



noodl[®]

Ultra-flexible SFP+
& QSFP+
Interconnects

flexing the limits

The most flexible
Data Center cable available

 LOROM

Since our establishment in 1988, Lorom Industrial Co. Ltd. has experienced an outstanding rate of growth. In doing so, we have become a key and preferred supplier to a number of Fortune 500 companies.

Our mission is to become a globally recognised and preferred supplier of the highest quality electronic assemblies available within the industry we serve.

Our successful growth could be attributed to many characteristics of Lorom, but one characteristic stands out above them all, our determination. Our determination to provide a world class service to all customers and this determination is shared from the CEO down to the operators. This has served the company well in its commitment to become a technological leader and a trusted brand.

The LOROM Group specializes in the design and manufacture of innovative and high performance solutions for both the standardized market and customer cable assemblies. Our unique manufacturing equipment is designed and manufactured in-house. This allows us to develop unique products that give unsurpassed electrical and mechanical performance to meet the most challenging conditions.

Flexing the limits

Our increasingly connected world and the oceans of data that is generated have put the data center under tremendous pressure to accommodate the growing demand efficiently and reliably.

It would appear that data growth - not lack of space, power or cooling, is the biggest challenge for large-enterprise data centers. The ever-increasing need for bandwidth driven by mobile devices, cloud computing, storage and not least the emergence of the internet of everything.

Network congestion and connectivity architecture becomes ever more challenging, driven by next-generation servers with multi-core processors and virtualization, that require significantly high input/output (I/O). Furthermore the growing need for remote connectivity enabling the "mobile office" is another contributor to the challenge.

Future proofing of data centers will minimize the need for upgrades in three to five years and eliminating significant down time. Data center operators should be careful to avoid reducing their initial capital expenditure at the cost of

greater operational expenditure during the total lifetime of their data center infrastructure.

Ensuring reliability in data centers is advantageous. Purchasing better quality equipment can reduce the need for ongoing maintenance and technical support during a data center's lifetime.

Designing server racks with more power efficient products that enhance FLOPs/Watt. Incorporate lower loss interconnect cables as well as higher density. Utilizing smaller dimension copper cables; reduce power conversion losses enabling higher power CPUs, memory and chipsets. Data center operators can reduce the cooling requirements, which in turn reduces the total power consumed by the data center.

High power CPUs, faster DDR memory, and the latest generation chipsets all demand lower voltages which creates a further need for high performance cable with unprecedented Signal Integrity, challenging the traditional implementation.

Lorom has extensive expertise in the design and manufacture of ultra-flexible wire and cable. By combining the correct cable construction with the proper choice of conductor, shielding and material compounds. Our custom manufacturing equipment employs state-of-the-art neutralization and tension control.

noodl® cable was developed specifically to address cable management challenges in the data center. By combining a wealth of knowledge and experience we were able to create wire and cable

that fits both critical application requirements and long life cycles. Our engineering teams were able to apply knowledge gained from other industries we serve that commonly require ultra-flexible cables; such as medical, robotics, avionics etc..

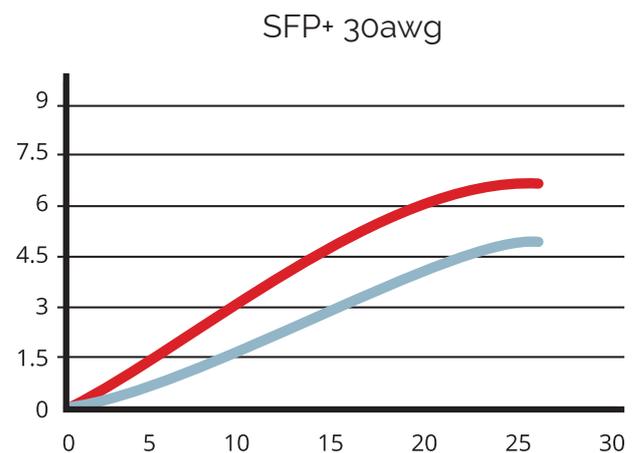
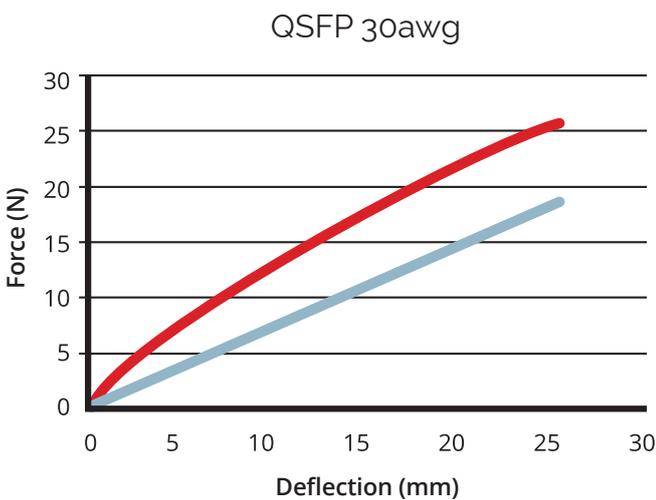
The durability and flexibility of our latest innovation noodl® high-speed certainly pays for itself by reducing field failures, down time of data centers and replacement costs caused by damaged cable assemblies. noodl® is a cost-effective investment for your data center.

FLEXIBILITY COMPARISON

Lorom noodl® vs. Industry Representative

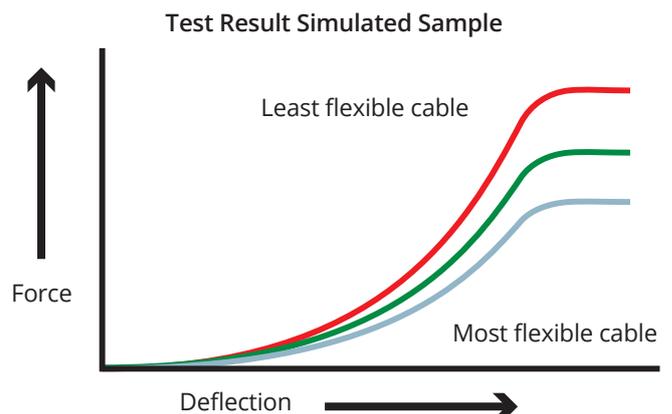
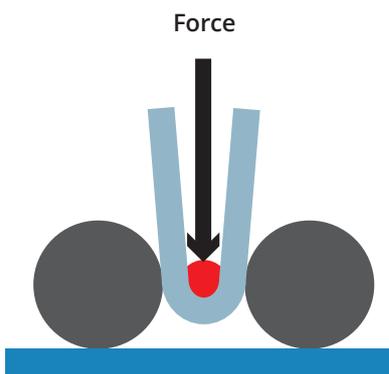
Regular cable

noodl® cable

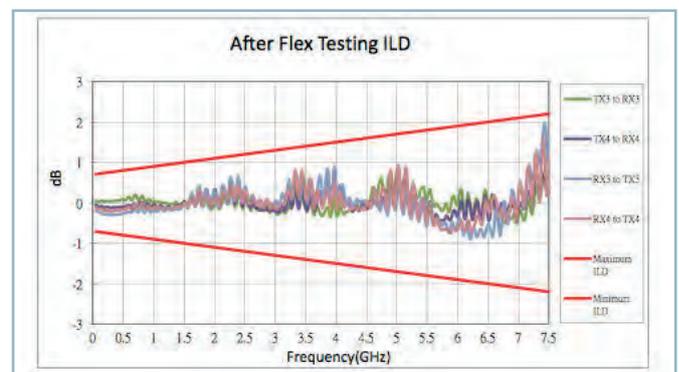
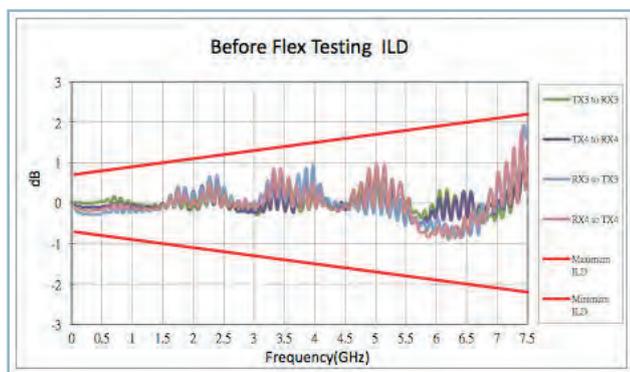
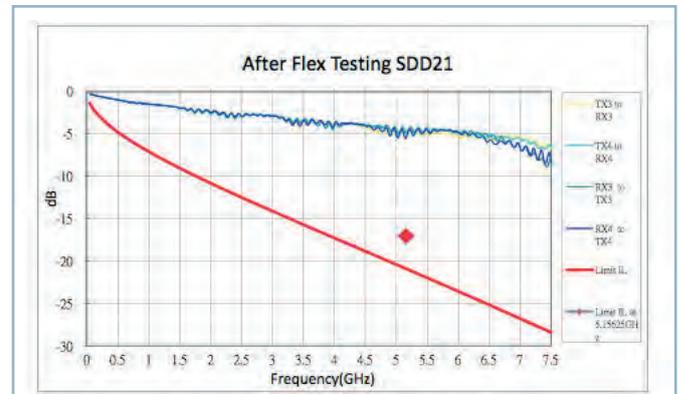
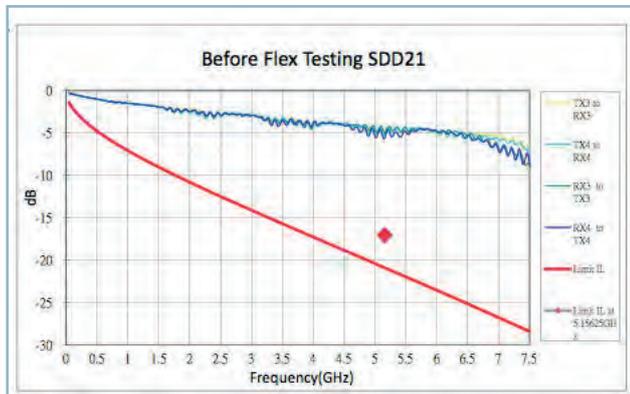


Lorom’s noodl® cable assemblies provide a **40% to 75%** improvement in flexibility over industry standard cable assemblies. The above force-deflection graphs demonstrate the force it takes to bend a given length of cable at a certain distance. The slope of these force-deflection curves is equivalent to the perceived cable flexibility.

The greater the slope the “stiffer” a cable feels when being dressed into a data center rack’s cable management tray by a user. The diagram below shows the concept of how the cable flexibilities is tested.



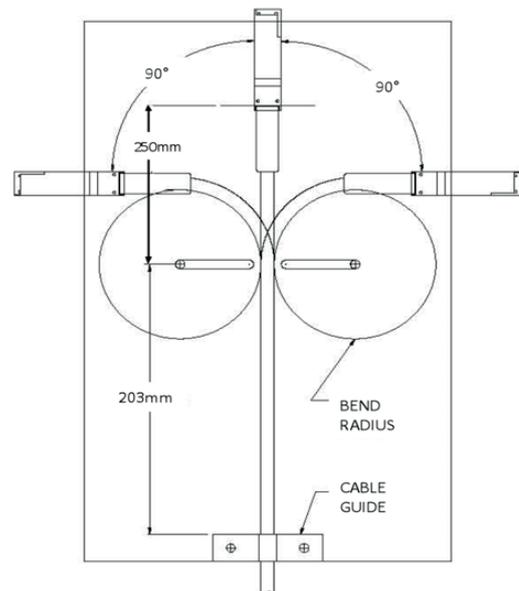
Test Setup SFF-8417 Rev 4.2



Flex-Cycle Testing

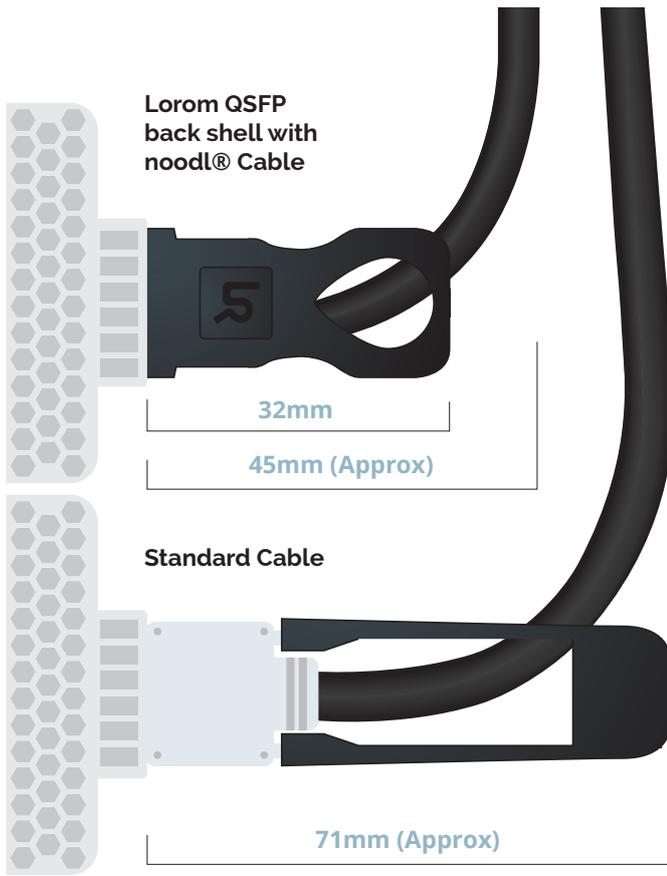
Cables were tested in accordance with SFF-8417 revision 4.2, Multi Conductor Cable Flex Cycle Test Procedure. During this test the cables were cycled 200 times.

One cycle is considered a 180 degree traversal as shown in the diagram (right). SFF defines a bend radius that is dependent of the cable outside diameter (OD). A weight is hung from the cable that to ensure it follows the test fixture mandrel perimeter that defines the desired bend radius.



The Signal Integrity (SI) data was tested for conformance to the representative industry standards for SFP+ and QSFP+ before and after cycling. No significant change was observed in SI performance after cycling and all the samples passed SI requirements after flex cycling.

FLEXIBILITY

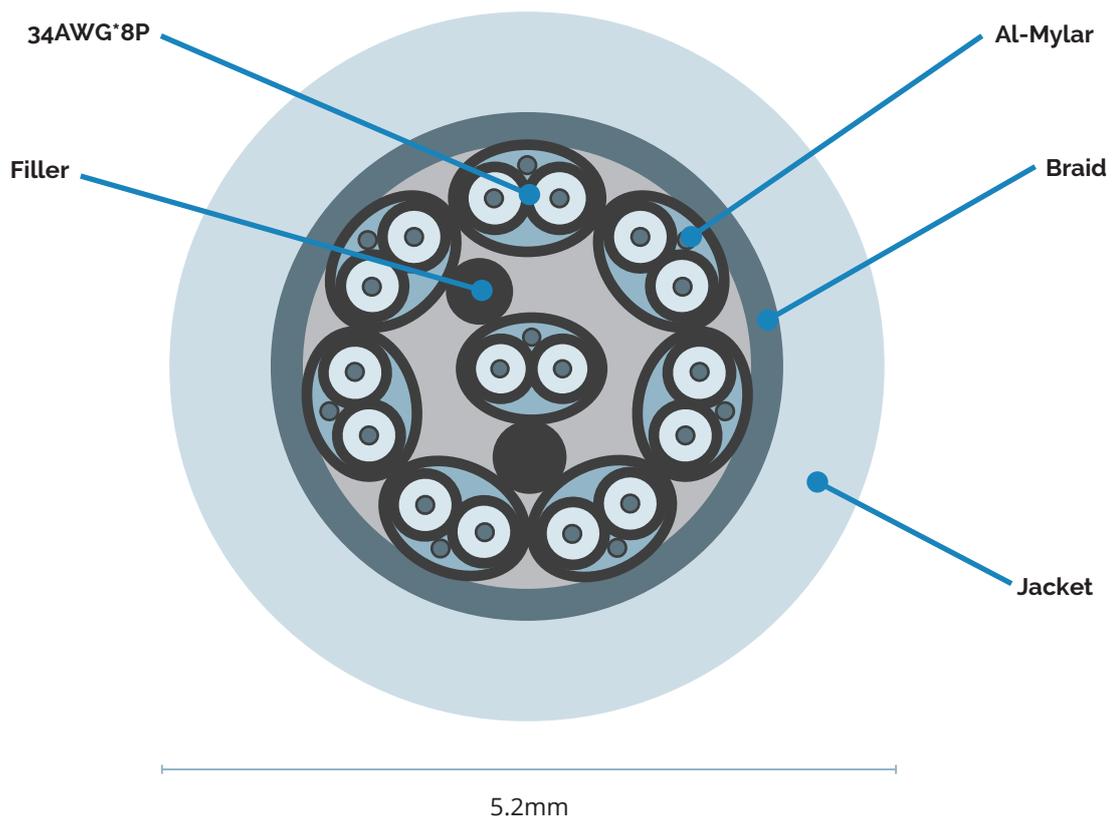


Lorom noodl® cables are designed to provide both excellent high-speed performance and high-flexibility. High-flexibility is achieved by minimizing mechanical stresses within the cable and reducing internal friction to the lowest possible degree.

Cables that are typically available in the industry have a functional bend radius limit of no smaller than 5 times cable OD. They should not be routed within a piece of equipment where it will be bent at an angle that is less than this, i.e. 3 times its OD. This may damage the internal wires or create a "kink" in the cable which could negatively affect overall performance but more importantly shorten the cable's usable life.

The Lorom noodl® cable in combination with the smallest in the industry back-shell allows a much tighter bend radius.

DIMENSIONS



What percentage of the manufacturing processes does your supplier actually control?

In order to rise above the standard Lorom has developed processes and equipment which are not currently available in the marketplace, in doing so are able to develop processing and manufacturing skills in every component of our SFP/ QSFP products.

Lorom views the cable assembly as an electromechanical device, and in doing so, has created a product with the highest bandwidth in the industry while also maintaining the smallest backshell currently available in the marketplace.

Our highly automated and controlled cable assembly capability uses the worlds first automatic soldering process, optimising the termination between the wire & PCB.

PCB-A

Lorom has invested significant resources over the last 10 years in PCB assemblies in order to offer our Customer complete Turn-Key solutions and One-Stop Shopping.

INJECTION MOULDINGS

We assist and help guide our customers through the technical process of selecting the best-suited polymers for the injection moulded parts necessary to meet their application.

TOOLING

With the latest 2D & 3D technology and state of the art facilities, Lorom produces tooling for all of our in-house requirements, including injection mouldings & die casting.

BULK CABLE

Lorom offers "Best-in-class" mode conversion (balance) due to proprietary manufacturing processes and equipment.

SIGNAL INTEGRITY

Lorom provides fully-equipped Signal Integrity & EMC testing labs in the USA & China, where our SI Engineers work to ensure consistent repeatability in performance.

DIE CAST

Our unique high-speed multi-slide die-casting process lends itself to the manufacture of intricate three dimensional connector housings and assemblies.

TEST & MEASUREMENT

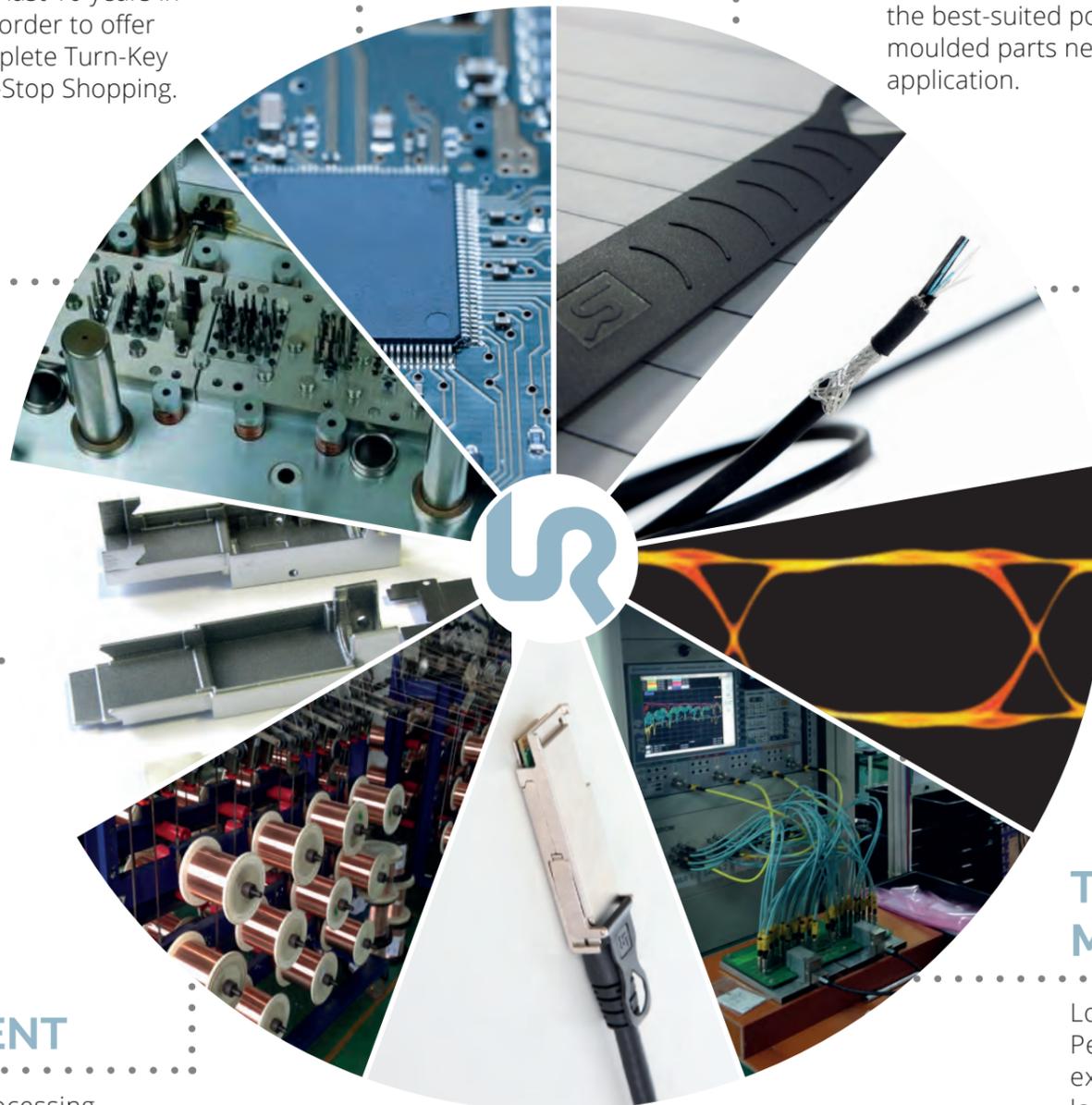
Lorom is proud to offer the Best Performing QSFP to the market, with exceptionally good ICR, (Insertion loss to Crosstalk Ratio) providing increased system budget, smaller physical size, as well as longer cable assembly length.

EQUIPMENT

Off the shelf processing equipment does not always produce consistent results... So we made our own!

CABLE ASSEMBLY

LOROM QSFP+ cable assemblies comprise the use of unique world-class, state-of-the-art , in-house developed E-MAXX® bulk cable, providing the highest level of signal integrity performance.





SFP+ passive copper cable assemblies provide a low cost alternative to fiber modules for short reach applications. They address applications such as 10 Gigabit Ethernet and 16G Fibre Channel. For these applications they support bidirectional serial data transmission rates from 1.125 Gbps to 14.025Gbps.

Lorom's SFP+ noodl® cable assemblies include an EEPROM programmed with standardized and customer specific data. This data includes information about the cable assembly such as; supplier, serial number, length, power, and type (copper vs. optical).

In addition to Signal Integrity performance, EMC and thermal dissipation performance are critical aspects of SFP+ cable assembly performance.

Our 360 degree cable braid crimp termination and our module EMI fingers ensure that EMI radiation is sufficiently reduced. The design of our modules die-cast further aids in cooling as it transfers and dissipates heat. This combined with low power consumption makes passive SFP+ copper cable assemblies a low cost solution for top-of-the-rack, rack-to-rack and within-rack data center applications.

Our SFP+ noodl® assemblies are offered in 34awg up to 1.0 meter, 30awg up to 3 meter and 26awg up to 5.0 meters. Other custom gauge sizes and lengths are also available.

Features:

- Bandwidth from 1Gbps to 16Gbps
- Uses the unique ultra flexible noodl® high speed cable
- Compatible with industry standard SFP cages
- 100 Ohm differential impedance
- 3.3v input source voltage
- EEPROM signature which can be customized
- Pull-to-release retractable pin latch design
- Pull tab allows compact belly-to-belly application
- 360 degree cable braid crimp and enhanced EMI skirt
- Various wire gauges provide diverse cable management options
- Breakout and cross-over cables can be engineered
- Able to custom engineer SFP+ cable solutions to system architecture

SFP+ 10GE/16G FC

Features & Benefits



Feature	Advantage	Benefit
Die-Cast	Safety release mechanism	Low risk of field failure
	Screws	Uniform torque
Wire Organizer	Controlled internal wire and drain wire management	Optimum SI performance
LOROM PCB Technology	Patented ground plane concept	Best crosstalk in the market
	Impedance control	Best in class common mode impedance
Passive Equalizer	Low cost RLC circuitry	Increase of distance/length
Bandwidth	Ready for next gen 16Gbps fibre channel	One product, reduction of inventory

RAW CABLE

Features & Benefits

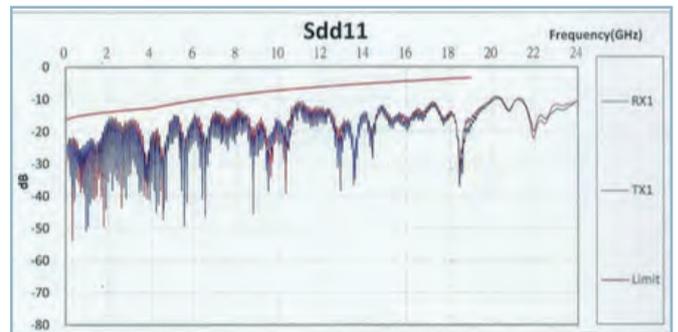
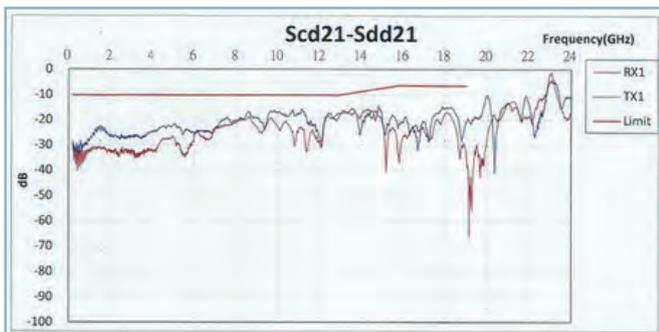
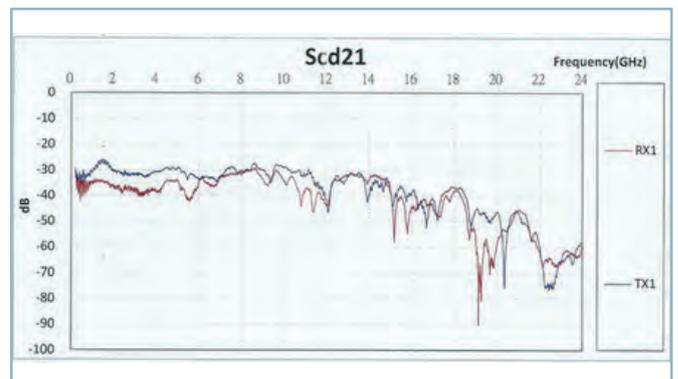
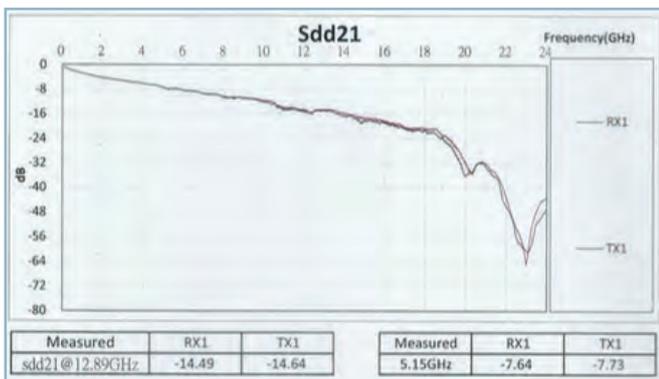
Article	Feature	Advantage	Benefit
Dielectric Skin Foam Skin	No contamination Stable tgΔ Low Ke	Lower loss (SDD12) Smaller physical size	Longer length Increased bandwidth Higher density Easier cable management Predictable frequency response
Pair shield (0-Tension Taping)	No physical deformation	Improved SCD12 (Mode conversion) Improved SDD11 (Return Loss)	Better matching and launch conditions Improved bandwidth Predictable frequency response
Cabling Technologies Emaxx®	No physical deformation Minimal "pistoning"	Minimal impact and stress induced on soldering point Improved SCD12 (Mode conversion) Improved SDD11 (Return Loss)	Reduction in field failure
EMC Shielding	Optimized braiding	Prediction of EMI performance Reduction of sampling Min -65dB Screening att.	Optimization of EMI performance Lower ramp up cost in testing etc.

This unique product offering exceeds the performance requirements specified in Ethernet and Fibre Channel specifications.

The SFP+ cable assembly product platform provides a cost-effective, high-speed solution that meets and exceeds the bandwidth requirements of current and future applications in servers and external storage systems.

This unique product offering exceeds the performance requirements specified in 16G fibre channel.

1m noodl cable assemblies verified & tested out to 20GHz bandwidth



Part Number	Length (meter)	AWG Size	Performance		
			dWDP (dB)	VMA (dB)	VCR (dB)
LRHSP B05 F005	0.5	34	1.08	0.33	40.68
LRHSP B05 F010	1.0	34	2.04	0.98	37.99
LRHSP B05 D020	2.0	30	3.32	1.08	36.75
LRHSP B05 D030	3.0	30	4.56	1.55	36.43
			4.75	4.5	32.5
			Requirement SFF-8431		

TECHNICAL DATA PHYSICAL

Compatibility:	SFF-8432
Shells:	Die cast zinc – Copper underplate with a nickel overplate
PCB:	Proprietary material laminate with 0.8 Micrometer (30u”) gold plated contact pads
Raw Cable:	2 individually shielded differential pair cables
Shield:	-65dB coupling attenuation 0-3 GHz 360° fully shielded EMI shield
Jacket:	PVC & LSOH [low smoke 0-halogen] CL2 Or AWM
Pull Tab:	Santoprene
Latch:	Die cast zinc - Copper underplate with a nickel overplate

ELECTRICAL PERFORMANCE

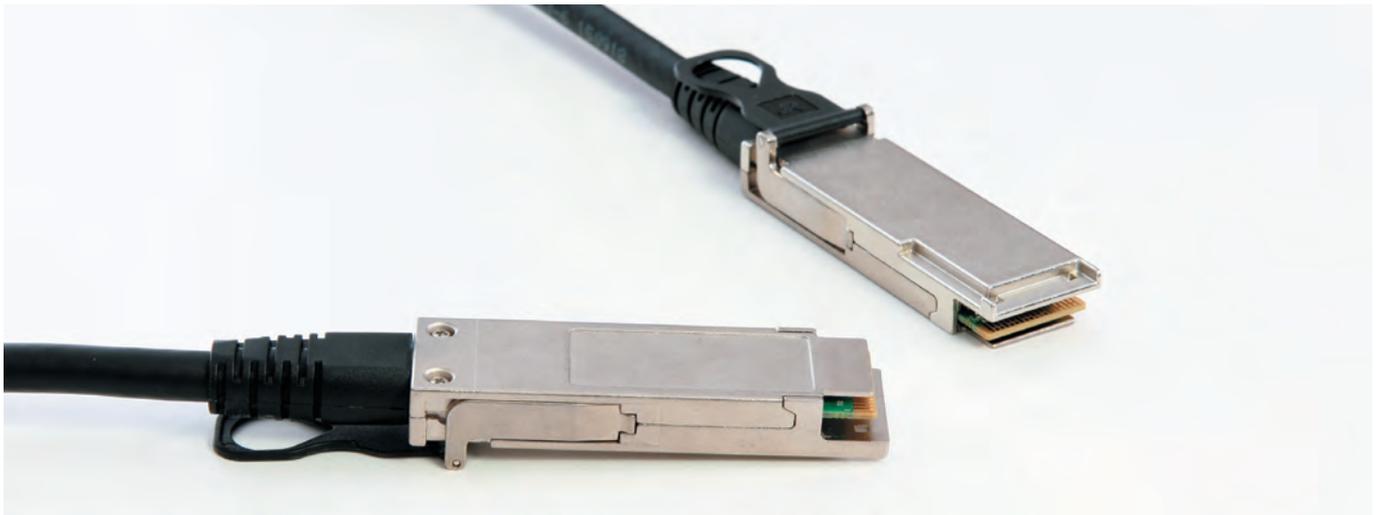
Compliance:	SFF-8431 (Ethernet 802.3, Fibre Channel FC-PI-4)
Current Rating:	0.5 amps maximum per contact
Withstanding Voltage:	300V DC

MECHANICAL PERFORMANCE

Durability:	100 cycles
Mating Force:	18N maximum

ENVIRONMENTAL

Operating Temperature:	-10°C to 70°C RoHs compliant
Thermal Shock:	EIA 364-32, test condition VII, 10 cycles, -55°C to 85°C
Temperature Life:	EIA 364-17, Method A, for 456 hours, 90°C
Mixed Flowing Gas:	EIA 364-65, Class IIA –14 days



The proliferation of high-bandwidth applications to millions and even billions of users, will continue to drive higher bandwidth requirements. Our advanced technologies for quad small form-factor, QSFP+, applications enable Ethernet and Infiniband applications to continue.

We continue to develop a new QSFP+ cable assemblies with unsurpassed performance. Our newly developed noodl® QSFP+ product

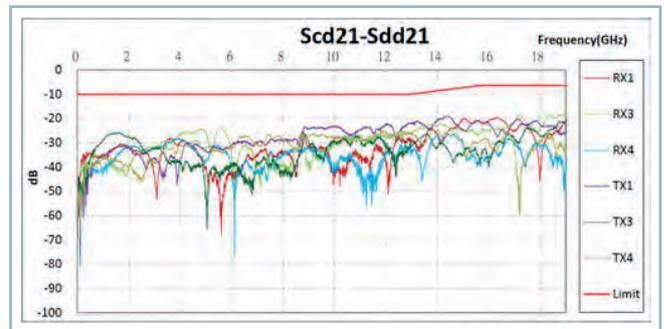
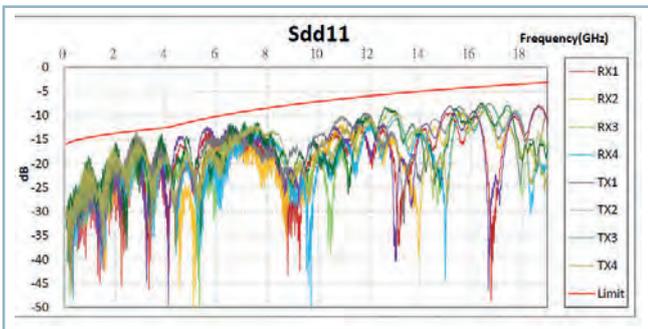
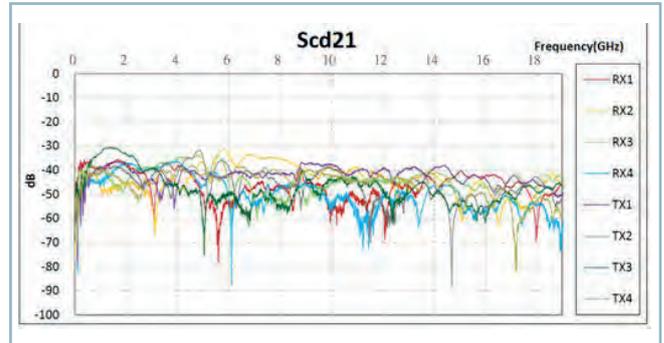
line is a highly flexible quad form factor. It enables easier cable management and routing within racks.

Lorom's noodl® QSFP+ products offers speeds up to 14Gbps per channel to support the Giga-bit Ethernet and Infiniband FDR. noodl® QSFP+ product line is developed within the SFF MSA (Multi-Source Agreement).

Features:

- Optimized interconnect and cable design minimizes insertion loss and NEXT
- Highest ICR in the industry (Insertion loss to Crosstalk Ratio)
- Bandwidth 56GB/s , 40GbE
- InfiniBand QDR, Fibre Channel, SFF 8635, Serial Attached SCSI (SAS)
- Uses the unique ultra flexible noodl® high speed cable
- Compatible with industry standard QSFP cages
- 100 Ohm differential impedance
- EEPROM signature which can be customized
- Screws
- Pull tab allows compact belly-to-belly application
- 360 degree cable braid crimp and enhanced EMI skirt
- Various wire gauges provide diverse cable management options AWG34 AWG30 supports up to 3m
- Breakout and cross-over cables can be developed
- Custom engineered QSFP+ cable solutions to suit system architecture

1.5 m noodl® Cable Assemblies Verified and Tested Out to 20GHz Bandwidth



Feature	Advantage	Benefit
Crimp Ring	360 EMC/EMI termination	Excellent EMC performance by design
	Pull Force	Robust mechanical design (Gorilla proof)
	Compression	No impedance degradation, or other negative SI affects
Die-Cast	Smallest back shell in the market	Easier cable management
	Screws	Uniform torque vs rivets
Wire Organizer	Controlled internal wire and drain wire management	Optimum SI performance
LOROM PCB Technology	Patented ground plane concept	Improved Crosstalk
	Impedance control	Best in class common mode impedance
Pull Tab Options	Custom pull tabs	Customer logo and colors
Boss Stub	Optional by choice	Multiple standards, one solution
Foil Out Bulk cable	Improvement of mode conversion	Optimum SI performance
Small OD Cable	Cable management & density	Improved cooling due to airflow
Smaller Bend Radius	Improved cable management	Ease of cable management, high density

Part Number	Length (meter)	AWG Size	Performance Insertion Loss (dB)	
			40GE @5.15625GHz	IB FDR/ 56G FC @7.03125GHz
LRHSP C08 F005	0.5	34	5.5	8.2
LRHSP C08 F010	1.0	34	7.7	11.1
LRHSP C08 F020	2.0	34	12.0	-
LRHSP C08 D020	2.0	30	10.0	-
LRHSP C08 D030	3.0	30	13.2	-
			17.04 IEEE 802.3ba-2010	13 IB FDR
Requirement				

TECHNICAL DATA PHYSICAL

Compatibility:	SFF-8436
Shells:	Die cast zinc – Copper underplate with a nickel overplate
PCB:	Proprietary material laminate with 0.8 Micrometer (30u”) gold plated contact pads
Raw Cable:	8 individually shielded differential pair cables
Shield:	-65dB coupling attenuation 0-3 GHz 360° fully shielded EMI shield
Jacket:	PVC & LSOH [low smoke 0-halogen] CL2 Or AWM
Pull Tab:	Nylon resin
Latch:	Die cast zinc - Copper underplate with a nickel overplate

ELECTRICAL PERFORMANCE

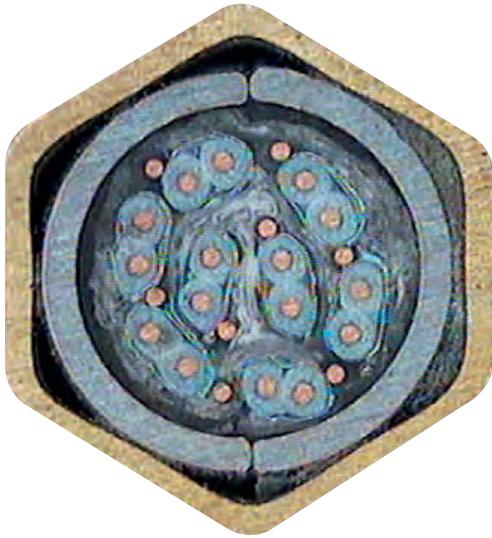
Signal Integrity:	IEEE802.3ba-2010, IB v2r1.3.1, FC-PI-6
Compliance:	SFF-8436
Current Rating:	0.5 amps maximum per contact
Withstanding Voltage:	300V DC

MECHANICAL PERFORMANCE

Durability:	250 cycles
Mating Force:	40N maximum

ENVIRONMENTAL

Operating Temperature:	-10°C to 70°C RoHs compliant
Thermal Shock:	EIA 364-32, test condition VII, 10 cycles, -55°C to 85°C
Temperature Life:	EIA 364-17, Method A, for 456 hours, 90°C
Mixed Flowing Gas:	EIA 364-65, Class IIA – 14 days



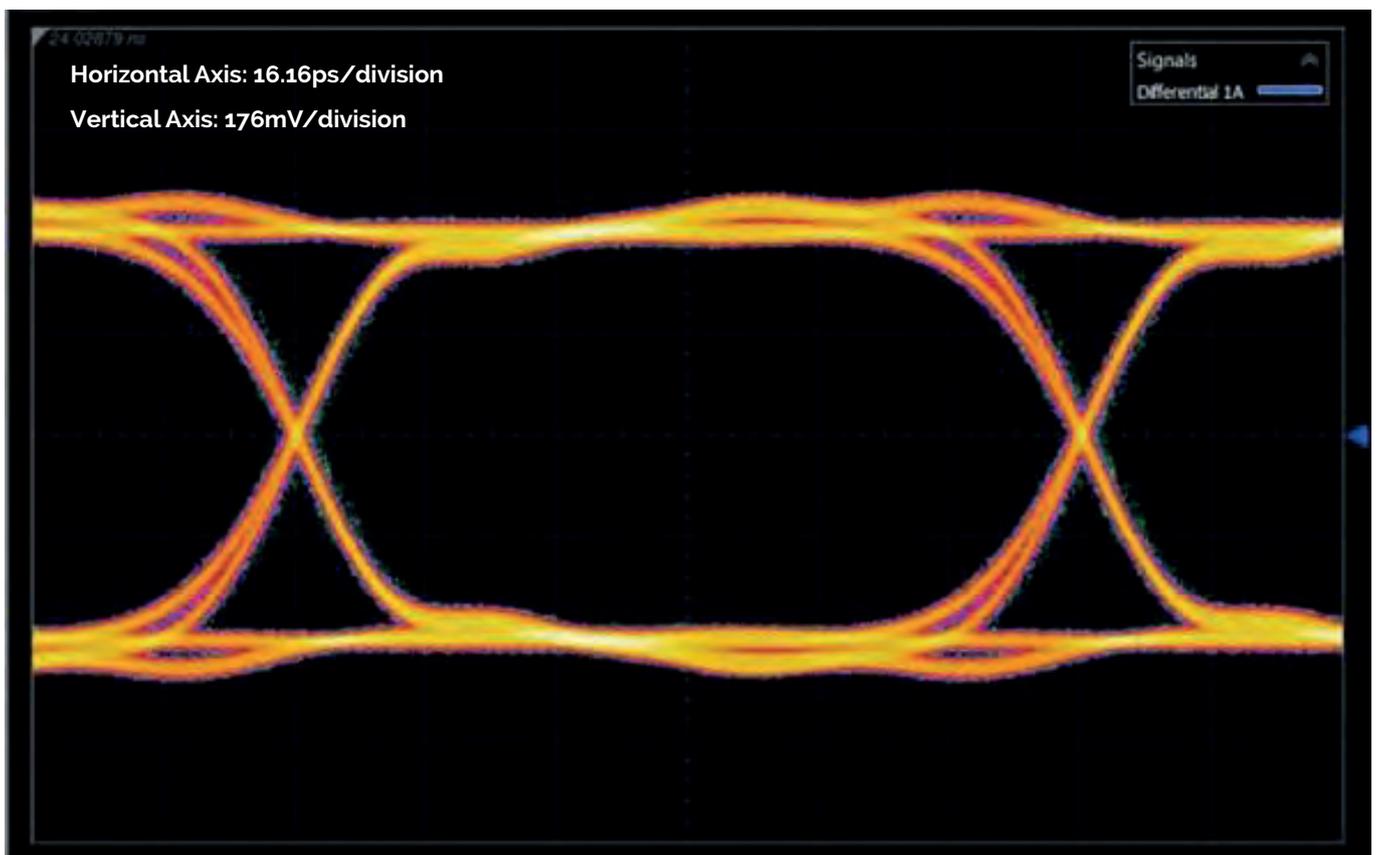
Our robust and ruggedized 360 degrees inner – outer crimp ring feature, enabling excellent EMI suppression and providing pull force of 240N

EYE DIAGRAM 3.0-METER

34awg NOODL Cable Assembly

Data Rate: 10.3125Gbps (Unit Interval: 96.97ps)

Below is a representative eye diagram of a Lorom SFP+ 3.0-meter 34awg noodl® cable assembly. The eye diagram includes the cables assembly, the evaluation test boards and their transmit equalization capabilities. This eye diagram was taken before the receiver input and thus does not include any receiver equalization. The evaluation boards were supplied by Credo Semiconductor. They support data rates up to 28Gbps including 10.3125Gbps.





e.g. "LRHSP B05 C 005"

LRHSP	B05	C	005
Name LoRom High Speed Products	Application B05: SFP+ 10G noodl® passive unequalized Ethernet IEEE 802.3ba B06: SFP+ 16G noodl® passive unequalized Fibre channel C09: QSFP noodl® unequalized Infiniband FDR C08: QSFP noodl® passive unequalized Ethernet IEEE 802.3ba	Gauge size A => AWG24 B => AWG26 C => AWG28 D => AWG30 E => AWG32 F => AWG34	Length (MT) 001 => 0,1m 010 => 1,0m 100 => 10,0m

Lorom P/N	Description	Data Rate	AWG	Unit of measure "MT"										
				0.5	1	1.5	2	2.5	3	3.5	4	5		
LRHSP C08 F xxx	QSFP 40G noodl® IEEE 802.3ba	40Gbps	34	✓	✓	✓	✓							
LRHSP C08 D xxx	QSFP 40G noodl® IEEE 802.3ba	40Gbps	30	✓	✓	✓	✓	✓	✓	✓	✓			
LRHSP C08 B xxx	QSFP 40G noodl® IEEE 802.3ba	40Gbps	26	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
LRHSP B05 F xxx	SFP+ 10G noodl® IEEE 802.3ba	10Gbps	34	✓	✓									
LRHSP B05 D xxx	SFP+ 10G noodl® IEEE 802.3ba	10Gbps	30	✓	✓	✓	✓	✓	✓					
LRHSP B05 B xxx	SFP+ 10G noodl® IEEE 802.3ba	10Gbps	26	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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