RF CABLES PRODUCT GUIDE

RF/microwave interconnect and precision test cables for 50-Ohm and 75-Ohm systems from DC to 67 GHz with a wide selection of connectors including 2.4mm, 2.92mm, SMA, N-Type, F-Type and BNC!

- All combinations of male and female connectors
- Options for straight, right angle, bulkhead, and quick-connect connections
- Performance qualified for reliability in the most demanding environments

TABLE OF CONTENTS - RF CABLES GUIDE 1/3

TEST CABLES DC to 67 GHZ

TABLE OF CONTENTS - RF CABLES GUIDE 2/3

INTERCONNECT CABLES DC to 50 GHZ

TABLE OF CONTENTS - RF CABLES GUIDE 3/3

APPLICATION NOTES

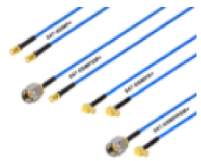
RECOMMENDED ACCESSORY

RF CABLES

PRODUCT GUIDE

NEW PRODUCTS

NEW PRODUCTS



KTFC-FL47+

Flex-Test Cables Designer's Kit
- DC to 40 GHz, 2.92mm, SMPM Connectors
- DC to 50 GHz, 2.4mm Connectors
- Hand Formable
- Flexible Interconnect
- Tight Bend Radius, 5mm Static Bend, 10mm Dynamic
- Excellent Return Loss

T50-2FT-VMVM+

2.4mm-Male Flex Test Cable
- Ultra-wideband, DC-50 GHz
- Good phase stability vs flexure
- Low Insertion Loss

E67 Model Series

Flex-Test
Instrumentation Test Cables
- Ultra-wideband operation, DC to 67 GHz
- Stainless steel 1.85mm connectors for long mating-cycle life
- Low insertion loss and excellent return loss
- Very flexible with small bend radius, 10mm

FL47 Series

Flexible Coaxial Cables
- DC to 40 GHz
- Tight Bend Radius, 5mm static bend, 10mm dynamic
- Excellent Return Loss and Insertion Loss
- Ideal for interconnect of sub-assembly systems
- 2.4mm, 2.92mm, SMPM connectors

FL86 Series

Flexible Coaxial Cables
- DC to 40 GHz
- Tight Bend Radius, 6mm static bend, 20mm dynamic
- Excellent Return Loss and Insertion Loss
- Ideal for interconnect of assembled systems
- 2.4mm, 2.92mm, SMPM connectors

For the latest information on Mini-Circuits' Cables, new products, product datasheets, product videos, professional articles and more please visit our website:

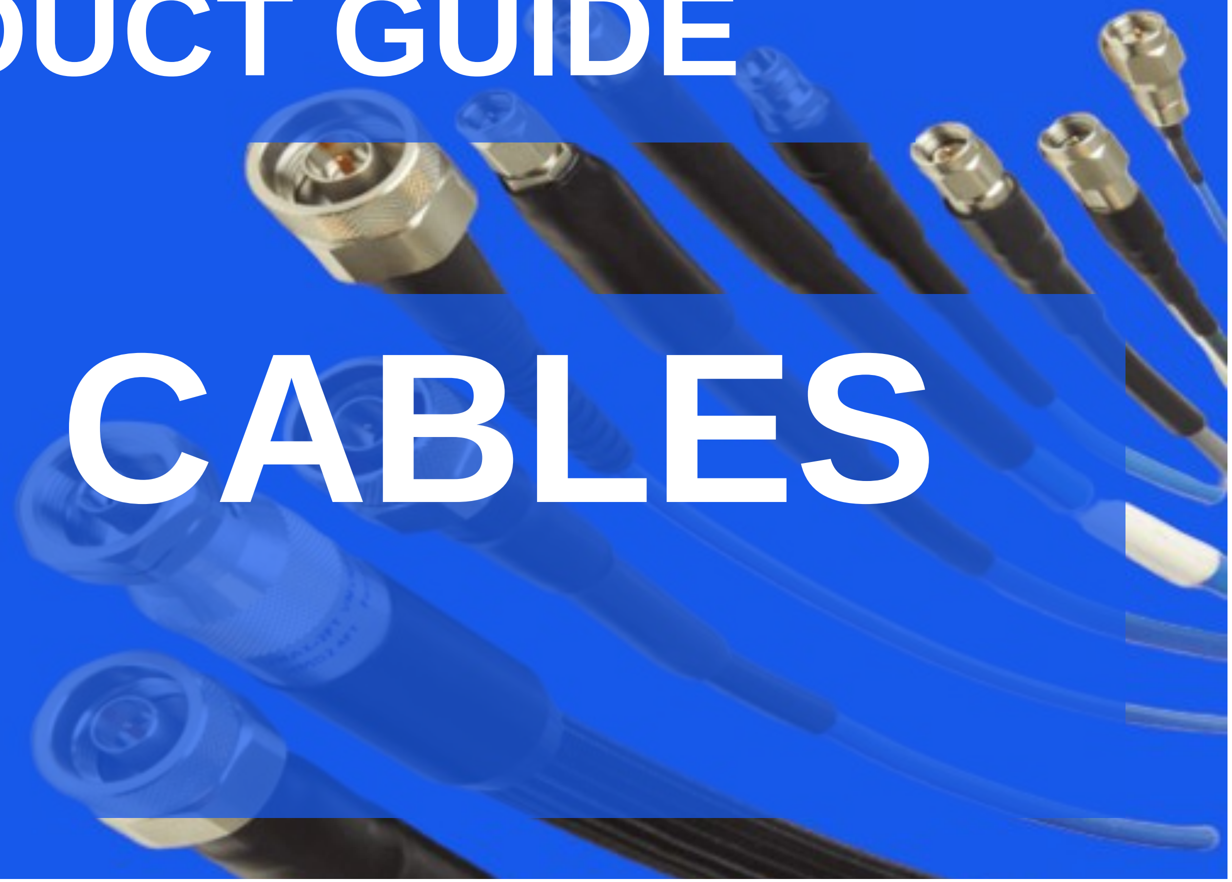
www.mcdi-ltd.com/rf-cables/

or call our Engineers directly on 077-5406075

All models can also be ordered in custom lengths and phase-matching

RF CABLES
PRODUCT GUIDE

TEST CABLES



Precision Test Cable | 75 Ω | DC to 3 GHz

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
CBL-2FM-75+	3	0.61	0.61	F-Type	Male	Straight	Standard	F-Type	Male	Straight	Standard
CBL-3FM-75+	3	0.77	0.91	F-Type	Male	Straight	Standard	F-Type	Male	Straight	Standard
CBL-3NM-75+	3	0.70	0.91	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
CBL-1MFM-75+	3	0.89	1.00	F-Type	Male	Straight	Standard	F-Type	Male	Straight	Standard
CBL-4NM-75+	3	0.80	1.22	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
CBL-6FM-75+	3	1.43	1.83	F-Type	Male	Straight	Standard	F-Type	Male	Straight	Standard
CBL-6NM-75+	3	1.43	1.83	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard

CBL Connector Series

CBL Connector Series

All models can also be ordered in custom lengths and phase-matching

Flexible Test Cable, Booted Joints | 50 Ω | DC to 18 GHz

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
ULC-1FT-SMSM+	18	0.70	0.30	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
ULC-1.5FT-SMSM+	18	1.40	0.46	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
ULC-2FT-NMNM+	18	1.60	0.61	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
ULC-2FT-SMNM+	18	1.50	0.61	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
ULC-2FT-SMSM+	18	1.80	0.61	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
ULC-3FT-NMNM+	18	2.20	0.91	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
ULC-3FT-SMNM+	18	2.20	0.91	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
ULC-3FT-SMSM+	18	2.70	0.91	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
ULC-1M-NMNM+	18	2.60	1.00	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
ULC-1M-SMNM+	18	2.50	1.00	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
ULC-1M-SMSM+	18	2.80	1.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
ULC-4FT-NMNM+	18	4.00	1.22	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
ULC-4FT-SMNM+	18	3.10	1.22	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
ULC-4FT-SMSM+	18	3.40	1.22	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
ULC-6FT-NMNM+	18	4.60	1.83	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
ULC-6FT-SMNM+	18	4.40	1.83	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
ULC-6FT-SMSM+	18	5.20	1.83	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
ULC-2M-SMSM+	18	5.90	2.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
ULC-8FT-SMSM+	18	5.40	2.44	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
ULC-10FT-SMSM+	18	7.50	3.05	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard

ULC Connector Series

ULC Connector Series

ULC Connector Series

All models can also be ordered in custom lengths and phase-matching

Flexible Test Cable | 50 Ω | DC to 26 GHz

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
FLC-2M-SMNM+	18	4.03	2.00	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
FLC-1FT-SMSM+	26	1.10	0.30	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FLC-1.5FT-SMSM+	26	1.26	0.46	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FLC-2FT-SMSM+	26	1.61	0.61	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FLC-3FT-SMSM+	26	2.50	0.91	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FLC-1M-SMSM+	26	2.62	1.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FLC-4FT-SMSM+	26	3.55	1.22	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FLC-6FT-SMSM+	26	5.04	1.83	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FLC-2M-SMSM+	26	5.50	2.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard

FLC Connector Series

FLC Connector Series

All models can also be ordered in custom lengths and phase-matching

Armored Test Cables | 50 Ω | DC to 40 GHz

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
APC-4FT-SMNM+	18	2.55	1.22	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
APC-6FT-NMNM+	18	3.80	1.83	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
APC-10FT-NMNM+	18	6.30	3.05	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
APC-15FT-NMNM+	18	9.00	4.57	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
KBL-1.5FT-LOW+	40	1.41	0.46	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
KBL-2FT-LOW+	40	1.74	0.61	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
KBL-1M-LOW+	40	3.05	1.00	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
KBL-4FT-LOW+	40	3.41	1.22	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
KBL-2M-LOW+	40	5.46	2.00	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard


APC Connector Series

KBL Connector Series

All models can also be ordered in custom lengths and phase-matching

Temperature Stable Cable | 50 Ω | DC to 40 GHz

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
TMP40-3F	40	2.40	0.91	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
TMP40-1M	40	2.60	1.00	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
TMP40-6F	40	4.60	1.83	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard

TMP40 Connector Series

All models can also be ordered in custom lengths and phase-matching

Precision Test Cable | 50 Ω | DC to 50 GHz | 1/3

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
CBL-1FT-SMSM+	18	0.30	0.75	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-1.5FT-SMSM-	18	0.46	1.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL1.5SMQ-SM+	18	0.46	1.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-0.5M-SMSM+	18	0.50	1.10	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-0.5M-NMNM+	18	0.50	1.20	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
CBL-0.5M-SMNM+	18	0.50	1.20	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-2FT-NMNM+	18	0.61	1.40	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
CBL-2FT-SFNM+	18	0.61	1.40	N-Type	Male	Straight	Standard	SMA	Female	Straight	Standard
CBL-2FT-SMNM+	18	0.61	1.40	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-2FT-SMSM+	18	0.61	1.40	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL2SMQ-NM+	18	0.61	1.40	N-Type	Male	Straight	Standard	SMA	Male	Straight	Quick Connect
CBL2SMQ-SM+	18	0.61	1.40	SMA	Male	Straight	Standard	SMA	Male	Straight	Quick Connect
CBL-3FT-NMNM+	18	0.91	1.90	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
CBL-3FT-SFNM+	18	0.91	1.90	N-Type	Male	Straight	Standard	SMA	Female	Straight	Standard
CBL-3FT-SFSM+	18	0.91	1.90	SMA	Male	Straight	Standard	SMA	Female	Straight	Standard
CBL-3FT-SMNM+	18	0.91	1.90	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-3FT-SMSM+	18	0.91	1.90	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL3NMQ-SM+	18	0.91	1.90	SMA	Male	Straight	Standard	N-Type	Male	Straight	Quick Connect
CBL3NMQ-SMQ+	18	0.91	1.90	N-Type	Male	Straight	Quick Connect	SMA	Male	Straight	Quick Connect
CBL3SMQ-SM+	18	0.91	1.90	SMA	Male	Straight	Standard	SMA	Male	Straight	Quick Connect
CBL-1M-SMSM+	18	1.00	2.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL3NMQ-NM+	18	0.91	2.00	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Quick Connect
CBL-1M-SMNM+	18	1.00	2.20	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard

CBL Connector Series

CBL Connector Series

CBL Connector Series

All models can also be ordered in custom lengths and phase-matching

Precision Test Cable | 50 Ω | DC to 50 GHz | 2/3

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
CBL-1FT-SMSM+	18	0.30	0.75	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-1.5FT-SMSM-	18	0.46	1.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL1.5SMQ-SM+	18	0.46	1.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-0.5M-SMSM+	18	0.50	1.10	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-0.5M-NMNM+	18	0.50	1.20	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
CBL-0.5M-SMNM+	18	0.50	1.20	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-2FT-NMNM+	18	0.61	1.40	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
CBL-2FT-SFNM+	18	0.61	1.40	N-Type	Male	Straight	Standard	SMA	Female	Straight	Standard
CBL-2FT-SMNM+	18	0.61	1.40	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-2FT-SMSM+	18	0.61	1.40	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL2SMQ-NM+	18	0.61	1.40	N-Type	Male	Straight	Standard	SMA	Male	Straight	Quick Connec
CBL2SMQ-SM+	18	0.61	1.40	SMA	Male	Straight	Standard	SMA	Male	Straight	Quick Connec
CBL-3FT-NMNM+	18	0.91	1.90	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
CBL-3FT-SFNM+	18	0.91	1.90	N-Type	Male	Straight	Standard	SMA	Female	Straight	Standard
CBL-3FT-SFSM+	18	0.91	1.90	SMA	Male	Straight	Standard	SMA	Female	Straight	Standard
CBL-3FT-SMNM+	18	0.91	1.90	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-3FT-SMSM+	18	0.91	1.90	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL3NMQ-SM+	18	0.91	1.90	SMA	Male	Straight	Standard	N-Type	Male	Straight	Quick Connec
CBL3NMQ-SMQ+	18	0.91	1.90	N-Type	Male	Straight	Quick Connec	SMA	Male	Straight	Quick Connec
CBL3SMQ-SM+	18	0.91	1.90	SMA	Male	Straight	Standard	SMA	Male	Straight	Quick Connec
CBL-1M-SMSM+	18	1.00	2.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL3NMQ-NM+	18	0.91	2.00	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Quick Connec
CBL-1M-SMNM+	18	1.00	2.20	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard


CBL Connector Series


CBL Connector Series

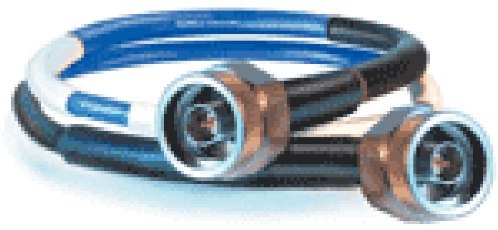

CBL Connector Series

All models can also be ordered in custom lengths and phase-matching

Precision Test Cable | 50 Ω | DC to 50 GHz | 3/3

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
CBL-15FT-NMNM+	18	4.57	9.20	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
CBL-15FT-SMNM+	18	4.57	9.20	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-15FT-SMSM+	18	4.57	9.25	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-20FT-NMNM+	18	6.10	12.00	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
CBL-20FT-SMSM+	18	6.10	12.50	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-25FT-NMNM+	18	7.62	15.00	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
CBL-25FT-SMSM+	18	7.62	15.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
CBL-50FT-SMSM+	18	15.24	31.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
T40-2FT-KFKM+	40	0.61	2.20	2.92 mm	Male	Straight	Standard	2.92 mm	Female	Straight	Standard
T40-2FT-KMKM+	40	0.61	2.20	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
T40-2FT-VFVM+	40	0.61	2.20	2.4 mm	Male	Straight	Standard	2.4 mm	Female	Straight	Standard
T40-3FT-KFKM+	40	0.91	3.30	2.92 mm	Male	Straight	Standard	2.92 mm	Female	Straight	Standard
T40-3FT-KMKM+	40	0.91	3.30	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
T40-3FT-VFVM+	40	0.91	3.30	2.4 mm	Male	Straight	Standard	2.4 mm	Female	Straight	Standard
T50-2FT-VFVM+	50	0.61	2.20	2.4 mm	Male	Straight	Standard	2.4 mm	Female	Straight	Standard
T50-2FT-VMVM+	50	0.61	2.70	2.4 mm	Male	Straight	Standard	2.4 mm	Male	Straight	Standard
T50-3FT-VFVM+	50	0.91	3.70	2.4 mm	Male	Straight	Standard	2.4 mm	Female	Straight	Standard



CBL Connector Series

T40 Connector Series

CBL Connector Series

All models can also be ordered in custom lengths and phase-matching

Precision Test Cable, Economy | 50 Ω | DC to 67 GHz

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
E40-1M-KMKM+	40	5.40	1.00	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
E40-2FT-KMKM+	40	3.40	0.61	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
E40-3FT-KMKM+	40	5.10	0.91	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
E40-6FT-KMKM+	40	8.70	1.83	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
E50-2FT-VMVM+	50	3.50	0.61	2.4 mm	Male	Straight	Standard	2.4 mm	Male	Straight	Standard
E50-3FT-VMVM+	50	6.30	0.91	2.4 mm	Male	Straight	Standard	2.4 mm	Male	Straight	Standard
E67-1M-EMEM+	67	5.50	1.00	1.85 mm	Male	Straight	Standard	1.85 mm	Male	Straight	Standard
E67-2FT-EMEM+	67	2.70	0.61	1.85 mm	Male	Straight	Standard	1.85 mm	Male	Straight	Standard
E67-3FT-EMEM+	67	4.20	0.91	1.85 mm	Male	Straight	Standard	1.85 mm	Male	Straight	Standard

E40 Connector Series

E50 Connector Series

E67 Connector Series

All models can also be ordered in custom lengths and phase-matching

VNA Cable | 50 Ω | DC to 67 GHz

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
VNAX-2FT-KMVRF+	40	2.00	2.00	2.4 mm	Female	Straight	Rugged	2.92 mm	Male	Straight	Standard
VNAC-2R1-K+	40	2.30	2.08	2.92 mm	Female	Straight	Rugged	2.92 mm	Male	Straight	Standard
VNAX-2FT-VMVRF+	50	2.40	2.00	2.4 mm	Female	Straight	Rugged	2.4 mm	Male	Straight	Standard
VNAX-2FT-EMERF+	67	3.70	2.00	1.85 mm	Female	Straight	Rugged	1.85 mm	Male	Straight	Standard
VNAX-3FT-EMERF+	67	5.36	3.00	1.85 mm	Female	Straight	Rugged	1.85 mm	Male	Straight	Standard
VNAX-1M-EMERF+	67	5.79	3.28	1.85 mm	Female	Straight	Rugged	1.85 mm	Male	Straight	Standard

VNAX Connector Series

VNAX Connector Series

VNAC Connector Series

All models can also be ordered in custom lengths and phase-matching

RF CABLES PRODUCT GUIDE

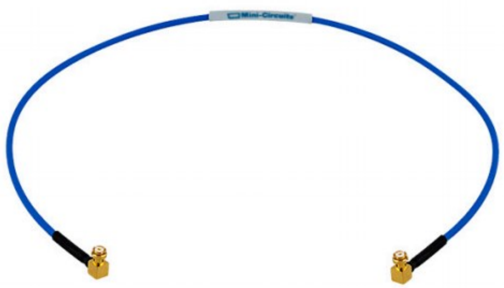
INTERCONNECT CABLES

Hand-Flex Interconnect, 0.047" center diameter | 50 Ω | DC to 18 GHz

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
047-3SMP+	18	0.34	0.08	SMP	Female	Straight	Standard	SMP	Female	Straight	Standard
047-3SMPR+	18	0.39	0.08	SMP	Female	Right Angle 0° Clocked	Standard	SMP	Female	Right Angle 0° Clocked	Standard
047-3SMPRC+	18	0.39	0.08	SMP	Female	Right Angle 180° Clocked	Standard	SMP	Female	Right Angle 0° Clocked	Standard
047-3SMPSM+	18	0.35	0.08	SMA	Male	Straight	Standard	SMP	Female	Straight	Standard
047-6SMP+	18	0.72	0.15	SMP	Female	Straight	Standard	SMP	Female	Straight	Standard
047-6SMPR+	18	0.75	0.15	SMP	Female	Right Angle 0° Clocked	Standard	SMP	Female	Right Angle 0° Clocked	Standard
047-6SMPRC+	18	0.78	0.15	SMP	Female	Right Angle 180° Clocked	Standard	SMP	Female	Right Angle 0° Clocked	Standard
047-6SMPSM+	18	0.75	0.15	SMA	Male	Straight	Standard	SMP	Female	Straight	Standard
047-12SMP+	18	1.51	0.3	SMP	Female	Straight	Standard	SMP	Female	Straight	Standard
047-12SMPR+	18	1.53	0.3	SMP	Female	Right Angle 0° Clocked	Standard	SMP	Female	Right Angle 0° Clocked	Standard
047-12SMPRC+	18	1.55	0.3	SMP	Female	Right Angle 180° Clocked	Standard	SMP	Female	Right Angle 0° Clocked	Standard
047-12SMPSM+	18	1.51	0.3	SMA	Male	Straight	Standard	SMP	Female	Straight	Standard

047 Connector Series



047 Connector Series

047 Connector Series

All models can also be ordered in custom lengths and phase-matching

Super Flexible Interconnect, 0.047” center diameter | 50 Ω | DC to 18 GHz

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
SLC-1M-SMSM+	18	4.90	1.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
SLC-2FT-SMSM+	18	2.90	0.61	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
SLC-3FT-SMSM+	18	4.40	0.91	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
SLC-4FT-SMSM+	18	6.00	1.22	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
SLC-6FT-SMSM+	18	8.80	1.83	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard

SLC Connector Series

All models can also be ordered in custom lengths and phase-matching

Hand-Flex Interconnect, 0.141” center diameter | 50 Ω | DC to 18 GHz 1/5

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
141-6BM+	3	0.10	0.15	BNC	Male	Straight	Standard	BNC	Male	Straight	Standard
141-8BM+	3	0.12	0.20	BNC	Male	Straight	Standard	BNC	Male	Straight	Standard
141-10BM+	3	0.15	0.25	BNC	Male	Straight	Standard	BNC	Male	Straight	Standard
141-12BM+	3	0.17	0.30	BNC	Male	Straight	Standard	BNC	Male	Straight	Standard
141-14BM+	3	0.20	0.36	BNC	Male	Straight	Standard	BNC	Male	Straight	Standard
141-18BM+	3	0.25	0.46	BNC	Male	Straight	Standard	BNC	Male	Straight	Standard
141-24BM+	3	0.31	0.61	BNC	Male	Straight	Standard	BNC	Male	Straight	Standard
141-6SMNB+	12.5	0.32	0.15	N-Type	Female	Straight	Bulkhead	SMA	Male	Straight	Standard
141-8SMNB+	12.5	0.32	0.20	N-Type	Female	Straight	Bulkhead	SMA	Male	Straight	Standard
141-10SMNB+	12.5	0.40	0.25	N-Type	Female	Straight	Bulkhead	SMA	Male	Straight	Standard
141-12SMNB+	12.5	0.58	0.30	N-Type	Female	Straight	Bulkhead	SMA	Male	Straight	Standard
141-14SMNB+	12.5	0.64	0.36	N-Type	Female	Straight	Bulkhead	SMA	Male	Straight	Standard
141-16SMNB+	12.5	0.76	0.41	N-Type	Female	Straight	Bulkhead	SMA	Male	Straight	Standard
141-18SMNB+	12.5	0.81	0.46	N-Type	Female	Straight	Bulkhead	SMA	Male	Straight	Standard
141-20SMNB+	12.5	1.01	0.51	N-Type	Female	Straight	Bulkhead	SMA	Male	Straight	Standard
141-24SMNB+	12.5	1.18	0.61	N-Type	Female	Straight	Bulkhead	SMA	Male	Straight	Standard
141-2SM+	18	0.15	0.05	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-2SMR+	18	0.14	0.05	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-2SMRC+	18	0.21	0.05	SMA	Male	Right Angle 180° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-3NM+	18	0.42	0.08	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
141-3SM+	18	0.21	0.08	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-3SMR+	18	0.20	0.08	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-3SMRC+	18	0.20	0.08	SMA	Male	Right Angle 180° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-3SMRSM+	18	0.28	0.08	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard

141 Connector Series

141 Connector Series

141 Connector Series

All models can also be ordered in custom lengths and phase-matching

Hand-Flex Interconnect, 0.141” center diameter | 50 Ω | DC to 18 GHz 2/5

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
141-4SBSM+	18	0.21	0.10	SMA	Male	Straight	Standard	SMA	Female	Straight	Bulkhead
141-4SM+	18	0.20	0.10	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-4SMNM+	18	0.49	0.10	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
141-4SMR+	18	0.31	0.10	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-4SMRC+	18	0.45	0.10	SMA	Male	Right Angle 180° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-4SMRSM+	18	0.39	0.10	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-5SM+	18	0.29	0.13	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-5SMNM+	18	0.84	0.13	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
141-5SMR+	18	0.40	0.13	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-5SMRC+	18	0.56	0.13	SMA	Male	Right Angle 180° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-5SMRSM+	18	0.31	0.13	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-6NM+	18	0.35	0.15	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
141-6SBSMR+	18	0.28	0.15	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Female	Straight	Bulkhead
141-6SM+	18	0.39	0.15	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-6SMNM+	18	0.67	0.15	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
141-6SMR+	18	0.46	0.15	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-6SMRC+	18	0.46	0.15	SMA	Male	Right Angle 180° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-6SMRSM+	18	0.50	0.15	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-7NM+	18	0.46	0.18	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
141-7SBSM+	18	0.37	0.18	SMA	Male	Straight	Standard	SMA	Female	Straight	Bulkhead
141-7SM+	18	0.47	0.18	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-7SMNM+	18	0.27	0.18	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
141-7SMR+	18	0.45	0.18	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-7SMRSM+	18	0.72	0.18	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard

141 Connector Series

141 Connector Series

141 Connector Series

All models can also be ordered in custom lengths and phase-matching

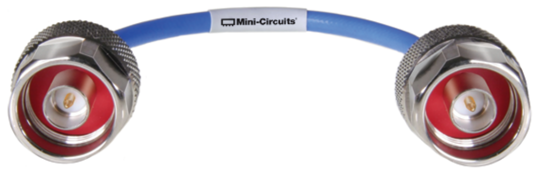
Hand-Flex Interconnect, 0.141" center diameter | 50 Ω | DC to 18 GHz 3/5

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
141-8NM+	18	1.20	0.20	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
141-8SM+	18	0.42	0.20	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-8SMNM+	18	0.86	0.20	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
141-8SMR+	18	0.51	0.20	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-8SMRSM+	18	0.70	0.20	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-9SM+	18	0.55	0.23	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-9SMR+	18	0.58	0.23	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-9SMRC+	18	0.72	0.23	SMA	Male	Right Angle 180° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-9SMRSM+	18	0.72	0.23	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-10NM+	18	0.53	0.25	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
141-10SM+	18	0.59	0.25	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-10SMNM+	18	0.69	0.25	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
141-10SMRNM+	18	0.50	0.25	N-Type	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-10SMRSM+	18	0.80	0.25	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-11SM+	18	0.57	0.28	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-11SMRSM+	18	0.80	0.28	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-12NM+	18	0.69	0.30	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
141-12SM+	18	0.66	0.30	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-12SMNM+	18	0.77	0.30	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
141-12SMR+	18	0.76	0.30	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-12SMRC+	18	0.72	0.30	SMA	Male	Right Angle 180° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-12SMRSM+	18	0.80	0.30	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-13SM+	18	0.50	0.33	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-13SMRSM+	18	0.92	0.33	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard

141 Connector Series

141 Connector Series



141 Connector Series

All models can also be ordered in custom lengths and phase-matching

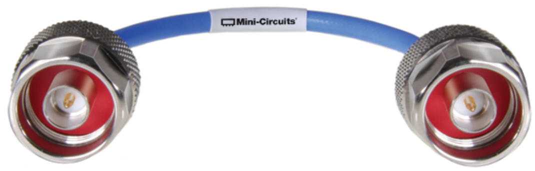
Hand-Flex Interconnect, 0.141” center diameter | 50 Ω | DC to 18 GHz 4/5

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
141-14SM+	18	0.73	0.36	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-14SMRSM+	18	1.03	0.36	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-15SM+	18	0.85	0.38	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-15SMRSM+	18	1.00	0.38	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-16SM+	18	0.90	0.41	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-16SMRSM+	18	1.04	0.41	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-17SM+	18	0.96	0.43	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-17SMRSM+	18	1.11	0.43	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-18SM+	18	0.89	0.46	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-18SMNM+	18	1.19	0.46	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
141-18SMRSM+	18	0.93	0.46	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-19SM+	18	0.86	0.48	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-0.5MSM+	18	0.86	0.50	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-20SM+	18	0.92	0.51	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-20SMRSM+	18	1.12	0.51	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-22SM+	18	1.12	0.56	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-24NM+	18	1.21	0.61	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
141-24SBSM+	18	1.10	0.61	SMA	Male	Straight	Standard	SMA	Female	Straight	Bulkhead
141-24SM+	18	1.12	0.61	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-24SMNM+	18	1.32	0.61	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
141-24SMRSM+	18	1.55	0.61	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-26SM+	18	1.20	0.66	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-30SM+	18	1.27	0.76	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-32SM+	18	1.30	0.81	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard

141 Connector Series

141 Connector Series



141 Connector Series

All models can also be ordered in custom lengths and phase-matching

Hand-Flex Interconnect, 0.141” center diameter | 50 Ω | DC to 18 GHz 5/5

Click here to view the products online with advanced filtering options.

ITEM NUMBER	FREQ HI	INSERTION LOSS	LENGTH (M)	CONNECTOR 1 TYPE	CONNECTOR 1 GENDER	CONNECTOR 1 ORIENTATION	CONNECTOR 1 MOUNTING TYPE	CONNECTOR 2 TYPE	CONNECTOR 2 GENDER	CONNECTOR 2 ORIENTATION	CONNECTOR 2 MOUNTING TYPE
141-36SBSMR+	18	1.60	0.91	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Female	Straight	Bulkhead
141-36SM+	18	1.51	0.91	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-36SMRSM+	18	2.19	0.91	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
141-1MSM+	18	1.67	1.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-40SM+	18	1.90	1.02	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-50SM+	18	2.50	1.27	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-1.5MSM+	18	3.53	1.50	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-60SM+	18	2.50	1.52	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-72SM+	18	3.10	1.83	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
141-2MSM+	18	3.36	2.00	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard


141 Connector Series


141 Connector Series


141 Connector Series

All models can also be ordered in custom lengths and phase-matching

Flexible Interconnect, 0.141" center diameter | 50 Ω | DC to 18 GHz

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
FL141-6NM+	18	0.20	0.15	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
FL141-6SM+	18	0.30	0.15	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FL141-6SMNM+	18	0.20	0.15	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
FL141-9SM+	18	0.37	0.23	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FL141-12NM+	18	0.40	0.30	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
FL141-12SM+	18	0.50	0.30	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FL141-12SMNM+	18	0.40	0.30	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
FL141-24NM+	18	0.90	0.61	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
FL141-24SM+	18	1.00	0.61	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FL141-24SMNM+	18	0.90	0.61	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard

FL141 Connector Series

FL141 Connector Series

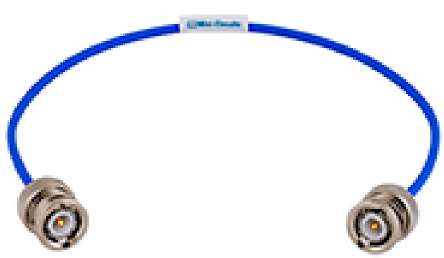
FL141 Connector Series

All models can also be ordered in custom lengths and phase-matching

Hand-Flex Interconnect, 0.086” center diameter | 50 Ω | DC to 40 GHz 1/4

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
086-6BM+	3	0.14	0.15	BNC	Male	Straight	Standard	BNC	Male	Straight	Standard
086-8BM+	3	0.18	0.20	BNC	Male	Straight	Standard	BNC	Male	Straight	Standard
086-10BM+	3	0.22	0.25	BNC	Male	Straight	Standard	BNC	Male	Straight	Standard
086-12BM+	3	0.27	0.30	BNC	Male	Straight	Standard	BNC	Male	Straight	Standard
086-18BM+	3	0.39	0.46	BNC	Male	Straight	Standard	BNC	Male	Straight	Standard
086-24BM+	3	0.51	0.61	BNC	Male	Straight	Standard	BNC	Male	Straight	Standard
086-6SBMMCR+	6	0.30	0.15	MMCX	Male	Right Angle 0° Clocked	Standard	SMA	Female	Straight	Bulkhead
086-2SM+	18	0.33	0.05	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-2SMR+	18	0.47	0.05	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-2SMRC+	18	0.47	0.05	SMA	Male	Right Angle 180° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-3SBSM+	18	0.47	0.08	SMA	Male	Straight	Standard	SMA	Female	Straight	Bulkhead
086-3SBSMR+	18	0.36	0.08	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Female	Straight	Bulkhead
086-3SM+	18	0.31	0.08	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-3SMR+	18	0.39	0.08	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-3SMRC+	18	0.45	0.08	SMA	Male	Right Angle 180° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-3SMRSM+	18	0.38	0.08	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-4SBSMR+	18	0.56	0.10	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Female	Straight	Bulkhead
086-4SM+	18	0.34	0.10	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-4SMR+	18	0.59	0.10	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-4SMRSM+	18	0.57	0.10	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-5SBSM+	18	0.42	0.13	SMA	Male	Straight	Standard	SMA	Female	Straight	Bulkhead
086-5SBSMR+	18	0.71	0.13	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Female	Straight	Bulkhead
086-5SM+	18	0.41	0.13	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard



086 Connector Series

086 Connector Series

086 Connector Series

All models can also be ordered in custom lengths and phase-matching

Hand-Flex Interconnect, 0.086” center diameter | 50 Ω | DC to 40 GHz 2/4

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
086-5SMPR+	18	0.43	0.13	SMP	Female	Right Angle 0° Clocked	Standard	SMP	Female	Right Angle 0° Clocked	Standard
086-5SMR+	18	0.66	0.13	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-5SMRSM+	18	0.57	0.13	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-6SBSM+	18	0.47	0.15	SMA	Male	Straight	Standard	SMA	Female	Straight	Bulkhead
086-6SBSMR+	18	0.76	0.15	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Female	Straight	Bulkhead
086-6SM+	18	0.52	0.15	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-6SMR+	18	0.76	0.15	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-6SMRC+	18	0.68	0.15	SMA	Male	Right Angle 180° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-6SMRSM+	18	0.57	0.15	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-7SBSM+	18	0.59	0.18	SMA	Male	Straight	Standard	SMA	Female	Straight	Bulkhead
086-7SM+	18	0.60	0.18	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-7SMR+	18	0.97	0.18	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-7SMRSM+	18	0.88	0.18	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-8SBSM+	18	0.70	0.20	SMA	Male	Straight	Standard	SMA	Female	Straight	Bulkhead
086-8SBSMR+	18	0.56	0.20	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Female	Straight	Bulkhead
086-8SM+	18	0.69	0.20	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-8SMPR+	18	0.90	0.20	SMP	Female	Right Angle 0° Clocked	Standard	SMP	Female	Right Angle 0° Clocked	Standard
086-8SMPSM+	18	0.63	0.20	SMA	Male	Straight	Standard	SMP	Female	Straight	Standard
086-8SMR+	18	0.93	0.20	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-8SMRSM+	18	0.92	0.20	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-9SBSM+	18	0.72	0.23	SMA	Male	Straight	Standard	SMA	Female	Straight	Bulkhead
086-9SM+	18	0.79	0.23	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-9SMR+	18	1.01	0.23	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-9SMRC+	18	1.00	0.23	SMA	Male	Right Angle 180° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard

086 Connector Series

086 Connector Series

086 Connector Series

All models can also be ordered in custom lengths and phase-matching

Hand-Flex Interconnect, 0.086” center diameter | 50 Ω | DC to 40 GHz 3/4

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
086-9SMRSM+	18	1.01	0.23	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-10SBSM+	18	0.78	0.25	SMA	Male	Straight	Standard	SMA	Female	Straight	Bulkhead
086-10SM+	18	0.85	0.25	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-10SMP+	18	1.05	0.25	SMP	Female	Straight	Standard	SMP	Female	Straight	Standard
086-10SMPR+	18	0.83	0.25	SMP	Female	Right Angle 0° Clocked	Standard	SMP	Female	Right Angle 0° Clocked	Standard
086-10SMR+	18	1.16	0.25	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-10SMRSM+	18	1.12	0.25	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-11SBSM+	18	1.10	0.28	SMA	Male	Straight	Standard	SMA	Female	Straight	Bulkhead
086-11SM+	18	1.17	0.28	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-11SMR+	18	1.22	0.28	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-11SMRSM+	18	0.80	0.28	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-12SBSM+	18	0.90	0.30	SMA	Male	Straight	Standard	SMA	Female	Straight	Bulkhead
086-12SM+	18	1.01	0.30	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-12SMR+	18	1.30	0.30	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-12SMRC+	18	1.22	0.30	SMA	Male	Right Angle 180° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-12SMRSM+	18	1.24	0.30	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-13SM+	18	1.00	0.33	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-14SBSM+	18	1.03	0.36	SMA	Male	Straight	Standard	SMA	Female	Straight	Bulkhead
086-14SM+	18	1.13	0.36	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-14SMR+	18	1.49	0.36	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-14SMRSM+	18	1.36	0.36	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-15SM+	18	1.19	0.38	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-15SMRSM+	18	1.43	0.38	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-16SBSM+	18	1.10	0.41	SMA	Male	Straight	Standard	SMA	Female	Straight	Bulkhead

086 Connector Series

086 Connector Series

086 Connector Series

All models can also be ordered in custom lengths and phase-matching

Hand-Flex Interconnect, 0.086” center diameter | 50 Ω | DC to 40 GHz 4/4

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
086-16SM+	18	1.33	0.41	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-16SMRSM+	18	1.50	0.41	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-18SBSMR+	18	1.71	0.46	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Female	Straight	Bulkhead
086-18SM+	18	1.41	0.46	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-18SMR+	18	1.90	0.46	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-18SMRSM+	18	1.70	0.46	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-20SM+	18	1.87	0.51	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-22SM+	18	2.02	0.56	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-24SM+	18	2.02	0.61	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-24SMR+	18	1.70	0.61	SMA	Male	Right Angle 0° Clocked	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-24SMRSM+	18	2.25	0.61	SMA	Male	Straight	Standard	SMA	Male	Right Angle 0° Clocked	Standard
086-36SM+	18	2.44	0.91	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
086-3KM+	40	0.49	0.08	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
086-4KM+	40	0.60	0.10	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
086-6KM+	40	0.89	0.15	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
086-9KM+	40	1.40	0.23	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
086-12KM+	40	1.70	0.30	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
086-15KM+	40	2.20	0.38	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
086-18KM+	40	2.40	0.46	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard
086-24KM+	40	3.20	0.61	2.92 mm	Male	Straight	Standard	2.92 mm	Male	Straight	Standard

086 Connector Series

086 Connector Series

086 Connector Series

All models can also be ordered in custom lengths and phase-matching

Flexible Interconnect, 0.086" center diameter | 50 Ω | DC to 50 GHz 1/2

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
FL086-6NM+	18	0.30	0.15	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
FL086-6SM+	18	0.40	0.15	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FL086-6SMNM+	18	0.30	0.15	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
FL086-9SM+	18	0.64	0.23	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FL086-12NM+	18	0.60	0.30	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
FL086-12SM+	18	0.90	0.30	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FL086-12SMNM+	18	0.70	0.30	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard
FL086-24NM+	18	1.40	0.61	N-Type	Male	Straight	Standard	N-Type	Male	Straight	Standard
FL086-24SM+	18	1.50	0.61	SMA	Male	Straight	Standard	SMA	Male	Straight	Standard
FL086-24SMNM+	18	1.40	0.61	N-Type	Male	Straight	Standard	SMA	Male	Straight	Standard

FL086 Connector Se-

FL086 Connector Se-

FL086 Connector Se-

All models can also be ordered in custom lengths and phase-matching

Flexible Interconnect, 0.086" center diameter | 50 Ω | DC to 50 GHz 2/2

Click here to view the products online with advanced filtering options.

P/N	FREQ HI (GHz)	INS LOSS (dB)	LENGTH (M)	CON 1 TYPE	CON 1 GENDER	CON 1 ORIENTATION	CON 1 MOUNTING TYPE	CON 2 TYPE	CON 2 GENDER	CON 2 ORIENTATION	CON 2 MOUNTING TYPE
FL086-6-35M+	26.5	0.60	0.15	3.5mm	Male	Straight	Standard	3.5mm	Male	Straight	Standard
FL086-12-35M+	26.5	1.20	0.30	3.5mm	Male	Straight	Standard	3.5mm	Male	Straight	Standard
FL86-12SMP+	26.5	1.45	0.30	SMP	Female	Straight	Standard	SMP	Female	Straight	Standard
FL86-12SMPKM+	33	1.46	0.30	SMP	Female	Straight	Standard	2.92mm	Male	Straight	Standard
FL86-12SMPVM+	33	1.45	0.30	SMP	Female	Straight	Standard	2.4mm	Male	Straight	Standard
FL86-12SSMPSMP+	33	1.45	0.30	SMPM	Female	Straight	Standard	SMP	Female	Straight	Standard
FL086-3KM+	40	0.50	0.08	2.92mm	Male	Straight	Standard	2.92mm	Male	Straight	Standard
FL086-4KM+	40	0.60	0.10	2.92mm	Male	Straight	Standard	2.92mm	Male	Straight	Standard
FL086-6KM+	40	0.80	0.15	2.92mm	Male	Straight	Standard	2.92mm	Male	Straight	Standard
FL086-12KM+	40	1.50	0.30	2.92mm	Male	Straight	Standard	2.92mm	Male	Straight	Standard
FL86-12KMVM+	40	1.60	0.30	2.92mm	Male	Straight	Standard	2.4mm	Male	Straight	Standard
FL86-12SSMP+	40	1.86	0.30	SMPM	Female	Straight	Standard	SMPM	Female	Straight	Standard
FL86-12SSMPKM+	40	1.79	0.30	SMPM	Female	Straight	Standard	2.92mm	Male	Straight	Standard
FL86-12SSMPVM+	40	1.81	0.30	SMPM	Female	Straight	Standard	2.4mm	Male	Straight	Standard
FL86-12VM+	50	1.96	0.30	2.4mm	Male	Straight	Standard	2.4mm	Male	Straight	Standard


FL086 Connector Se-


FL086 Connector Se-


FL086 Connector Se-

All models can also be ordered in custom lengths and phase-matching

RF CABLES
PRODUCT GUIDE

APPLICATION NOTES

CBL Series Ruggedized Test Cable - Super Flex Testing

Introduction

Mini-Circuits CBL Series Test Cables are specifically designed and manufactured for use in stringent test lab environments where cables are often bent and twisted many times during normal use. This stress can ultimately result in catastrophic failure. It is however the degradation that can occur prior to total failure that is the real danger as this can result in erroneous measurements. To ensure performance in this environment, Mini-Circuits has qualified the CBL Series through extensive Flex Testing - up to 20,000 flex-cycles.

Qualification Testing - Flex Cycles

Flex Test Setup

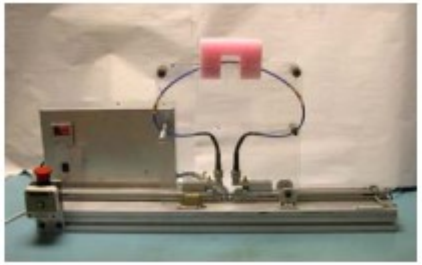


Figure 1 Flex Test Setup-Close

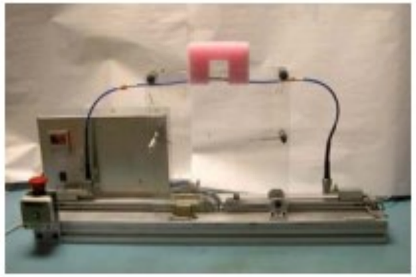


Figure 2 Flex Test Setup-Open

Application Note | CBL Series Ruggedized Test Cable - Super Flex Testing |

Mini-Circuits Cable Test Data

Figure 3 below shows insertion loss taken after 1000, 1500, 2000, 3000, 4000, 5000, 7000, 10000, 15000, and 20000 bends and repeatable performance for return loss as shown below in Figures 4 & 5.

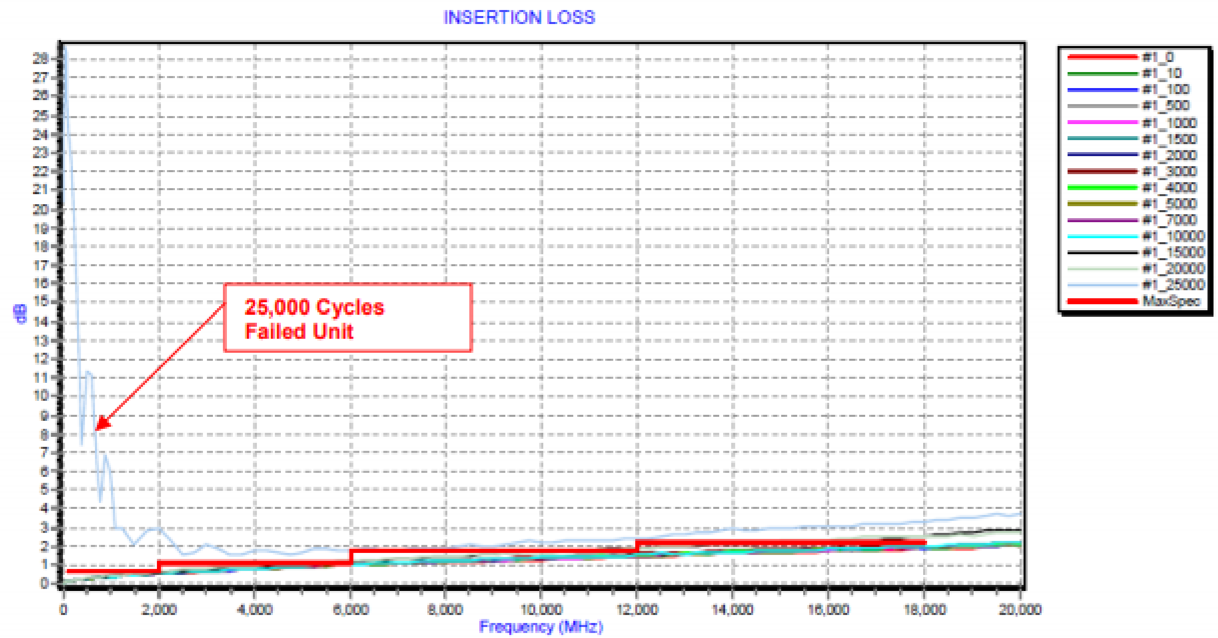


Figure 3 Insertion Loss

Application Note | CBL Series Ruggedized Test Cable - Super Flex Testing |

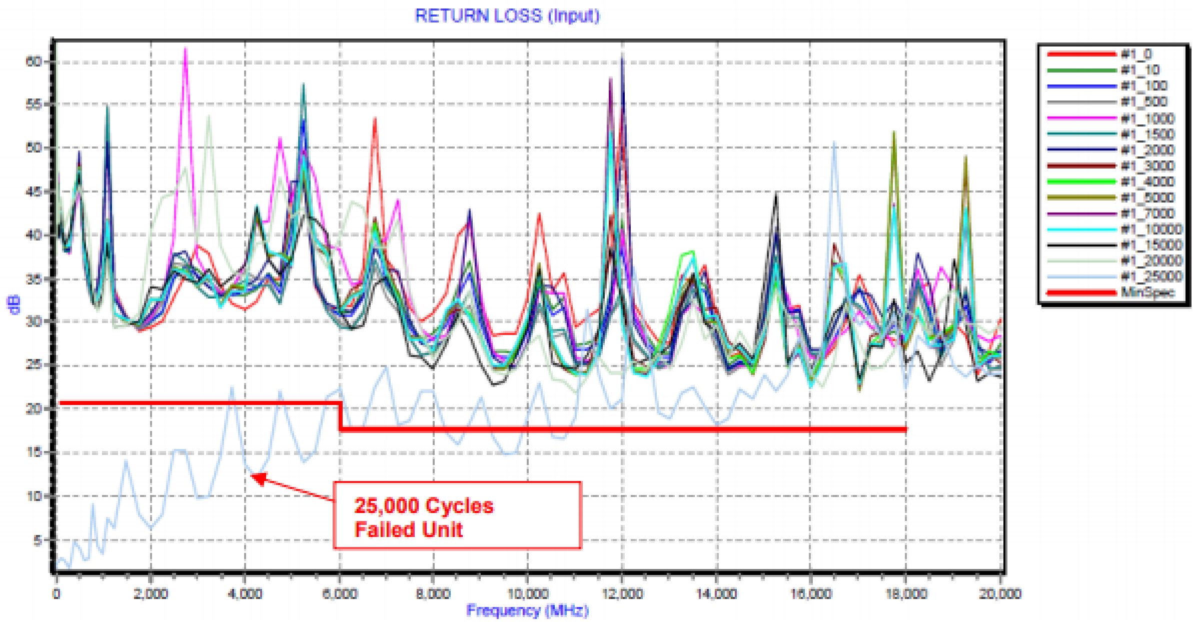


Figure 4 Return Loss-Input

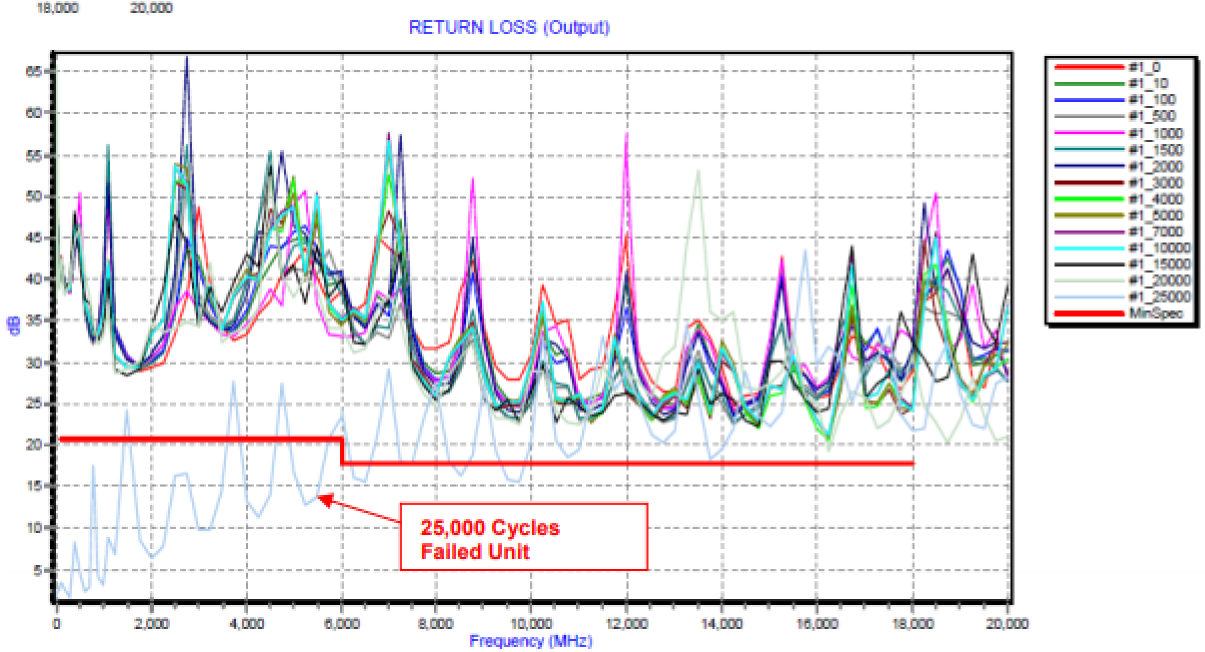


Figure 5 Return Loss-

Performance Change vs. Flexure using Cable Flexure Test Fixture

Introduction

Mini-Circuits FLC Series Test Cables are specifically designed and manufactured for use in stringent test lab environments where cables often undergo bending during normal use. This can result in a change of performance versus flexure. To demonstrate performance change versus flexure, Mini-Circuits has developed a controlled method of test and evaluated our FLC3FT-SMSM+ model by applying various bend radii to a 3ft cable and measuring the change in insertion loss, insertion phase, and VSWR versus flexure normalized to the reference position.

Qualification Testing - Electrical Performance vs. Flexure Test

Cable Flexure Test Fixture

Fixture (B85-L26000-00) used in the setup is designed and built by MCT specifically for the performance vs. flexure test. The fixture as shown in figure 1 below has 2 adjustable arms to support the connector ends when connected to Agilent PNA-X Network Analyzer at Ports 1 & 2. A 3ft flexible cable is wrapped around a 4 inch mandrel which slides along the scaled bar creating the specified bend radius.

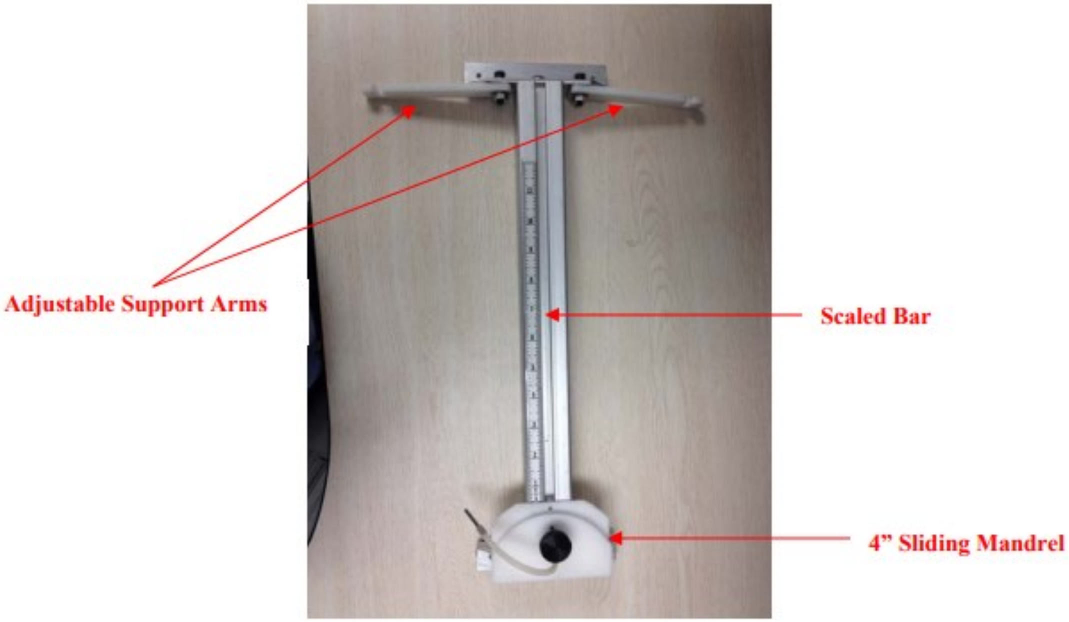
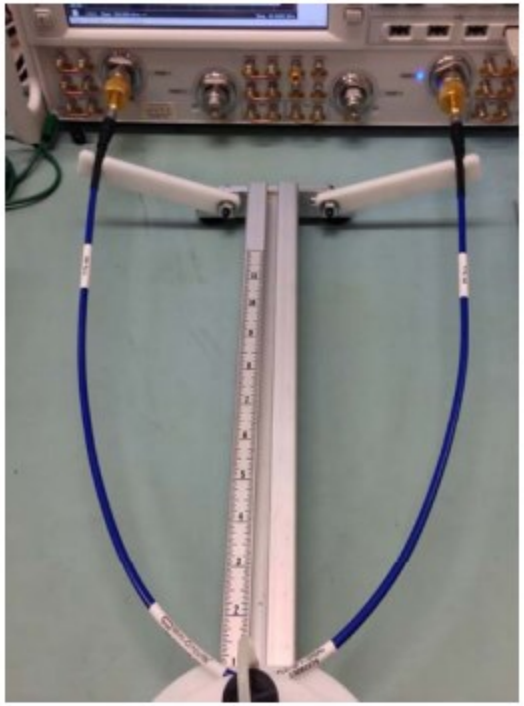


Figure 1: Cable Flexure Test Cable (MCL P/N: B85-L26000-00)

Cable Flexure Test Fixture Setup

Figures 2 to 5 below show the Flexure Test Setup used in assessing the electrical performance vs. flexure. This flexure test fixture applies a symmetric bend radius to apply a stress on the cable.



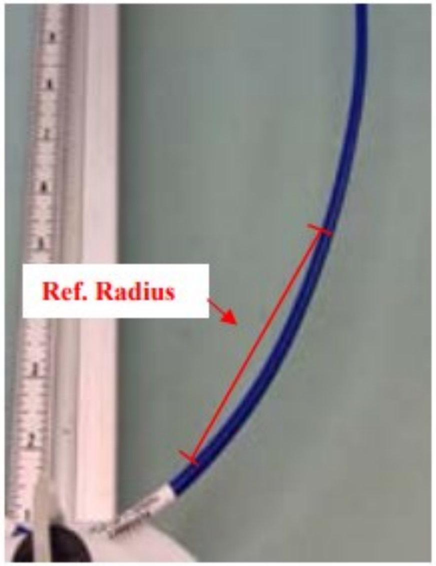


Figure 2: 3ft. Flexible Test Cable attached to the Cable Flexure Test Fixture at its reference start position

Application Note | Performance Change vs. Flexure using Cable Flexure Test Fixture| 3/7

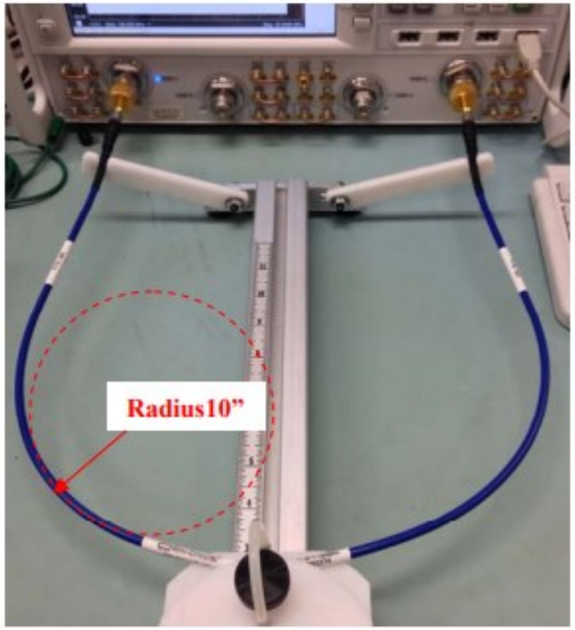


Figure 3: 3ft. Flexible Test Cable with a bend radius of 10"

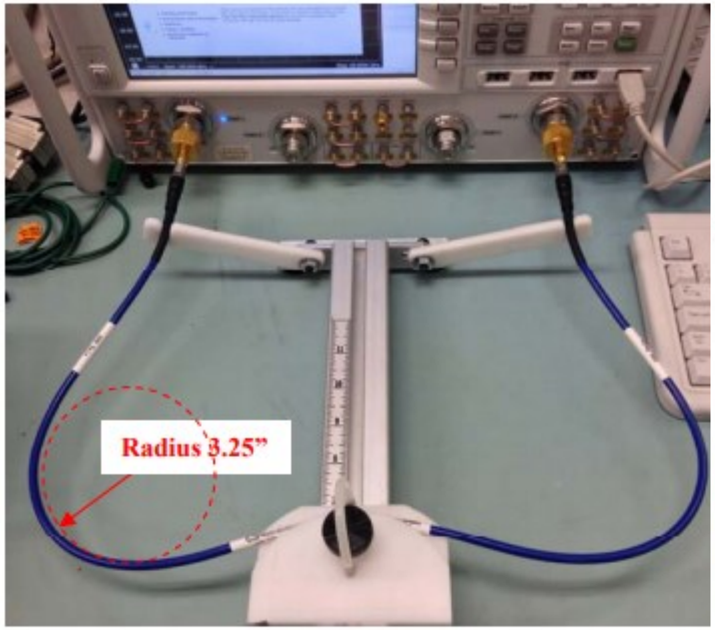


Figure 4: 3ft. Flexible Test Cable with a bend radius of 3.25"

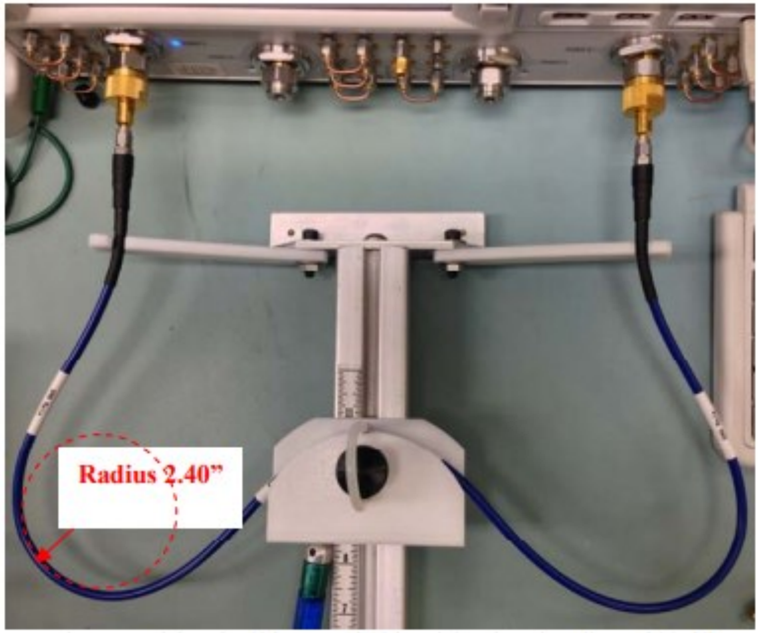


Figure 5: 3ft. Flexible Test Cable with a bend radius of 2.40"

Application Note | Performance Change vs. Flexure using Cable Flexure Test Fixture| 4/7

Performance Change vs. Flexure Data

Figure 6 below shows the typical absolute values normalized to the reference position 0, for each electrical performance from DC-26GHz measured using a 3ft cable.

Parameter	Condition (GHz)	Bend Radius (Inches)			Units
		10	3.25	2.40	
Insertion Loss	DC-6 6-18 18-26	0.00 0.01 0.01	0.01 0.02 0.04	0.01 0.03 0.05	dB
Insertion Phase	DC-6 6-18 18-26	0.03 0.03 0.07	0.49 1.7 2.9	0.09 0.31 1.6	Deg
VSWR	DC-6 6-18 18-26	0.00 0.01 0.01	0.01 0.02 0.08	0.01 0.02 0.11	:1

Figure 6

Note: Cable Flexure Test Fixture specifically designed to take measurements using Agilent PNA-X Network Analyzer at Port-1 & Port-2.

Application Note | Performance Change vs. Flexure using Cable Flexure Test Fixture| 5/7

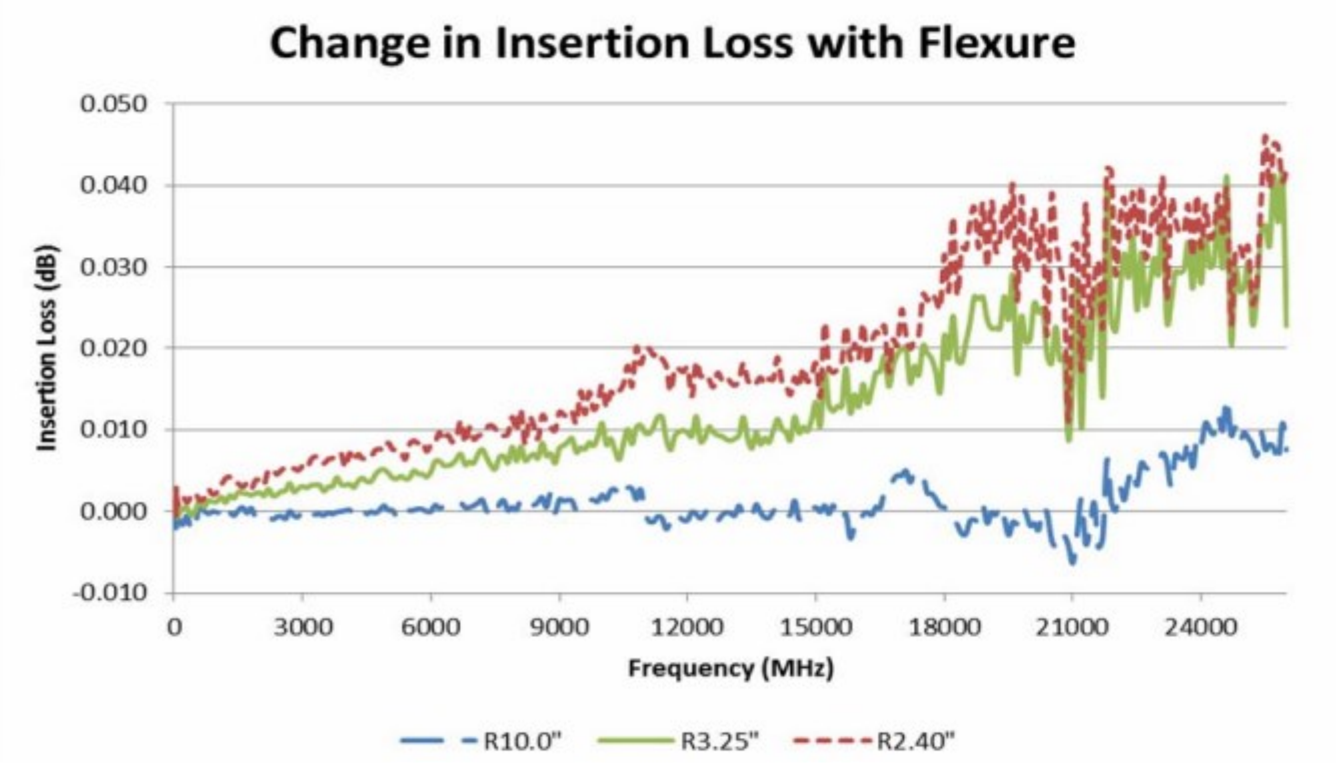


Figure 7: Change in Insertion Loss with flexure in reference to start position

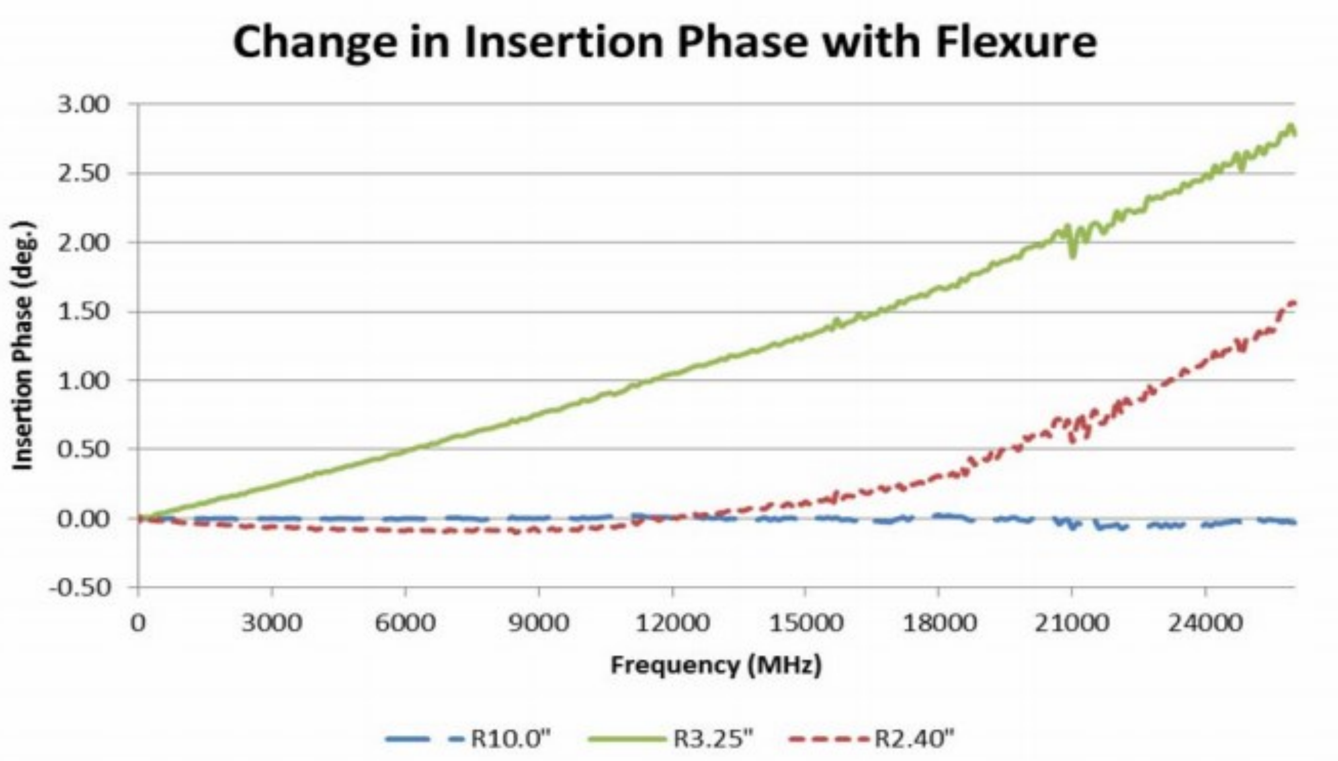


Figure 8: Change in Insertion Phase with flexure in reference to start position

Application Note | Performance Change vs. Flexure using Cable Flexure Test Fixture| 7/7

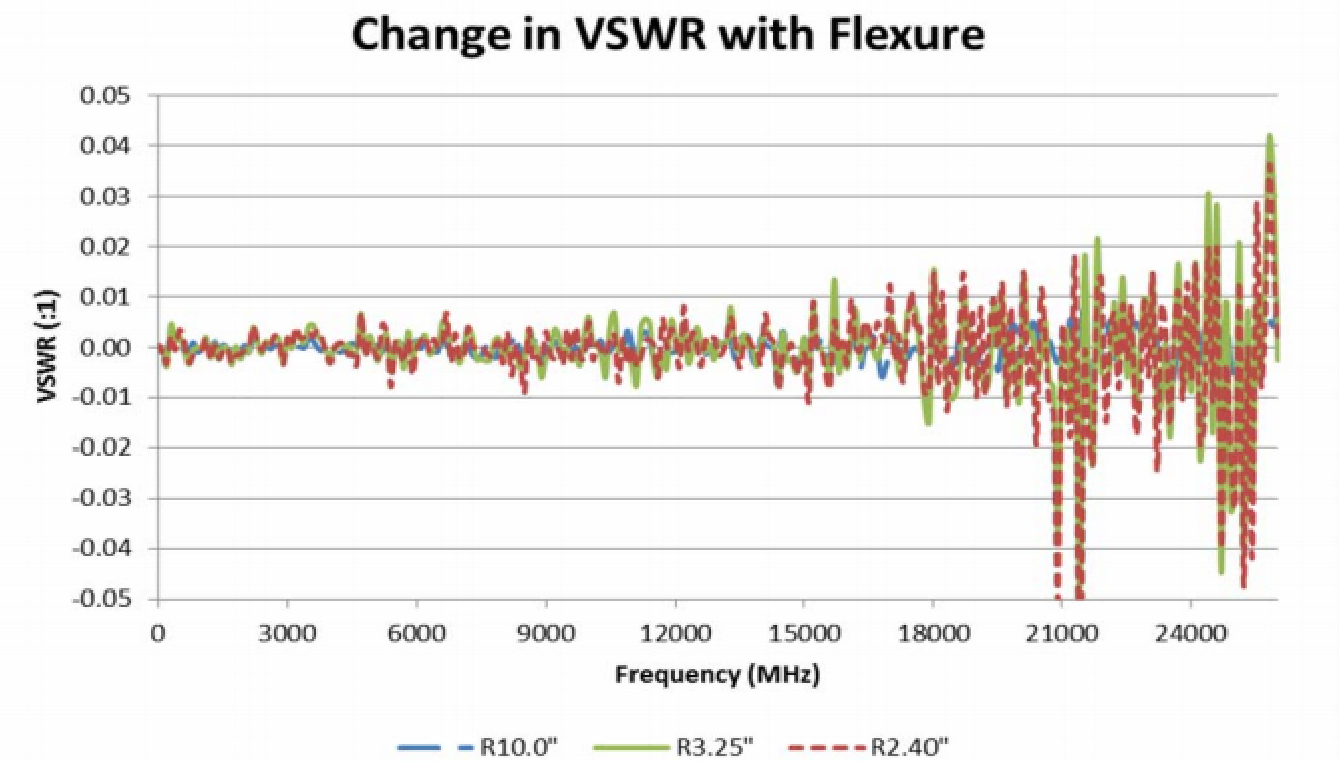


Figure 9: Change in VSWR with flexure in reference to start position

Conclusion

Max change in insertion loss at the most extreme case bend radius of 2.40" is 0.05dB, which is found at the frequency range of 18-26 GHz. Max change in insertion phase is 2.9 degrees with a 3.25" bend radius flexure, which is seen at the higher frequencies. Max change in VSWR at the most extreme case bend radius of 2.40" is 0.11 and is also found at higher frequencies. In conclusion, change in performance change versus flexure is minimal and suitable for lab use.

More than Just a Phase: Understanding Phase Stability in RF Test Cables

AN- 46- 004

I. Introduction

One important factor in ensuring accurate, repeatable measurements in RF test applications is the stability of performance of the test cable used. In most test environments, cables undergo frequent bending during normal use, which can result in changes in phase and other performance parameters. Depending on the cable, these changes can be significant enough to degrade the accuracy and precision of your measurements. Therefore, in choosing the right test cable for your needs, it's important to consider how bending affects cable phase performance and how a cable is (or isn't) qualified for stability of phase versus flexure.

This article will review the basics of phase stability in RF coaxial cables and identify the factors that affect phase performance. Two methods of testing phase change versus flexure will be explored, and the preferred method used to qualify Mini-Circuits' T40 and T50-series phase-stable cables presented and explained in detail.

II. Why Phase Matters

Phase stability is desirable in test cables because it:

- Ensures good phase tracking with changing temperature, and lowers residual errors and uncertainties
- Improves antenna gain for better system performance and accuracy
- Provides better bit error rate (BER) which increases effective range
- Extends the length of time between calibrations and minimizes drift between calibrations

III. What Causes Phase Change?

In general, phase is affected by the physical length of the cable assembly, the cable bend radius, and the cable assembly technique. Recall that the electrical length of an RF line in degrees is defined by:

$$\text{Electrical Length [deg]} = 360° * \frac{L}{\lambda}$$

$$\text{And } \lambda = \frac{\frac{c}{\sqrt{\varepsilon_r}}}{f}$$

Application Note | Understanding Phase Stability in RF Test Cables | 2/8

Where f is frequency in L Hz, is physical length in meters, ε_r is the dielectric constant of the cable material, *c* is the speed of light in meters per second, and λ is the wavelength.

Cables are typically designed to operate over a wide frequency range and minimize attenuation (loss). The longer the electrical length, the greater the loss. Since electrical length (and loss) is directly proportional to the square root of ε_r, most RF cables are manufactured from materials with a low dielectric constant, usually PTFE (Teflon) and in some cases SiO_2. PTFE is more common because it's easy to bend without damaging, while SiO_2 is brittle and only suitable for semi-rigid cable assemblies. All Mini-Circuits' cables use PTFE, as a good degree of flexibility is needed in most applica-tions.

One drawback of the flexible PTFE construction is, of course, the potential for phase changes (and other performance changes) due to bending. Bending the

cable changes the physical length at the point of bend. It may also constrict and loosen the dielectric, shielding, and braiding around the center con-ductor, which can also affect the electrical length and result in phase changes.

Depending on the design and construction, some cables will exhibit greater sensitivity of phase with bending than others. Mini-Circuits' T40- and T50 -series cables are specifically designed and tested for stability of phase versus flexure. What follows will explain the methodology Mini-Circuits uses to qualify phase stability in these models.

Figure 1: Mini-Circuits

T50-3FT-VFVM+ phase-stable test cable

IV. How Phase Change is Measured

Measuring phase change versus flexure involves connecting the cable to a VNA and sweeping phase across frequency with some setup to bend the cable into specified radii to show corresponding changes in phase. There are, of course, many setups we could conceive to measure phase stability, and the reliability of this parameter depends on the robustness of the test method used. Mini-Circuits has explored multiple test methods to determine the most reliable procedure to characterize phase stability in our test cables.

Unexpected Result from the "Cross-Bow" Two-Port Method

The cross-bow-like fixture shown in Figure 2 below was built as one possible solution for measurement of cable performance vs. flexure. The apparatus has two adjustable arms to support the connector ends when connected to VNA ports 1 and 2. The cable is wrapped around a 4 inch mandrel which slides along the scaled bar, creating the specified bend radius. Figure 2 pictures the setup with measurements being made on Mini-Circuits model T50-3FT-KMKM+ at 10", 3.25", and 2.4" radii.

We would expect the relationship between bend radius and phase change to be linear. However, the data collected on the cable using this method exhibited a parabolic-shaped phase vs. flexure curve. This result is likely due to the multiple radial bends in the cable in this configuration: two in one direction, and one in the opposite direction. The data from this test is unusable because it gives the appearance of the cable being more resistant to phase change in tighter bends, which deviates from the expected performance.

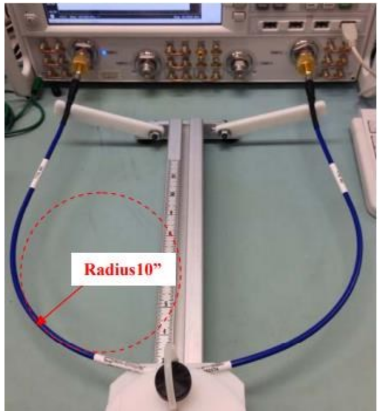
Preferred Procedure: The One-Port Method for Testing

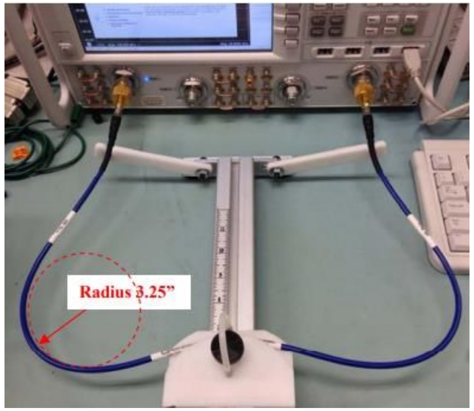
In the setup pictured in Figure 4, one-port calibration was performed on the VNA. The DUT (cable T50-3FTKMKM+) was connected to the VNA and terminated at the end with a short. The VNA was then normalized in the straight position. The cable was then wrapped one full turn (360°) around a mandrel of specified radius in one direction, and measurement was taken by sweeping phase across frequency. The cable was straightened, and the VNA normalized again. A second measurement was taken with the cable wrapped one full turn in the opposite direction, around a second mandrel on the opposite side. This procedure was repeated for radii of 2" and 3". The data collected on the cable using this method exhibited the expected linear relationship between phase change and flexure (Figure 5). This method avoids any effects of additional bends in the cable and other factors that may distort the measurement, and the data is usable.

V. Conclusion

The measurement of phase versus flexure varies from

company to company in the RF cable industry, and it’s important to understand how manufacturers specify phase stability when selecting a cable for an application in which this is a desired feature. Mini-Circuits uses the one-port method explained above to test phase stability in all of our T40- and T50-series phase-stable RF test cables. Data from this test is presented on the datasheet for all models in these families.





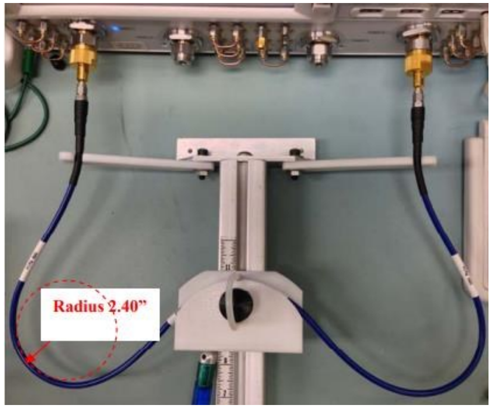


Figure 1: “Cross Bow” apparatus for measuring cable performance versus bend at 10”, 3.25”, and 2.4” bend radii.

Application Note | Understanding Phase Stability in RF Test Cables | 5/8

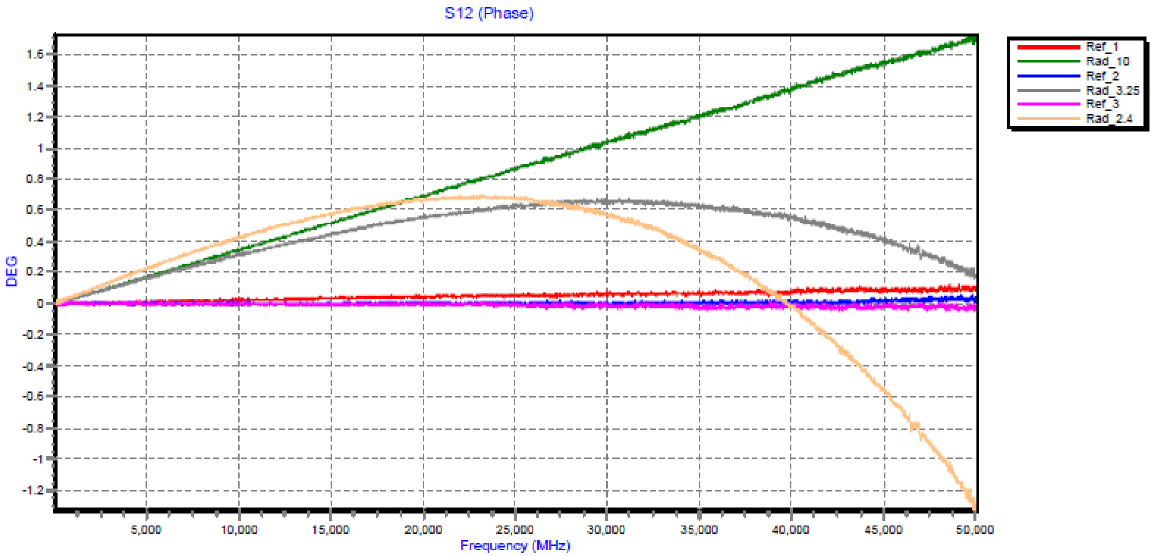


Figure 2: T50-3FT-KMKM+ using the "cross-bow" two port method, exhibiting a parabolic relationship between phase change and flexure.

Application Note | Understanding Phase Stability in RF Test Cables | 6/8

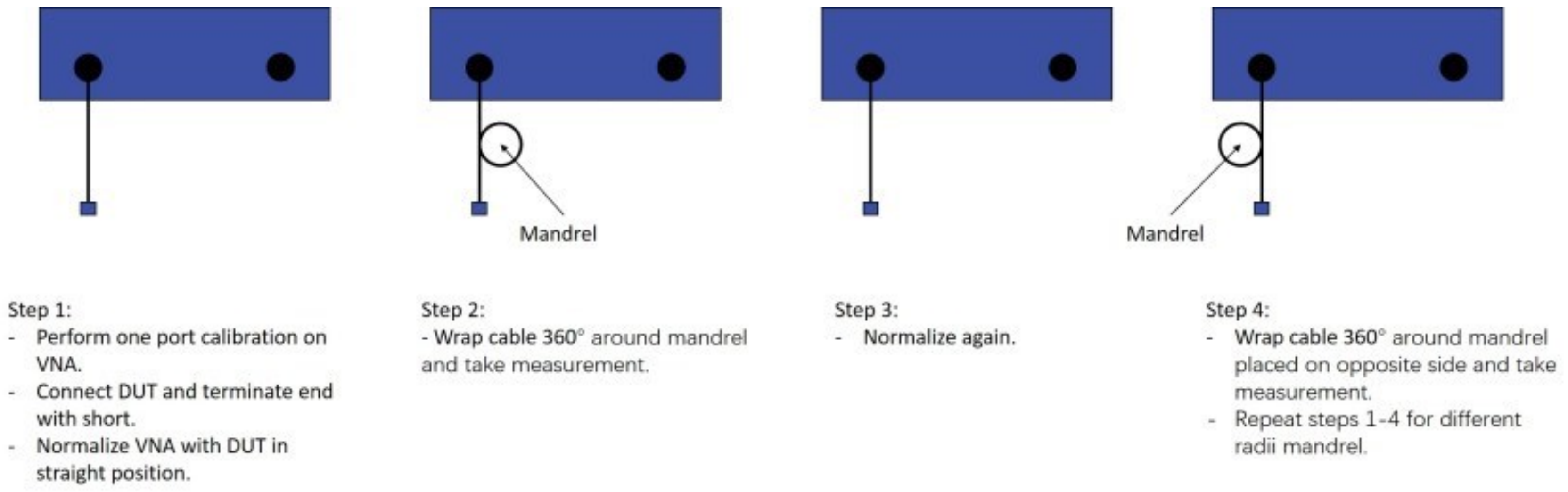


Figure 3: Simple visualization of the one-port method for testing phase stability vs. flexure.

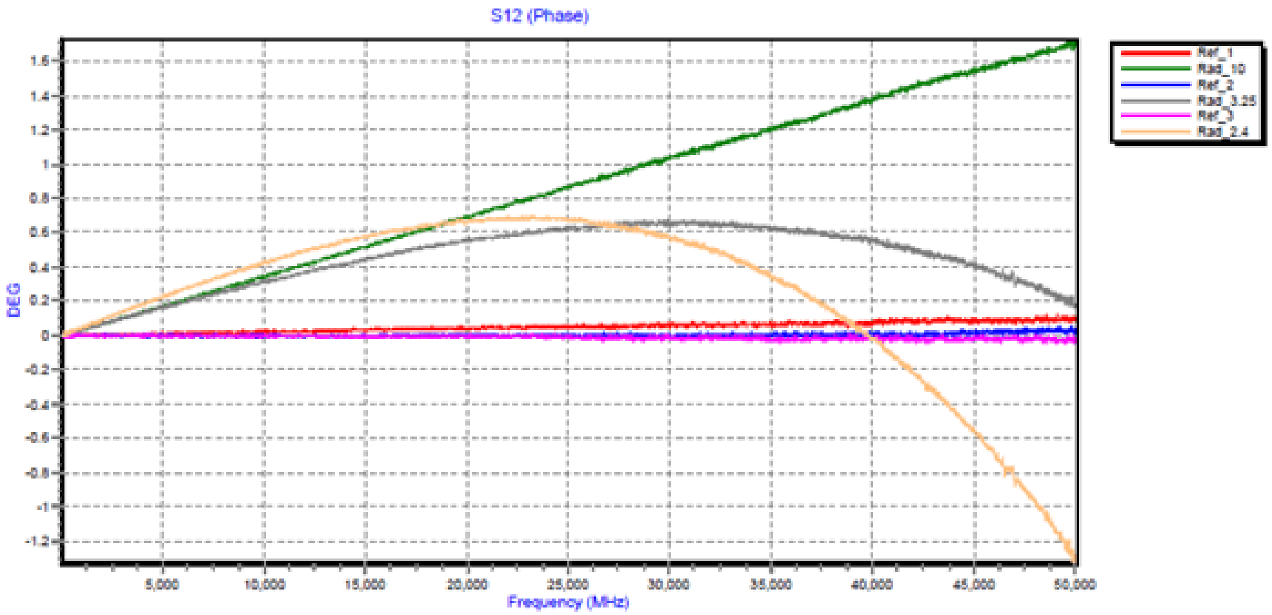


Figure 4: T50-3FT-KMKM+ using the “cross-bow” two port method, exhibiting a parabolic relationship between phase change and flexure.

Application Note | Understanding Phase Stability in RF Test Cables | 8/8

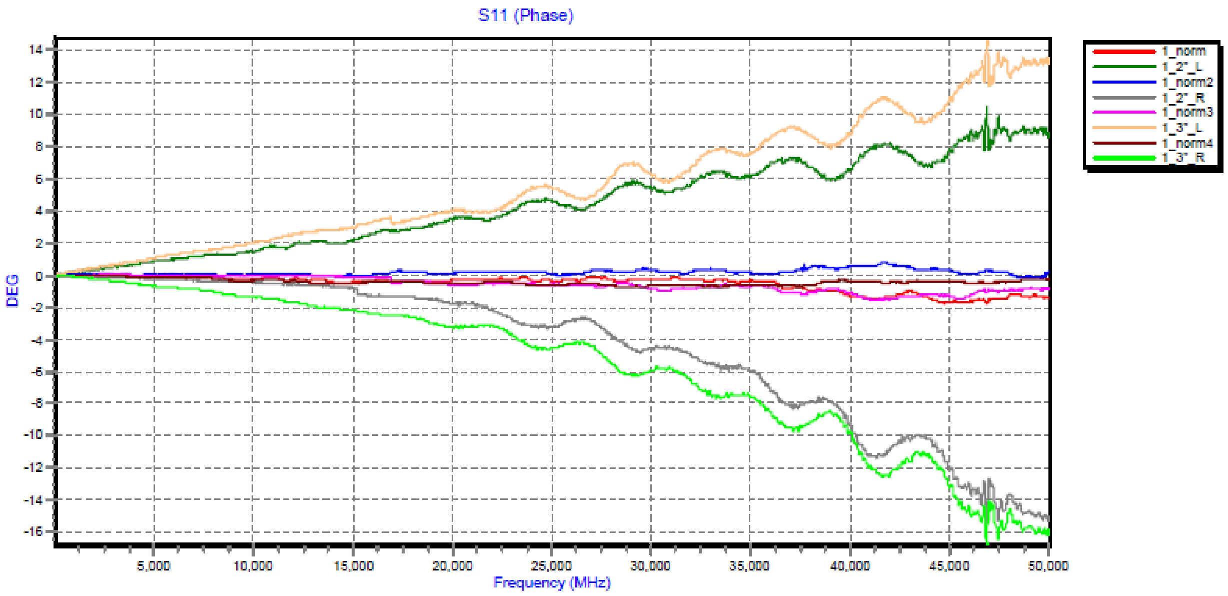


Figure 4: T50-3FT-KMKM+ using the one-port method, exhibiting the expected relationship between phase change and flexure. *S11 halved to obtain phase change.

Introduction

Selecting the right RF/microwave cable assembly can be a confusing task considering the variety of products on the market and the multiple characteristics of each. Adding to the challenge, many products don't lend themselves to a straightforward, "spreadsheet" comparison. This guide was written to go beyond the spec sheet and help you find the right cable for your needs more quickly and more knowledgeably. We will review the different categories of RF cables and their attributes and provide some guidelines on how to prioritize parameters for your application. Note that we omitted fundamental RF theory because much has been written on that subject and this is meant to be a practical resource for engineers in the field rather than a study guide. We also omitted corrugated and CATV coaxial cable as those are typically used for niche applications.

A Brief Overview of Coaxial Cable Types:

All coaxial cable consists of a center conductor surrounded by a dielectric insulator, usually PTFE, an outer metal shield to prevent signal leakage and an outer jacket to protect the inner layers from damage. As we will see, the variations of this structure are many and complex, and it serves the user to understand the various categories of coaxial cable construction and the differences between them.

Figure 1: Basic construction of RF coaxial cable

The following is a summary of the different categories of coaxial cables and their attributes:

Semi-Rigid Cable (Soft Annealed Copper Tubing)

Semi-rigid coaxial cable assemblies use solid copper tubing as an outer sheath rather than braided sheathing. The solid material offers excellent shielding which is useful in some high-frequency applications, but its main drawback is that it's not flexible. Semi-rigid cables are typically customized with lengths, bend shapes and connector configurations specified to the customer's intended use within a unique system layout. They are not intended to be bent or flexed after initial forming, and can be easily damaged during installation.

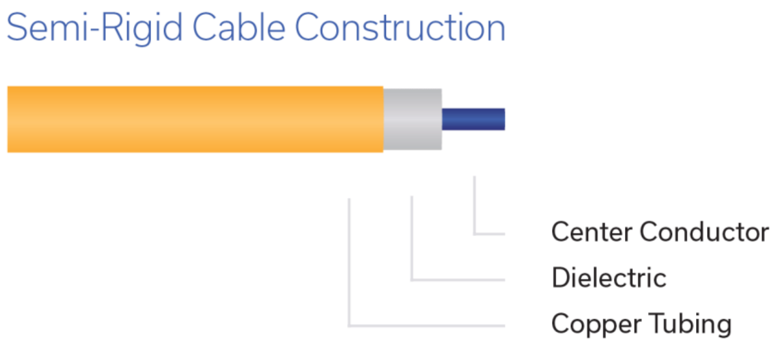


Figure 2: Illustration of semi-rigid cable construction

Pros:

- Efficient RF transmission
- Highly shielded
- Tight bend radius possible
- Good return loss (when the assembly is built correctly)
- Large supplier base for assemblies (but limited number of cable makers)
- Large variety of connectors including crimp, clamp and solder attachments
- Four basic, 50Ω sizes: 0.047", 0.086", 0.141", 0.250" (086 and 141 are the most popular)
- Tin plated copper, tin plated aluminum, and low loss versions available but far less popular
- Smaller diameters suitable through 40 GHz or higher

Cons:

- Must be custom-built
- Assembly is dedicated to each position in the system. Not versatile.
- Requires bend-shape drawings (engineering and drafting time)
- Cable is not flexible
- Supplier may require NRE/tooling charge
- Poor soldering process can cause cracked solder joints at installation
- Many suppliers take process shortcuts that can result in latent field failures

Mini-Circuits does not offer semi-rigid cables due to their inherent cost and lack of versatility. Alternative cable types for interconnect applications have achieved outstanding performance with better overall value and versatility. See tin-soaked cable below.

Braided Flexible Coaxial Cable (RG Style)

"RG" style (for "Radio Guide") cables use metal braided outer shield rather than solid tubing used in semi-rigid cables. This gives them greater flexibility and resilience making them suitable for re-use in various bend shapes and comparatively more affordable than semi-rigid designs. RG style cables can be manufactured faster than more sophisticated types of braided flexible cable (see high-performance braided flexible coax below), which lowers cost and lead time. Conductor, dielectric and shielding types vary widely within this category, but in general, braided shielding is inherently lossier than solid tubing, resulting in greater attenuation and lower maximum frequency ratings, typically topping out between 3 and 6 GHz.

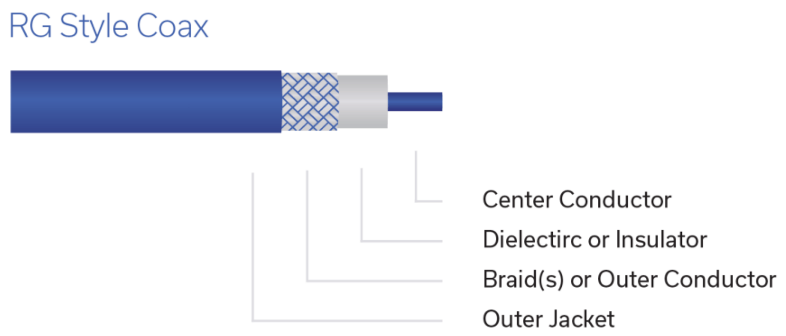


Figure 3: Construction of an RG style RF coaxial cable

Pros:

- Wide variety (many cable and assembly suppliers)
- Does not require bend-shape drawings
- Re-bendable, reasonable flex life
- Low unit price, shorter lead times
- Wide variety of connector options depending on the cable including crimp, clamp and direct solder

Cons:

- Less shielding than semi-rigid
- Slightly higher attenuation than similar size semi-rigid
- Can have inconsistent performance between lots or suppliers
- Not spec'd for use above approximately 6 GHz
- Poor assembly techniques and strain relief often result in early connector attachment failure.

Examples of some of Mini-Circuits' high-performance braided flexible coaxial cables are shown in Figures 1-5 below.

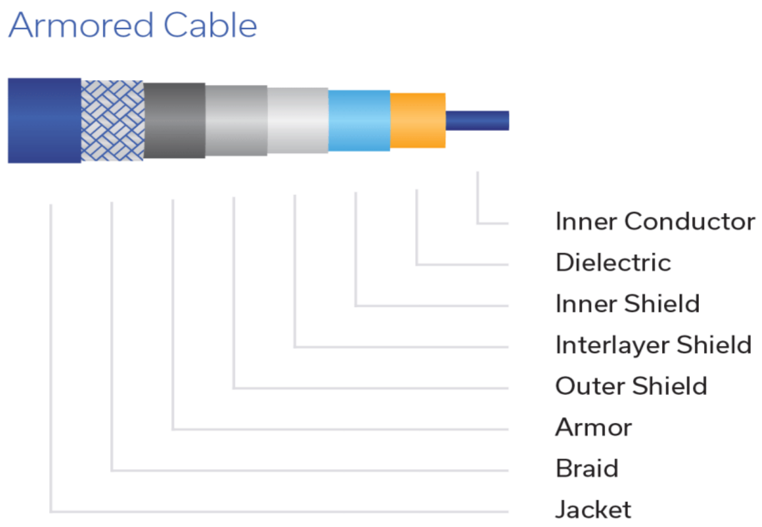


Figure 4: Construction of an armored test cable

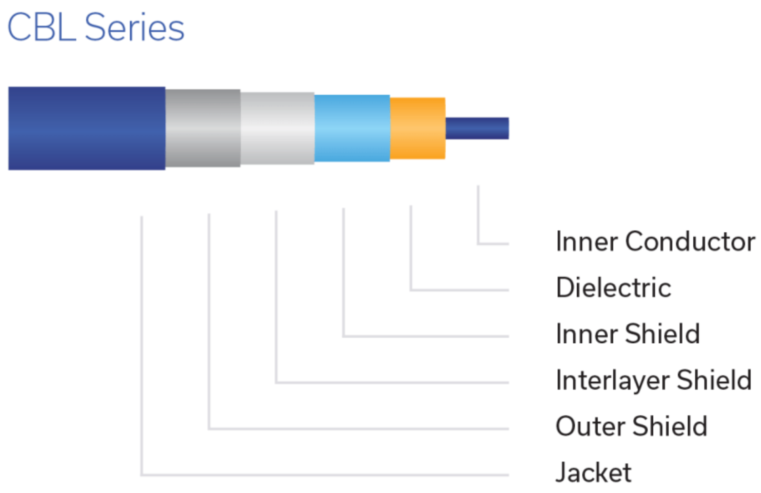


Figure 5: Construction of a high-performance braided coaxial test cable

Examples of some of Mini-Circuits' high-performance braided flexible coaxial cables are shown in Figures 1-5 below.

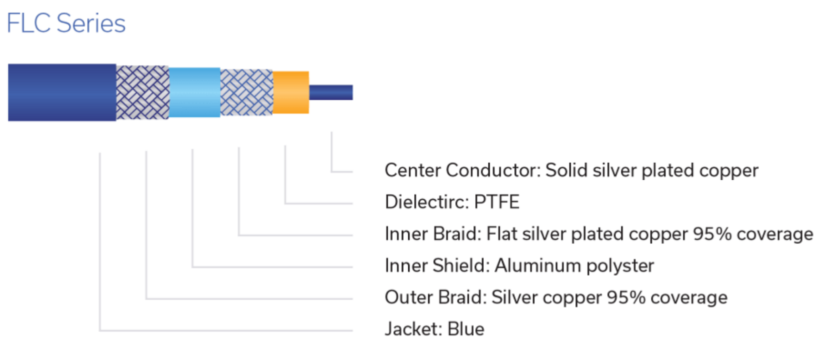


Figure 6: Construction of an ultra-flexible high performance braided coaxial cable

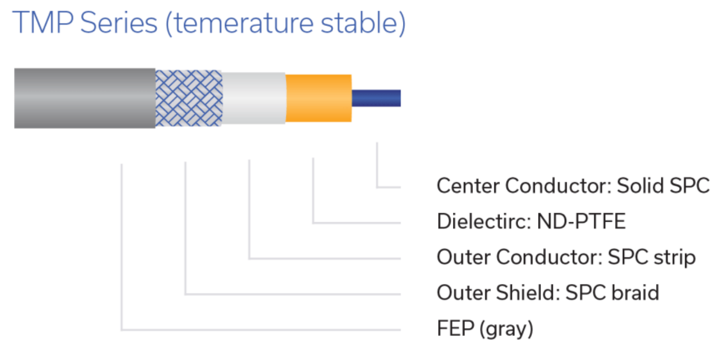


Figure 7: Construction of a temperature stable high-performance coaxial cable

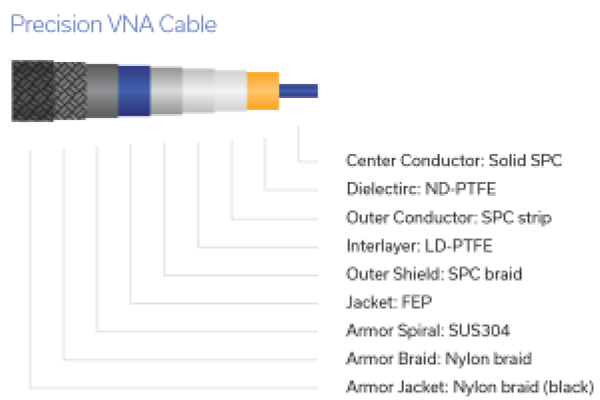


Figure 8: Construction of a precision VNA cable

Pros:

- Wide variety designed to meet specific technical challenges
- Highly shielded
- Very good return loss through 67 GHz
- Long flex life
- RF stable performance with flexure
- Low loss options

Cons:

- More expensive than semi-rigid or RG flexible coax, longer lead times
- More limited cable and assembly supplier base
- Many cables only available as assemblies
- May have a more limited bend radius (more easily degraded from handling abuse)
- Typically requires high assembly skill level to derive the best performance
- More limited connector availability

Tin-Soaked Coaxial Cable (Mini-Circuits HandFlex®)

Mini-Circuits' HandFlex® interconnect cables are built with a tin-soaked copper braid outer shield. These cables offer both flexibility and outstanding performance up to 40 GHz. They also retain their shape after bending, which makes them an excellent substitute for semi-rigid interconnect cables without the need for custom bending. Their hand formability also makes them easier to install in tight spaces with less risk of damage to the cable or connector interface.

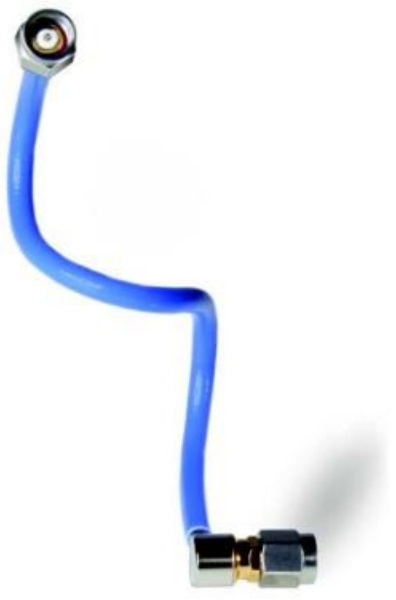


Figure 9: Tin-soaked copper braid interconnect cable (HandFlex)

Pros:

- A true hybrid of semi-rigid and braided flexible coax with some attributes of both
- Shielding and transmission efficiency similar to semi-rigid
- Somewhat re-bendable
- Does not require bend-shape drawings
- Very good return loss
- Attenuation similar to semi-rigid
- Cost-effective, off-the-shelf delivery or short lead times
- Available in 0.047”, 0.086”, (both through 40 GHz) and 0.141” (to 26.5 GHz)
- Popular connector options. Direct solder only.
- Low loss and jacketed versions available

Cons:

- Connector attachment can be an area of weakness
- Susceptible to damage/degradation from overly aggressive bending

RF Connector Types and Attachment Methods:

Connectors should be chosen according to the frequency requirements of the application and connector types of the equipment at the input and output of the cable. The chart below shows the most popular connector series and corresponding frequency limits for each.

RF Connector Types and Attachment Methods:

Connectors should be chosen according to the frequency requirements of the application and connector types of the equipment at the input and output of the cable. The chart below shows the most popular connector series and corresponding frequency limits for each.

Connector Series	Frequency Limit
F-Type (75Ω)	1 GHz
BNC	4 GHz
MMCX (Micro-Miniature CoaXial)	6 GHz
N-Type	11 GHz
SMA	24 GHz
SMP (Snap-On)	25 GHz
3.5 mm	34 GHz
2.92 mm	40 GHz
2.4 mm	50 GHz
1.85 mm	67 GHz
1 mm	110 GHz

Generally speaking, a connector should be chosen for the cable assembly with a center contact and dielectric that have similar diameters to that of the cable center conductor and dielectric. Assuming the attachment process is done correctly, matching sizes results in the optimum return loss.

Connectors are usually attached to the cable in one of three ways: crimp, clamp or solder/clamp and direct solder. A general understanding of the different assembly helps the user evaluate the performance and reliability of a given cable.

Crimp:

While occasionally used on semi-rigid cables, crimp connectors are popular for lower frequency, RG cables. Crimp attachments require less labor but may require specialized crimping tools. They are best used on cables that are not handled frequently. Surprisingly, many suppliers opt to use crimp attachments on test cables, which is not appropriate and affects reliability. An assembly marketed as a test cable with crimp attachments should raise questions about quality in the user's mind.

Clamp or Solder/Clamp:

Clamp or solder/clamp attachments are used more often in cable designs for military and aerospace applications. They are much more expensive and complicated to assemble, but far more reliable than crimp and will not result in latent cracked solder joints. Mini-Circuits uses solder/clamp on its CBL, ULC and other series of test cables for superior reliability.

Direct Solder:

This method is very popular for semi-rigid and hand formable (e.g. Mini-Circuits HandFlex®) cable. Direct solder connectors ironically are the lowest cost but are also the highest performance because they are simple and result in fewer RF discontinuities. Within this category there are separate and no-separate contact designs. Separate contact designs employ a variety of captivation methods depending on the maker including barb, epoxy, and mechanical shoulders. Soldering skill and technique is very important to the performance and reliability of the finished product. Lack of skill and proper technique in the manufacturing process will almost always result in cold solder joints or cracked solder joints either immediately or later in the field. Field failures can obviously be expensive to remedy.

Identifying Your Application Requirements

With the various coaxial cable types, connector options and their respective attributes in mind, consider the specific operating requirements of the application as the logical starting point.
The best way to optimize system performance and keep costs under control is to address the cable requirements early in system design. Include mechanical and packaging engineers in the decision-making process if the task of selecting interconnects will fall to them. Often, fitting everything into a given space without compromising system performance can be challenging. With deadlines looming, options can become limited and interconnect costs can rise.

To start identifying and prioritizing your desired parameters, answer at least these questions:

1. Is the cable installed and never handled again (AKA “in-the-box”) or is it handled frequently as with a test cable?
2. Will it only need to exhibit the defined performance at rest or while in motion such as with an antenna gimbal cable?
3. Will it need to maintain its RF characteristics at extreme temperatures such as in a temp chamber?
4. Will the cable be subjected to extreme environmental conditions like high altitude, humidity and vibration such as in flight, or is it a benign environment like a design lab (RF breadboard)?
5. Is the required connector series appropriate for the application? Are they common or very unusual for the size of cable being considered?

Answering these questions will help define the ideal cable category and better narrow the search to specific cables and suitable suppliers.

A Simple Framework for Your Coaxial Cable Search:

Even in ideal circumstances, the choice of a coaxial cable will usually require compromise, so Mini-Circuits suggests users first parse their needs according to the following framework:

1. Need-to-have: attributes that cannot be compromised.
2. Nice-to-have: attributes that are desirable, but are not necessarily mandatory.

These characteristics can then further be organized into four categories according to their key attributes:

1. RF performance
2. Materials/construction
3. Connector series
4. Mechanical / environmental operating conditions.

<u>Rule of thumb:</u>

A cable that achieves the first three need-to-have characteristics will likely be the cable or assembly of choice at the best price. Continued investigation with suppliers in an attempt to include additional need-to-have and nice-to-have characteristics will reveal if there is a price trade off, which may help you make a more informed decision.

Sometimes it is impossible to allow certain trade-offs above in system design. In those instances, high performance coax may be the only solution. For example, a supplier may be able to stay within the loss budget and/or cable diameter constraints by using high perfomance coax at greater cost. Or perhaps other goals can be achieved simultaneously. There is no free lunch, however, and achieving more electrical, mechanical and environmental requirements usually involves higher prices, more limited connector selection and/or longer lead times.

Performance Parameters and Common Tradeoffs

For ease of viewing, the most common performance parameters for RF coax cables are summarized in the table below:

Electrical	Mechanical	Environmental
Frequency range	Outside diameter	Temperature range
Attenuation (max loss)	Flexibility (min. bend radius)	Humidity
Power handling	Flex life	Vibration
RF stability	Weight	Resistance to solvents/UV
Shielding	Dielectric material	Outgassing
Return loss / VSWR	Connector series	Altitude

Impedance is a compromise between power handing and attenuation and changed by varying the ratio of inner & outer conductor sizes. We do not list impedance in the table above because the majority of communications systems are 50Ω, while 75Ω is standard for CATV systems. Mini-Circuits sells both 50Ω 75Ω test cables.

Cable diameter affects many other attributes, which is why it's usually at the top of the list in the selection process. Increasing the outer diameter of a cable can reduce its insertion loss, increase power handling and termination strength. However, wider cable diameter also results in lower maximum frequency rating, increase in minimum bend radius, less flexibility and more weight. Wider cable diameters also limit choice of connector types, which has additional consequences outlined in greater detail below.

Bend radius, flexibility and flex life all depend on cable diameter, so customers with strict requirements for these factors will gravitate toward cables with smaller diameters. This typically means sacrificing power handling and insertion loss performance to some extent.

Rule of thumb:

- The one-time minimum bend radius of a cable is 5x the outside diameter of the cable.
- The minimum re-bendable radius of a cable is 10x the outside diameter.
- There is some variation in this rule depending on the frequency and tolerance for RF degradation after bending.

Application Note | Choosing the Right RF Coaxial Cable Assembly for Your Application| 12/13

Power handling increases with cable diameter. Users with high power requirements may therefore need to sacrifice cable flexibility and high frequency performance. Additionally, smaller connector types and poor return loss that result from low quality connector attachment can reduce power handling. Power handling also degrades at high altitude and high temperature, so users building systems for these operating conditions should ensure the cables they choose have been properly qualified.

Operating frequency range is typically a hard requirement defined by the bandwidth of the system, but frequency determines a number of other factors system designers need to weigh. For example, cable attenuation is a function of frequency: the higher the frequency, the leakier the signal. Better return loss is also more difficult to achieve as frequency increases. Frequency dependent losses can be mitigated by adding shielding; triple shielded cable is often used to achieve similar isolation to that of semi-rigid cables. More shielding typically requires additional outer conductor layers which adds complexity to the production process and cost to the end product.

RF stability depends on several factors, including whether the cable will be subject to regular handling and bending (in the lab) or fixed in placed. Most cables include manufacturer ratings on minimum bend radius and total number of flex cycles before RF performance starts to degrade. Learn more about how bending affects phase stability here. RF stability is also affected by a number of environmental factors such as temperature, which becomes important when cables are used in temperature chambers for high temperature operating life (HTOL) testing, or in assembled systems where extreme temperatures are expected. Mini-Circuits offers cables specially designed for phase stability versus bend and temperature stable cables.

Other environmental factors such as UV protection, resistance to solvents and outgassing are highly specialized requirements for niche applications demanding careful selection of all materials including the cable jacket. For outgassing concerns, the cable construction, the glue used in the heat shrink strain relief, gasket materials and epoxies are all specialized materials. Space applications will also require vented connectors with highly specialized internal designs and attachment processes to prevent voltage breakdown. These are not trivial challenges to overcome and RG cable will almost never suffice.

Passive intermodulation (PIM) are harmonics created by non-linearity in RF connections or devices, which can result in degradation of received signal. Low PIM cable assemblies require cable and connectors built specially to reduce PIM. Historically corrugated cable (not discussed here) offers the best PIM performance but today some braided coax comes close to corrugated.

Conclusion

As we've seen, choosing the right cable for a given application involves a number of complex electrical, mechanical and environmental variables. With a solid foundation on the different types of coaxial cable construction, RF connectors and attachment methods, key performance parameters and common tradeoffs, you'll be better equipped to make a more informed decision.

Mini-Circuits online cable search tool provides a good starting place to narrow down your search by cable type, diameter, connector configuration and other factors. Our off-the-shelf selection includes over 375 models, but we often support customers with custom options including unjacketed cables, special connector requirements and more. If you don't see what you need on our website, contact admin1@mcdi-ltd.com to discuss a solution for your needs.

RF CABLES

RECOMMENDED ACCESSORIES

Recommended Accessories | Torque Wrench

Torque Wrench TRQ-516-08

Mini-Circuits' Precise Break-over Torque Wrench TRQ-516-08 allows for precise mating force and easy use in tight spaces. The head will break over to signal the user when preset torque is achieved. It will effectively prevent over/under tightening.

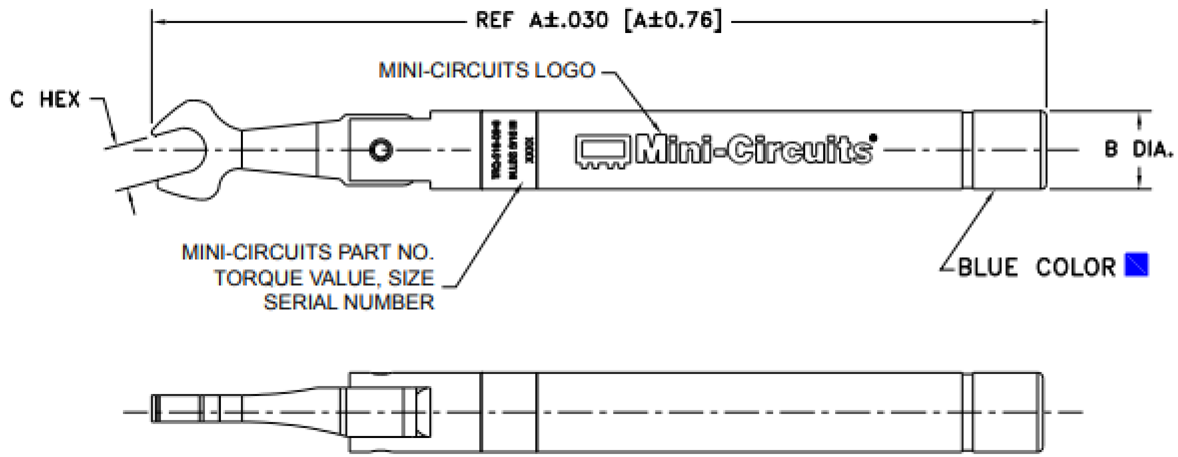
Features:
- Lab quality
- Accuracy
- Precise preset torque
- Prevent over or under tightening
- Light weight, easy to use
- SMA, 3.5mm, 2.92mm, 2.4mm,1.85mm connectors

Performance standards are in compliance with ANSI/NCSL Z540 and ISO 10011

Wrench Torque	8±0.32 inch-lbs (0.9±0.04 NM)
Wrench Size	8.0 mm (5/16 inches)
Wrench Head	Stainless steel
Color	Blue Handle
Handle	Aluminum blue anodized
Length	6.44±.030
Weight	83.05 gms

Performance standards are in compliance with ANSI/NCSL Z540 and ISO 10011

Outline Drawing



TRQ-526-08 Video Demo

[Click for more Information & Datasheet]

Mini-Circuits Exclusive Representative in Israel

Hasharon 6 | Ramat Hasharon | Israel

Web: www.mcdi-ltd.com | Phone: 077-5406075 | Email: admin1@mcdi-ltd.com

For the latest information on Mini-Circuits' Cables, new products, product datasheets, product videos, professional articles and more please visit our website:

www.mcdi-ltd.com/rf-cables/

or speak with our Engineers directly by calling 077-5406075