

SC-DC/SC-QC fiber optic connector

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Abstract. The SC-DC™ and SC-QC™ (SC-DC/SC-QC are registered trademarks of Siecor) are multifiber optical connectors for conventional optical network applications. The SC-DC and SC-QC connectors were designed to provide a new interface technology that is significantly smaller than the duplex SC interface. The small SC-DC and SC-QC connector interfaces occupy half the space of an SC connector, effectively doubling the number of fiber ports in a given space. In addition, SC-DC and SC-QC connectors are simpler to install as well as offering greater packing density for both electronics and cable management. The connector design and performance of the SC-DC/SC-QC connector for both single-mode and multimode applications are described. © 1998 Society of Photo-Optical Instrumentation Engineers. [S0091-3286(98)01712-7]

Subject terms: fiber optic connectors.

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1 Introduction

To meet the demands of ever-increasing fiber densities in fiber optic interconnections, a new multifiber connector has been developed. There are two versions of this connector, the SC-DC (abbreviation for SC-dual contact of two optical fibers in one SC connector) and the SC-QC (abbreviation for SC-quattro contact of four optical fibers in one SC connector). The connectors support both single-mode and multimode applications.

Figure 1 shows the connector design. The connector uses standard SC connector hardware packaging a special multifiber ferrule. The SC hardware was chosen for its proven design with high density and easy push-pull insertion. The SC-DC/SC-QC features installation procedures and tools similar to the single-fiber SC connector, providing up to four times the density of the standard simplex SC.

A schematic of the connector ferrule is shown in Fig. 2. The ferrule is thermoset molded using a filled epoxy providing tight dimensional control during molding. The ferrule outside diameter is 2.5 mm, with either two or four holes of approximately 126- μ m diameter along the centerline. The holes are on a 250- μ m (SC-QC) or 750- μ m (SC-DC) center-to-center pitch. An alignment groove with a 350- μ m radius is positioned along each side of the ferrule at 2.6-mm center-to-center spacing. This enables the ferrule to mate with other multifiber ferrules (e.g., mini-MT ferrule), containing guidepins at this standard spacing.

The ferrule's critical features are the alignment grooves and fiber holes, since they determine fiber alignment and hence connector performance. When two ferrules are mated inside a coupler, they are aligned axially and radially by ribs or pins in the coupler sleeve. The ferrule outer diameter has clearance in the coupler sleeve, and does not affect the alignment. Utilizing a standard 2.5-mm-diam ferrule, packaged within the SC body, enables the use of conventional termination and polishing equipment in the field or factory. The internal ferrule geometry makes termination possible on current single-fiber cable as well as future two- and four-fiber ribbon cable.

The SC-DC/SC-QC couplers maintain the standard SC-type footprint, guaranteeing compatibility with current SC hardware and outlets. To prevent insertion of a single-fiber SC connector into the SC-DC/SC-QC coupler, the keyway was set off center.

The design differentiates between single-mode and multi-mode in the coupler insert. The multimode coupler shown in Fig. 3(a), utilizes a one-piece all-composite alignment insert with precision molded ribs. The single-mode coupler insert shown in Fig. 3(b) utilizes two pins that are captured inside the sleeve. Incorporating the alignment pins inside the sleeve provides for a symmetric connector design and easy cleaning of the ferrule endface.

The connector has also been developed in a field-installable version, the SC-DC UniCam™, to support applications such as cut-to-length jumper cables, field termination, and repair of cables. This design can be installed in

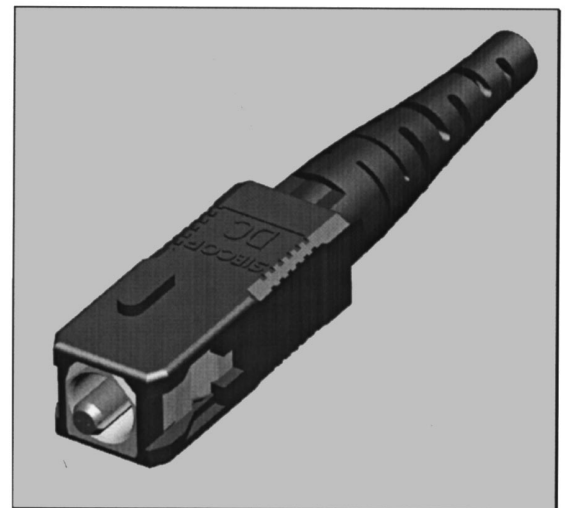
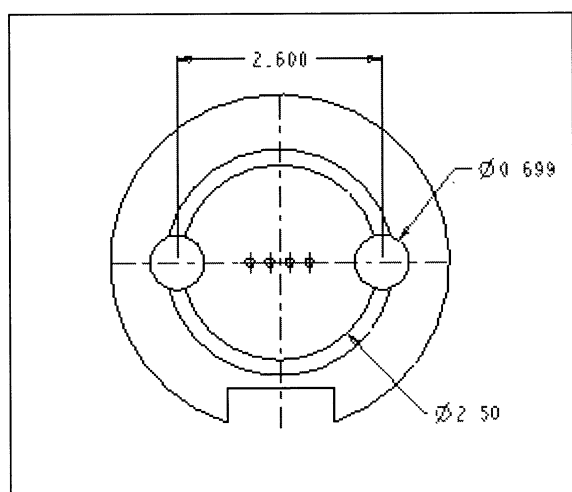
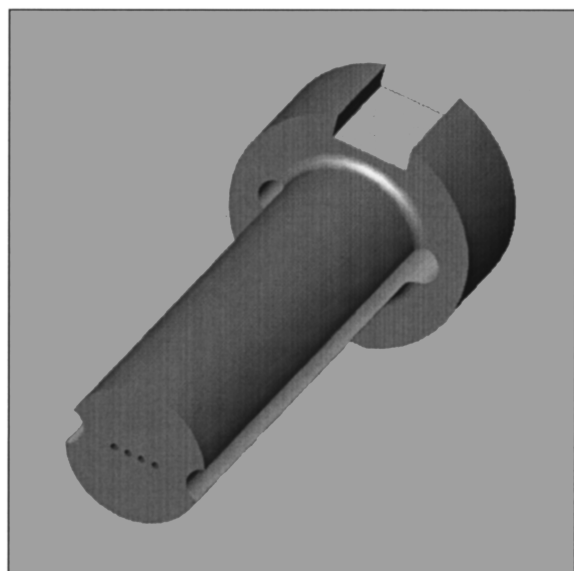


Fig. 1 SC-DC/SC-QC connector.



(a)



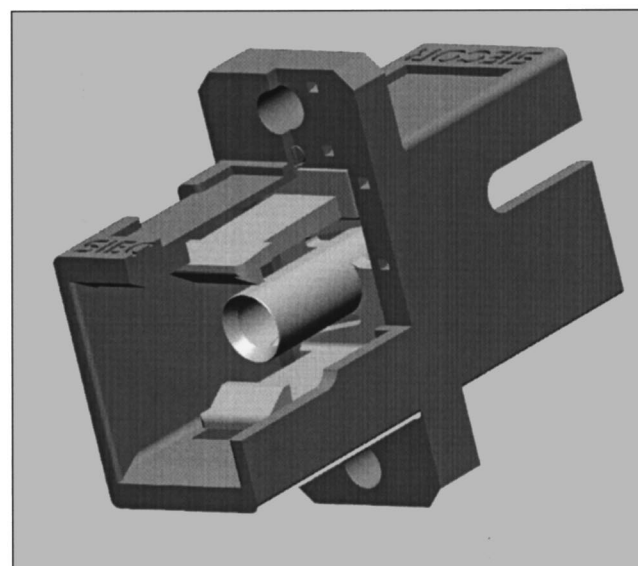
(b)

Fig. 2 SC-QC ferrule design, (a) front view and (b) side view.

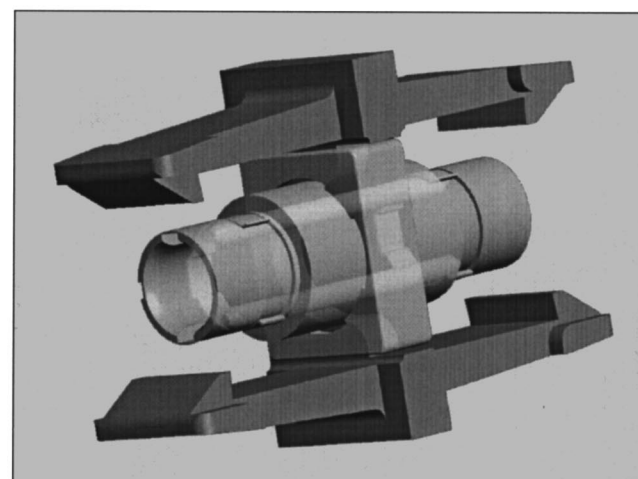
less than 1 min and utilizes the prestubbed fiber concept,¹ which eliminates epoxy and polishing in the field and guarantees highest quality endface geometry. Alignment of pre-polished UniCam fiber stub and the in-field fiber is achieved with a gel-filled mechanical splice element, captured inside the connector hardware. The splice consists of two halves, a flat top and a V-groove-based bottom to guide the fiber. Figure 4 shows a cross section exposing the mechanical splice element.

2 Experimental Test Results

Test results for SC-DC and SC-QC connectors demonstrate an average insertion loss of 0.33 dB for single-mode



(a)



(b)

Fig. 3 SC-DC/SC-QC (a) multimode and (b) single-mode couplers.

and 0.11 dB for multi-mode. Figures 5(a) and 5(b) show a histogram of multimode (MM) and single-mode (SM) data for the SC-QC connector along with sample size and statistical results of the measurement. The results were

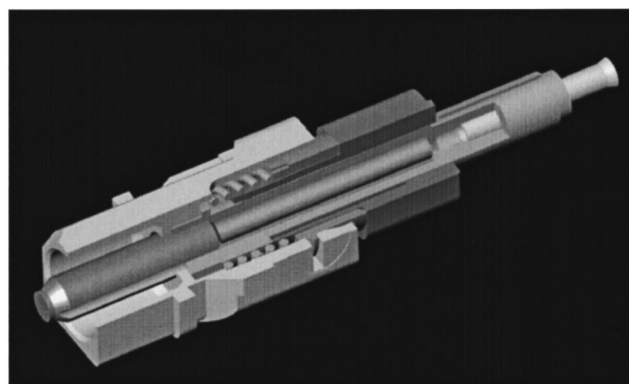
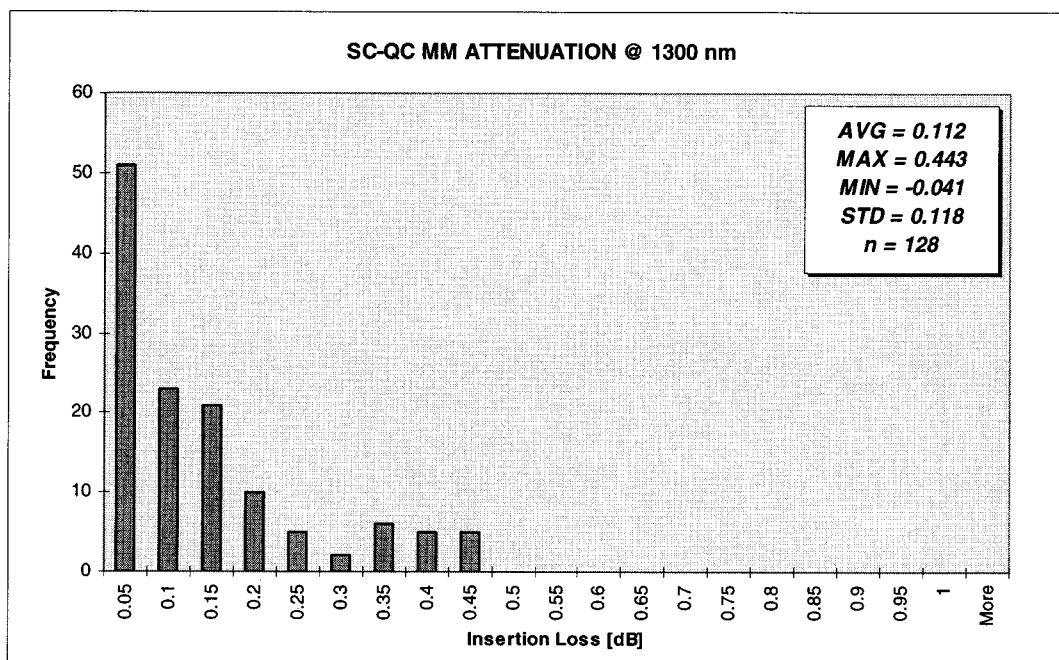
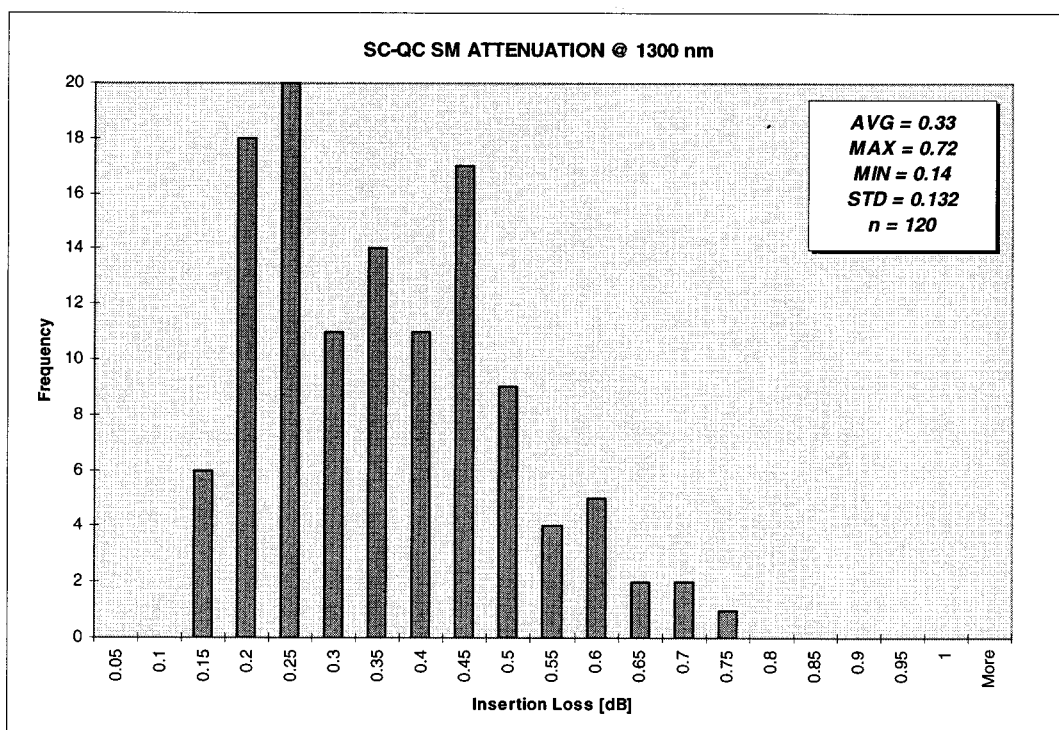


Fig. 4 SC-DC UniCam connector.



(a)



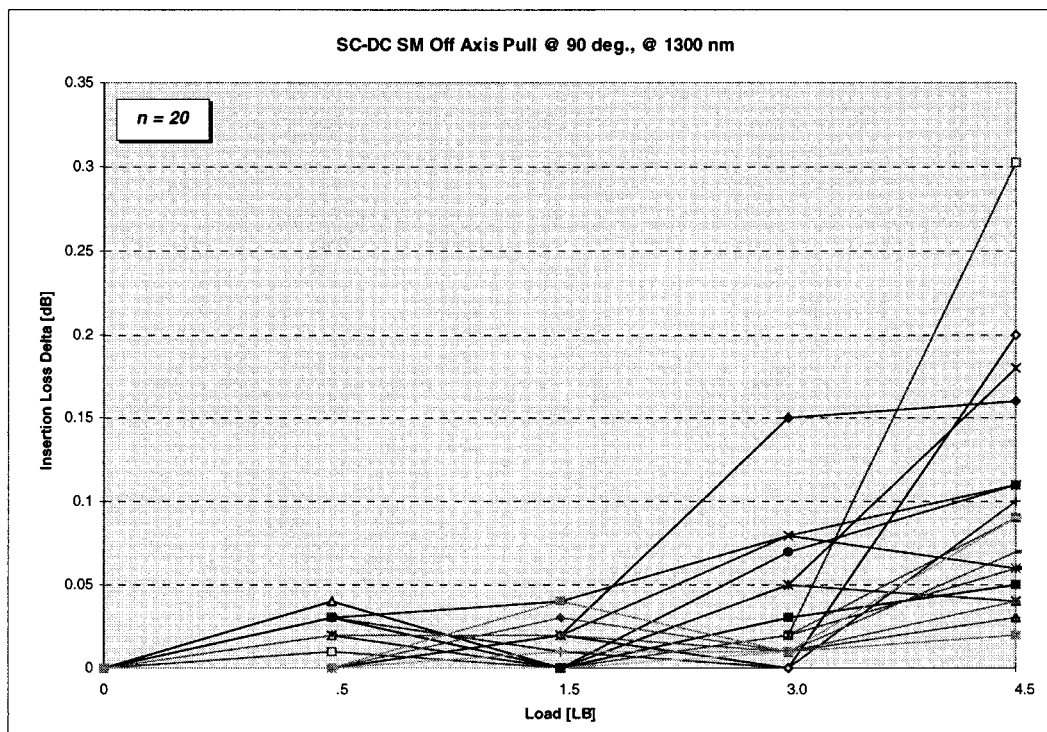
(b)

Fig. 5 (a) Multimode and (b) single-mode attenuation loss histograms for the SC-QC.

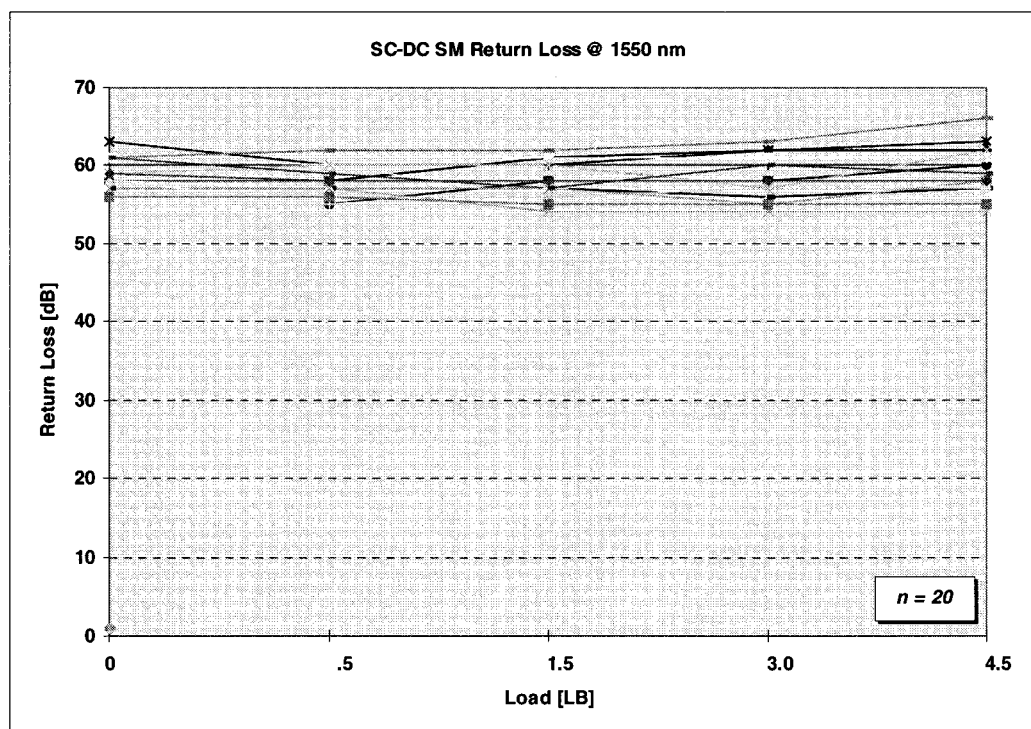
achieved with dry physical contact; no index-matching gel was used.

Capturing the pins (single-mode) or molded ribs (multi-mode) inside the mating sleeve provides maximum float of the ferrule within the SC connector and coupler hardware. This design decouples the mated ferrules from external

forces applied to the cable. Test results demonstrate stable insertion loss and return loss under loads up to 4.5 lb off-axis pull at 90 deg. Figure 6(a) illustrates the side load performance and Fig. 6(b) the return loss performance of the single-mode SC-DC per Bellcore GR 326 CORE test procedure.



(a)



(b)

Fig. 6 Single-mode (a) insertion loss and (b) return loss performance under load (90 deg off axis) for the SC-DC coupler.

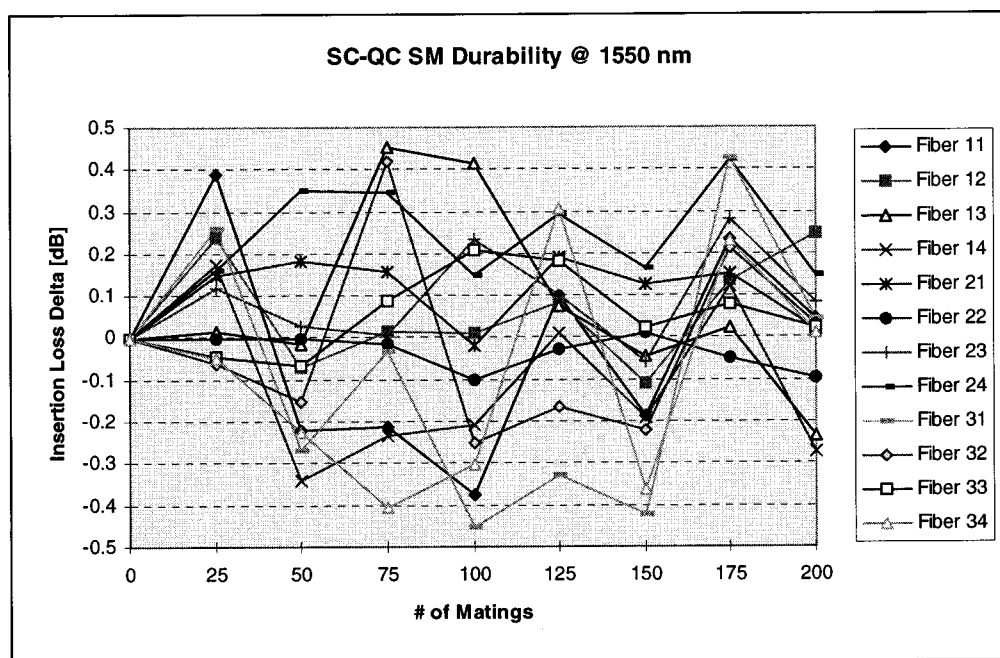


Fig. 7 Single-mode durability performance for the SC-QC coupler.

The connectors were also subjected to durability testing. Test results for the SC-DC/SC-QC connector show no insertion loss degradation up to 500 rematings. Figure 7 demonstrates SC-QC single-mode insertion loss performance of three connector pairs (12 fibers), per Bellcore GR 326 CORE test procedure.

Temperature cycling of the SC-DC/SC-QC connector revealed stable attenuation and back reflection from -40 to $+70$ °C. The average change in attenuation was less than 0.1 dB, and return loss delta was less than 3 dB.

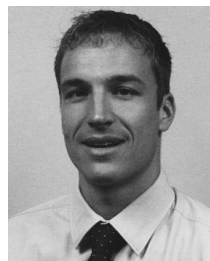
The SC-DC/SC-QC multimode connector was subjected to standard Bellcore and Electronics Industry Association/Telecommunications Industry Association (EIA/TIA) testing. The multimode connector design meets or exceeds these optical, mechanical, and environmental requirements.

3 Conclusions

The new multifiber optical connector for either two or four fibers features a complete symmetric design, eliminating system preengineering. Incorporating a standard 2.5-mm outer diameter ferrule in the SC package provides the use of current SC termination tools and procedures, achieving four times the density of the SC connector. The optical performance of the SC-DC/SC-QC connector meets or exceeds industry standards such as those of EIA/TIA and Bellcore.

References

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Karl M. Wagner received his masters degree in mechanical engineering in March 1993 from the Technical University of Munich, Germany. After working in Italy and Germany, he joined Siecor in 1995 within the Hardware and Equipment division. He is presently product development engineer responsible for the SC-DC connector development.



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Markus Giebel: Biography and photograph not available.