol” can be set by the user (1, 2 or capture oversampling).

FSK deviation error		R&S®FSW-K70 automatically selects calculation range
FSK measurement deviation		
Carrier frequency drift		
Carrier frequency error		

For the following results, the parameter “display points per symbol” can be set by the user (1, 2 or capture oversampling). The estimated FSK deviation error and the estimated carrier frequency drift may be optionally compensated before calculating these values.

Frequency error	RMS and peak value of corresponding trace	user-settable calculation range (evaluation range)
Magnitude error	RMS and peak value of corresponding trace	
Mean power		

Bit error rate

The bit error rate measurement requires that an XML file containing all valid transmit sequences is loaded. The length of the transmit sequences needs to coincide with the length of the result range. It is recommended to use an external trigger or a synchronization pattern to align the result range for this measurement.

Bit error rate		current value
		best-case value
		worst-case value
		accumulative value

Detected symbols

Symbol formats		binary
		octal
		decimal
		hexadecimal
Symbol marker		detected synchronization patterns are marked in green

Measurement uncertainty (nominal)

Specifications apply from +20 °C to +30 °C, signal level ≥ –25 dBm, properly adjusted reference level, offset between analyzer's center frequency and the signal's center frequency is smaller than 5 % of symbol rate, no additional I/Q impairments, random data sequence. Capture oversampling is set to 4. For symbol rates < 1 kHz or frequencies > 5 GHz, accuracy may be limited by phase noise.

Residual errors for QPSK

The modulation is QPSK, the TX filter is RRC with rolloff factor 0.22, the measurement filter is RRC with rolloff factor 0.22 and EVM is normalized to mean reference power. The parameter "estimation points per symbol" is set to 1, as is the parameter "display points per symbol" for the result summary. The result length is 150 symbols and the number of averages is 10.

Residual EVM RMS (averaged value)	symbol rate = 100 kHz	
	CF = 1 GHz	< 0.5 %
	CF = 2 GHz	< 0.5 %
	CF = 3 GHz	< 0.5 %
	symbol rate = 1 MHz	
	CF = 1 GHz	< 0.5 %
	CF = 2 GHz	< 0.5 %
	CF = 3 GHz	< 0.5 %
	symbol rate = 10 MHz	
	CF = 1 GHz	< 1.0 %
	CF = 2 GHz	< 1.0 %
	CF = 3 GHz	< 1.0 %
	symbol rate = 20 MHz	
	CF = 1 GHz	< 2.0 %
	CF = 2 GHz	< 2.0 %
	CF = 3 GHz	< 2.0 %
Carrier frequency error uncertainty (2σ value)	symbol rate = 100 kHz	R&S®FSW frequency uncertainty [9] +
	CF = 1 GHz	3 Hz
	CF = 2 GHz	3 Hz
	CF = 3 GHz	3 Hz
	symbol rate = 1 MHz	R&S®FSW frequency uncertainty [9] +
	CF = 1 GHz	15 Hz
	CF = 2 GHz	15 Hz
	CF = 3 GHz	15 Hz
	symbol rate = 10 MHz	R&S®FSW frequency uncertainty [9] +
	CF = 1 GHz	400 Hz
	CF = 2 GHz	400 Hz
	CF = 3 GHz	400 Hz
	symbol rate = 20 MHz	R&S®FSW frequency uncertainty [9] +
	CF = 1 GHz	600 Hz
	CF = 2 GHz	600 Hz
	CF = 3 GHz	600 Hz

[9] For R&S®FSW frequency uncertainty, refer to the reference frequency stated in the R&S®FSW specifications.

Residual errors for FSK

The modulation is 2FSK, the TX filter is RRC with rolloff factor 0.2, the measurement filter is RRC with rolloff factor 0.2 and the FSK reference deviation is half the symbol rate. The parameter “estimation points per symbol” is set to 4 (capture oversampling), as is the parameter “display points per symbol” for the result summary. The result length is 150 symbols and the number of averages is 10.

Residual frequency error RMS (averaged value)	symbol rate = 100 kHz	
	CF = 1 GHz	< 0.5 %
	CF = 2 GHz	< 0.5 %
	CF = 3 GHz	< 0.5 %
	symbol rate = 1 MHz	
	CF = 1 GHz	< 0.5 %
	CF = 2 GHz	< 0.5 %
	CF = 3 GHz	< 0.5 %
	symbol rate = 10 MHz	
	CF = 1 GHz	< 1.0 %
	CF = 2 GHz	< 1.0 %
	CF = 3 GHz	< 1.0 %
	symbol rate = 20 MHz	
	CF = 1 GHz	< 2.0 %
	CF = 2 GHz	< 2.0 %
	CF = 3 GHz	< 2.0 %

Residual errors for predefined standards

Measurements are based on the corresponding predefined standards. The number of averages is 10.

Residual EVM RMS (averaged value)	3GPP WCDMA (CPICH)	
	CF = 1 GHz	< 1.0 %
	CF = 2 GHz	< 1.0 %
	CF = 3 GHz	< 1.0 %
	GSM EDGE (3π/8-8PSK, normal burst)	
	CF = 1 GHz	< 0.6 %
	CF = 2 GHz	< 0.6 %
	CF = 3 GHz	< 0.6 %
	GSM (normal burst)	
	CF = 1 GHz	< 0.8 %
	CF = 2 GHz	< 0.8 %
	CF = 3 GHz	< 0.8 %
Residual frequency error RMS (averaged value)	Bluetooth® (DH1)	
	CF = 1 GHz	< 0.8 %
	CF = 2 GHz	< 0.8 %
	CF = 3 GHz	< 0.8 %

Ordering information

Designation	Type	Order No.	Remarks
Vector Signal Analysis	R&S®FSW-K70	1313.1416.02	
Spectrum and Signal Analyzer	R&S®FSW8	1312.8000.08	
Spectrum and Signal Analyzer	R&S®FSW13	1312.8000.13	
Spectrum and Signal Analyzer	R&S®FSW26	1312.8000.26	
Spectrum and Signal Analyzer	R&S®FSW43	1312.8000.43	
Spectrum and Signal Analyzer	R&S®FSW50	1312.8000.50	
Recommended options and extras			
Digital Baseband Interface	R&S®FSW-B17	1313.0784.02	
RF Preamplifier, 100 kHz to 13.6 GHz	R&S®FSW-B24	1313.0832.13	for the R&S®FSW8/13. Contact service center
RF Preamplifier, 100 kHz to 26.5 GHz	R&S®FSW-B24	1313.0832.26	for the R&S®FSW26. Contact service center
RF Preamplifier, 100 kHz to 43.5 GHz	R&S®FSW-B24	1313.0832.43	for the R&S®FSW43. Contact service center
Electronic Attenuator, 1 dB steps	R&S®FSW-B25	1313.0990.02	
28 MHz Analysis Bandwidth	R&S®FSW-B28	1313.1645.02	
40 MHz Analysis Bandwidth	R&S®FSW-B40	1313.0861.02	
80 MHz Analysis Bandwidth	R&S®FSW-B80	1313.0878.02	
160 MHz Analysis Bandwidth	R&S®FSW-B160	1313.1668.02	contact service center
320 MHz Analysis Bandwidth	R&S®FSW-B320	1313.7172.02	contact service center
Analog Baseband Inputs, 40 MHz Analysis Bandwidth	R&S®FSW-B71	1313.1651.13	for the R&S®FSW8/13. Contact service center
Analog Baseband Inputs, 40 MHz Analysis Bandwidth	R&S®FSW-B71	1313.1651.26	for the R&S®FSW26/43. Contact service center
80 MHz Analysis Bandwidth for Analog Baseband Inputs	R&S®FSW-B71E	1313.6547.02	R&S®FSW-B71 required.

For R&S®FSW product brochure, see PD 5214.5984.12 and www.rohde-schwarz.com

Service you can rely on

- Worldwide
- Local and personalized
- Customized and flexible
- Uncompromising quality
- Long-term dependability

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Environmental commitment

- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system

Certified Quality System
ISO 9001

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