

Introduction to NKRF (part of NKE Group)

Quality interconnects for demanding applications



AS9100D

CERTIFIED

ISO 9001



NKRF is India's only indigenous **full-spectrum, military and space qualified** RF cable assembly manufacturer



Support for protos, or scale manufacturing at rapid TAT

- **Annual production capacity** of **75K** RF assemblies, 200k+ copper crimps
- Repaired assemblies inside **Embraer** with **<24 hour TAT**



Highest quality, even at the highest complexity

- World-class facility
 - **Dust-free, temperature controlled**
 - **Class 100k** clean room
- Mission critical skill sets
 - **Phase and amplitude matching**
 - Miniaturized assemblies **under a microscope**



Engineering support for complex interconnects

- **DC-40GHz** across a range of connectors and cables
- **Design & engineering support** for complex & mixed harnesses (RF, control, power, fibre)



Repair & solutioning with any cable / connector OEM

- **One-on-one equivalents** for any cable, connector, or assembly
- **100% repair of 40 cable assemblies** with no assembly instructions or spares support



/ NOT EXHAUSTIVE
Battle-tested internationally and in space

- Deployments across **defence, space, medical** and **research**
- ~10 years of space heritage in **European satellites**



Qualified, certified, Indian



Certified by CEMILAC for **fixed-wing and rotary-wing aircrafts**



PAX-300 for **space**

We are **full-stack harnesses mfg.** offering expertise in designing RF and copper harnesses, with a growing presence in **fibre optics**



RF cable assemblies

- **DC to 40 GHz** mfg. in Bangalore, and upto 110 GHz via our partners
- Precision **phase matching - 300 nos of 300mm** phase matched to $\pm 3.5^\circ$, at **18GHz**
- **Proven deliveries** in harsh environments, across land, naval, air, and space



Wire harnesses

- **Complex space and aerospace grade harnesses**
 - Power, Signal/ communication
 - Ethernet (Cat 5/6/7...)
 - USB
- **Experienced** across connectors (including MIL certified)
 - Circular connectors (Series I, II, III)
 - D-sub, Micro-D, Nano-D
 - High power
 - DVI



Fiber Optics

NEW

- **Ruggedized simplex, duplex or quad patch cords** for all applications
 - Air/ Land/ Navy
 - Multi-mode/ single mode
- **Support multiple termini**
 - **MIL-approved:** M29504, ARINC connectors, TFOCA
 - Standard connectors: LC, FC, SC, ST

We support many OEMs...



We support **international principals**, across a range of product groups – **energy, interconnects, microwave components** and more

Honeywell

Passive components for space (e.g., circulators, isolators, switches)



High performance cables from DC to 40Ghz



Passive waveguide components – including filters, circulators and more



Directional couplers, power splitters, hybrids



Radar technology components (e.g., transmitter, converters, LNAs)



Small cell lithium-ion battery technology



RF & Microwave Filters



RF - Connectors, Adaptors, Cable & Assemblies
Wire Harness Assemblies, Moulded Wire Harness
Tactical Fiber Optic Cable Assemblies, Flexible Circuit Assemblies

JYEBAO

High frequency cable interconnects for various applications



RF and Microwave filters, multi-function assemblies

We directly serve the **5 largest Indian defense and space PSUs, and 70%+ of defense & space labs** along side many private partners

We serve a variety of government entities, **pan India**

Defence PSUs



Defence labs & services



11/ 14 labs

LRDE
CASDIC
CABS
DLRL
DRDL
ASL



ADA
ADE
RCI
NSTL
DEAL

Ministry of Space



10/15 units



We have a healthy book of **domestic** and **international** private customers



Astra Microwave Products Limited



IIT Madras



BITS Pilani



APPENDIX

NKRF is a **full-spectrum, military and space qualified** state of the art RF lab with **in-situ repair capabilities**

/ NOT EXHAUSTIVE

Our unit is **qualified for space and defence use** supporting a wide array of **cable and connector types from DC to 40GHz**

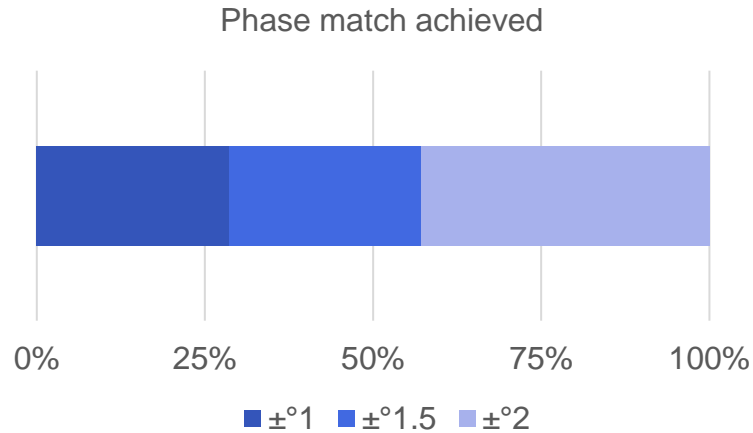
- **Annual production capacity of 75K** high frequency cable assemblies with **space and MIL qualified team**
 - Certified by respective **Indian governmental authorities**
- We provide **full spectrum coverage** from DC to Ka band (40 GHz) – **vendor agnostic**, and specializing in manufacturing **phase matched, amplitude matched, low loss cable assemblies**
 - Spanning semi-rigid, handformable, flex and ruggedized cables
 - Radiation hardened (Tefzel), Nomex, Aramid and zero halogen jackets
 - Right-angle, reverse polarity, multi-port, hermetically sealed connectors
 - Phase & amplitude matching capabilities
- Our phase matching capability spans both **volume and precision**
 - **300 cables** – in a set, **DC to 18GHz**, phase matched to **±3.5° of length 300mm**
 - **70 cables** – in a set, **DC to 40GHz**, phase matched to **±2° of length 300mm**
- Our cables have been successfully **flown** on **military aircrafts**, and even on **European satellites!**

We excel at services including **in-situ repair – even when we weren't the OEM!**

- Our **trained personnel** has **experience** in producing & repairing cable assemblies both on-site and in our manufacturing unit for a variety of use cases
 - Supported multiple clients with **rapid TAT** for **FIM** (“Free issue of material”) requirements
 - Performed in-situ repair of cable assemblies on **Embraer aircraft** with **<24 hour TAT**
 - **100% repair of 40 cable assemblies within <72 hours** supplied by a competitor OEM, with no assembly instructions or spares support
 - Offsite repair of **phase matched cable assemblies** within 1.25 VSWR, with replacement of damaged cables

We consistently outperform for our clients (1/2): We are trailblazers in phase matching at high frequency, as well as space applications

Very high frequency phase match (DC to 40 GHz) for ultra large batch



- **Within 1 week**, our engineers delivered **70 cables** internally phase-matched within **2°** vs. **client requirement of 3°** for DefenceCo
- Despite limited margin for error, **~95%** of our cable assemblies met **VSWR of 1.30:1** vs need of 1.40:1!

Space grade cable assemblies (DC to 8 GHz) assembled in class 100K clean room

Photos obscured to maintain client confidentiality, but can be shared during live presentation

- SpaceCo wanted **130 cable assemblies** with low loss despite varying physical contortions for each cable
- Leveraging our **world-class clean room**, (built to support scale space applications) – our engineers delivered **~95%** cable assemblies within **1.25 VSWR**

We consistently outperform for our clients (2/2): Our experience extends to building composite systems including mechanical housing



Design

- NKRF asked to build **MIL qualified component** for **fighter platform**
- Final design approved post **multiple iterations** – including for **external mechanical housing** (32 port adapter box)
 - **Adaptor box** built to interface to rear antenna using **long length** phase matched cable assemblies; and butt mated to front antenna
 - **Connectors redesigned** to match external system
 - **BMA connector with lock facility** approved



Build

- Adapter box **precision engineered** to spec, to support phase matched cables assemblies from **DC to 18 GHz**
- **90%+** of cable assemblies phase matched to **within $\pm 4^\circ$** , ready for delivery in **5 days**



Test

- Composite system sent for extensive QA and **approved by appropriate Indian military qualification bodies**
- **NKRF-designed** system passed **ESS** (environmental stress screening)
 - Vibration testing
 - Thermal shock
 - Thermal cycling
- System additionally cleared **SOFT** (safety of flight test)
- **Qualification testing** expected to be complete by **Feb 2025** with support of DRDO lab

We are not just a manufacturer, but a **design partner** in solving our client's most challenging problems

/ NOT EXHAUSTIVE

Situation & complication



Co-engineering makeshift adaptor to reduce delay in system launch

- DefenceCo designed a system to operate across **DC to 18GHz**, however the **adaptor** component factored into the design operated only from **DC to 11 GHz**
- Design error was caught during testing – any change to the design would lead to a **significant delay in timelines**

Redesign of flexible cables to ensure continued operations

- DefenceCo was using short length cables from an **overseas vendor for a high power application**
- Their design required the cable to be **formed into shape** to fit the housing parameters, with sharp bending leading to **high VSWR** (high power reflection)

Rapid prototyping of complex cable assembly

- DefenceCo was importing a **Y cable** multifunction assembly for their radar application, and had **indigenized a portion of the design**
- However, based on vendor feedback they were anticipating **risk of no supply** – and **without** any agreed upon **transfer of design or technology**

Solution



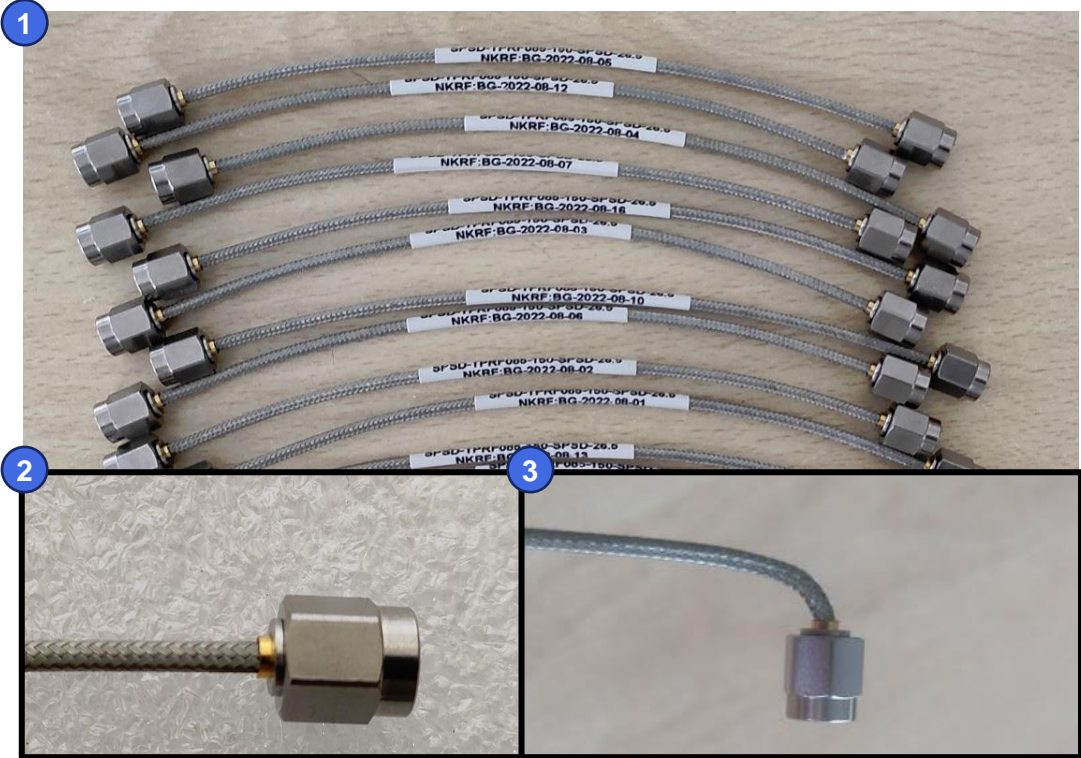
- NKRF design engineering team realized that system allowed a **flexibility of ~70mm length** for the **adaptor sub-system**
- Team was able to design a **makeshift right angle phase matched adaptor set** with connectors and a **65mm length of cable**
- Despite the extremely small length of cable, (and resultant **difficulty of phase match**) – production team was able to meet specs and **crash delay from 12+ months to <2 weeks**

- Using a **preformed cable template**, and products from our OEMs we were able to test & iterate on a design which met the VSWR specifications
- Additionally, we were able to add **design modifications** (such as heatsinks) to ensure high **power operation at altitude of 75,000 feet**

- **NKRF design & engineering team** worked closely with DefenceCo engineers to design a **workable solution from scratch**
- Through **iterative prototyping** – a solution was found in **<4 weeks**, and is awaiting testing and qualification

Executed projects: Precision assemblies including mini-bend connectors for space, and micro-SMP (SMPM) assemblies

Mini-bend SMA connectors manufactured for European space and medical industries



Connectors able to bend at cable/ connector joint without any impact on performance

SMPM contacts – right angle, straight and size 16 coax for D38999 assemblies



Assembled leveraging specialized equipment by skilled technicians

Executed projects: Multiport and semi-rigid cable assemblies

Multiport RF cable assembly with Mini-SMP & SMA Connectors (DC-18GHz)

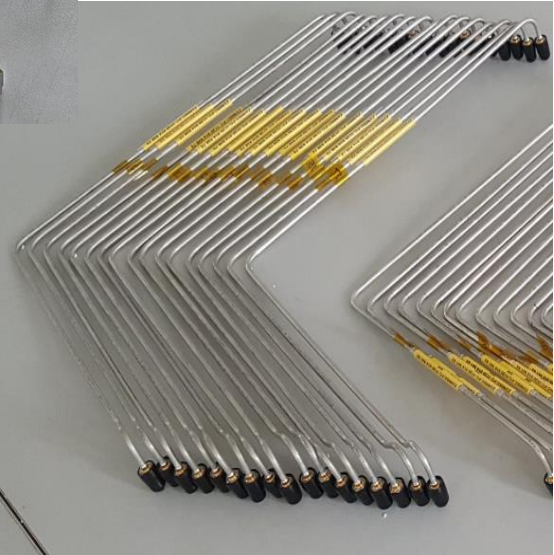


Varying batch size in each D38999
Achieved phase matching despite low tolerances!

Semi-rigid cable assembly with different types of bends



Achieved VSWR of 1.2 despite bend



Executed projects: Large batch of phase matched cables, and multi-branch harnesses for harsh environments

Set of 70 phase matched RF cable assemblies @40GHz



Achieved ± 3 degree phase match across the full set of 70 cables

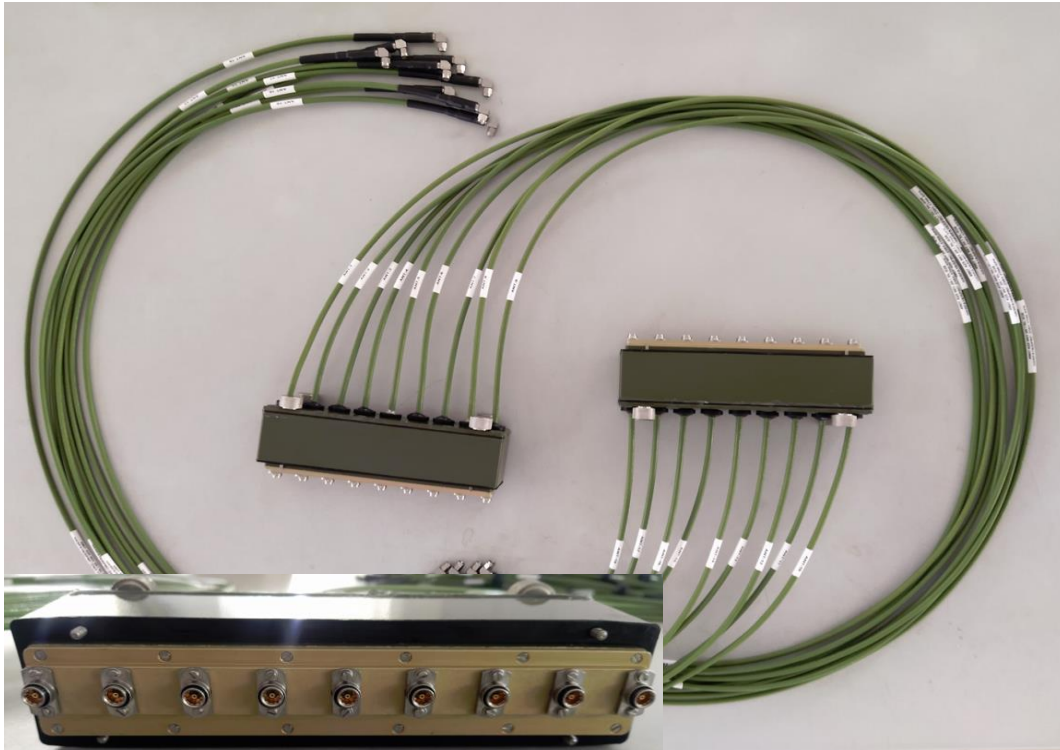
Multi-branch harnesses shielded for harsh environments



Cable complied to EMI/ EMC MIL-STD 461F

Executed projects: Phase matching including adaptors, and short length assemblies (upto ~60mm)

Phase matched assemblies $\pm 1^\circ$ @ 3.3GHz



Phase matched including adaptors inside the box

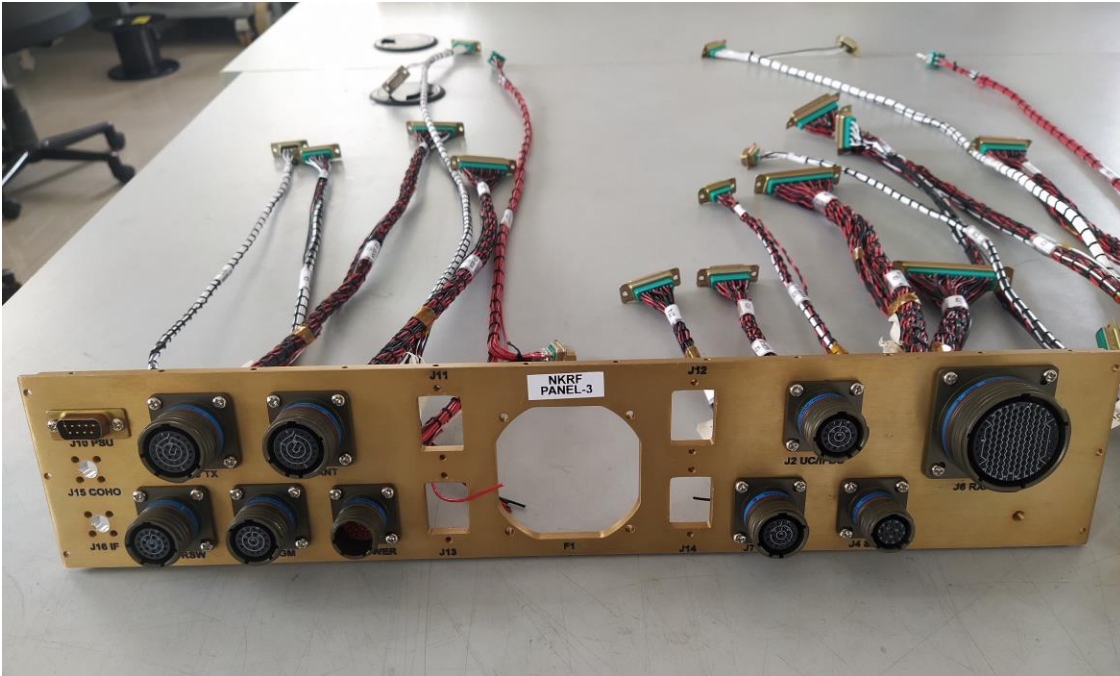
Short length (60mm) high & low power cable assemblies upto 18GHz



Delivered with heatsinks designed in-house!

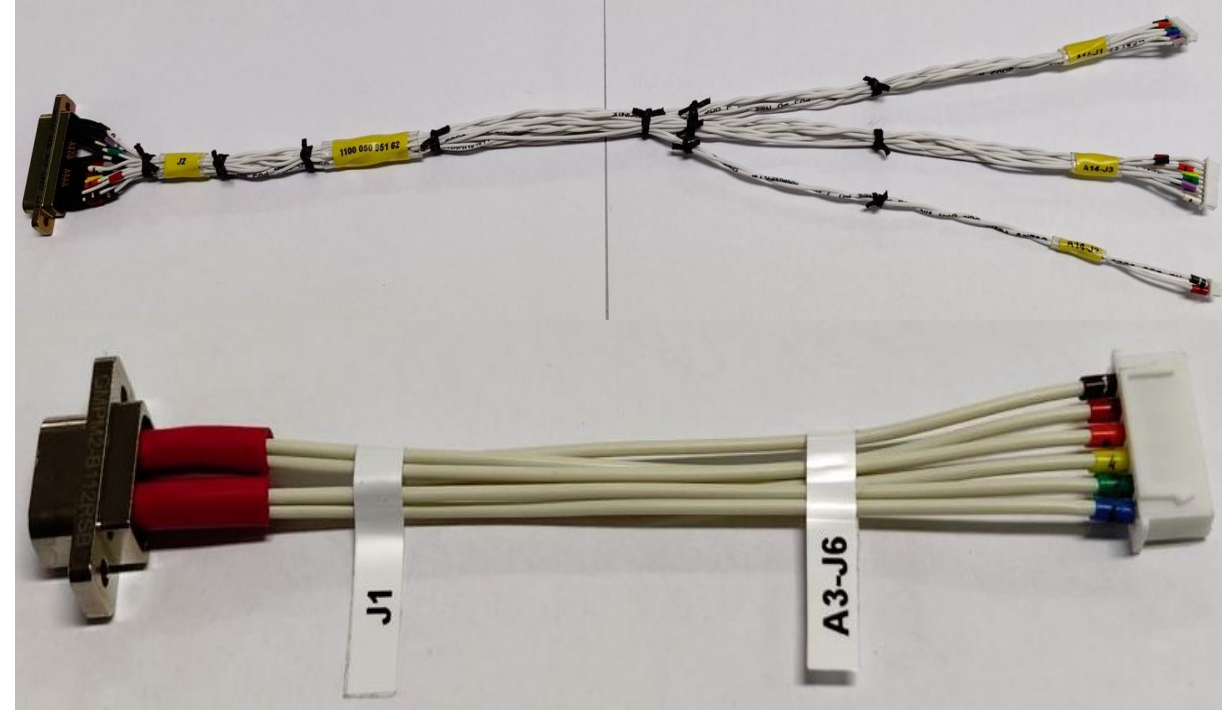
Executed projects: Panel wiring with circular connectors and micro-D harnessing

Panel harnessing circular connector to D-sub connectors



Power/ signal lines within LRUs for air applications

Micro-D harnessing inside LRUs



Harnessing within active components for power & signal

Executed projects: Fibre optical assemblies and engineering

ARINC connector to 6 LC connectors for land application



Supporting PC and Angular PC grade optical connections

Indigenously engineered U-cable for a ground radar



Multiport RF cable assembly engineered to retain U-shape for ease of installation

