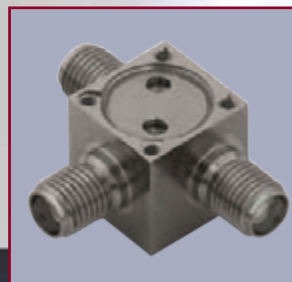


COAXIAL ISOLATORS & CIRCULATORS



Since the first flight model was delivered to a satellite manufacturer in 1993 TRAK Microwave Ltd. has delivered over 140,000 flight models to 30 customers based in 15 countries.

Over the past 2 decades TRAK's ferrite isolators and circulators have been integrated into more than 400 payloads and have amassed an estimated 5 billion hours of operation aboard earth orbiting platforms and interplanetary probes.

Low Power Coaxial Isolators & Circulators

TRAK has delivered over 40,000 coaxial isolators and circulators operating in assigned bands from 400 MHz to 25GHz with most FMs built using the TRAK compact structure, the most recent version of which features fully integrated RF interconnects and contain TRAK's patented glitch free, internal grounding structure. In combination the latest incarnation provides the ultimate in terms of robustness, electrical stability and EMC performance. These solid isolators and circulators are available in wide frequency range. Device size is dependant on operating frequency and electrical specification. All isolators and circulators are designed to meet the operating conditions (frequency, bandwidth, temperature and RF power) specified by the customer with options including finish, connector position, length and orientation dictated by the application.



Features

- Patented internal grounding structure
 - Glitch free by design
- Stainless steel housing with fully integrated RF connectors
 - Ultra low magnetic moment
 - Gold plating is available as an optional finish
- A wide variety of coaxial connectors such as SMA, TNC or SMP
 - Note that connector choice is power and frequency dependant
- A wide variety of coaxial male pin or female socket interfaces
- Extended barrel lengths
- Isolator termination options include
 - 50Ω resistive 3W terminations as standard
 - >10MΩ absorptive elements, 1W terminations by request
 - ZerΩ [resistive 1W terminations with DC short to ground] by request

TRAK has existing coaxial designs for most assigned frequency bands.

The following table illustrates the more common with typical performances over a 100°C operating temperature range.

Operating Band [GHz]	Insertion Loss [dB max]	Return Loss [dB max]	Isolation Loss [dB min]	Body Size Excluding Connectors
1.00 to 1.20	0.30	21	21	25.4 x 25.4 x 13 mm
1.20 to 1.30	0.30	21	21	25.4 x 25.4 x 13 mm
1.20 to 1.40	0.30	21	21	25.4 x 25.4 x 13 mm
1.50 to 1.70	0.30	21	21	25.4 x 25.4 x 13 mm
2.00 to 2.20	0.30	21	21	25.4 x 25.4 x 13 mm
2.00 to 4.00	0.30	21	21	25.4 x 25.4 x 13 mm
2.10 to 2.30	0.30	21	21	25.4 x 25.4 x 13 mm
2.20 to 2.40	0.30	21	21	25.4 x 25.4 x 13 mm
2.40 to 2.60	0.30	23	23	25.4 x 25.4 x 13 mm
2.70 to 3.10	0.30	21	21	19.0 x 19.0 x 13 mm
3.20 to 4.20	0.40	19	19	19.0 x 19.0 x 13 mm
3.40 to 3.70	0.30	21	21	19.0 x 19.0 x 13 mm
3.70 to 4.20	0.35	20	20	19.0 x 19.0 x 13 mm
4.00 to 6.00	0.40	20	20	13.0 x 13.0 x 13 mm
4.00 to 8.00	0.40	19	19	13.0 x 13.0 x 13 mm
4.40 to 4.90	0.30	23	23	13.0 x 13.0 x 13 mm
5.20 to 5.90	0.30	21	21	13.0 x 13.0 x 13 mm

Operating Band [GHz]	Insertion Loss [dB max]	Return Loss [dB max]	Isolation Loss [dB min]	Body Size Excluding Connectors
5.70 to 7.10	0.40	20	20	13.0 x 13.0 x 13 mm
6.50 to 18.0	0.60	16	16	13.0 x 13.0 x 13 mm
8.00 to 10.0	0.30	21	21	13.0 x 13.0 x 13 mm
8.00 to 12.0	0.40	19	19	13.0 x 13.0 x 13 mm
8.00 to 16.0	0.50	17	17	13.0 x 13.0 x 13 mm
8.00 to 18.0	0.50	16	16	13.0 x 13.0 x 13 mm
10.7 to 12.8	0.30	23	23	13.0 x 13.0 x 13 mm
12.7 to 14.5	0.30	23	23	13.0 x 13.0 x 13 mm
17.3 to 18.1	0.30	23	23	13.0 x 13.0 x 13 mm
18.0 to 20.0	0.30	23	23	13.0 x 13.0 x 13 mm
18.0 to 20.5	0.30	23	23	13.0 x 13.0 x 13 mm
18.0 to 22.0	0.40	20	20	13.0 x 13.0 x 13 mm
18.3 to 20.5	0.30	23	23	13.0 x 13.0 x 13 mm
20.0 to 21.0	0.30	23	23	13.0 x 13.0 x 13 mm
20.5 to 21.5	0.30	23	23	13.0 x 13.0 x 13 mm
21.0 to 22.5	0.30	23	23	13.0 x 13.0 x 13 mm
23.0 to 25.0	0.40	20	20	13.0 x 13.0 x 13 mm

Qualification Status

TRAK successfully completed a comprehensive qualification in 2014 on the 13.0 x 13.0 x 13 mm and 19.0 x 19.0 x 13 mm housings. A copy of this document is available on request in printed or digital format.

High Power Coaxial Isolators & Circulators

TRAK has a particular expertise in high power isolators and circulators for SSPA and TRM applications. Experience and heritage is focused in L, S & C communication and GNSS bands with RF powers up to 117W CW currently in orbit and designs offered at 140W. Ferrite isolators and circulators are optimized for thermal efficiency, low insertion loss and feature combinations of solid TNC (male or females), tabs and sockets.

TRAK uses unique design techniques to manage the thermal dissipation in the device and termination.

Examples of high power devices are included in the following table for devices featuring at least one TNC port.



Operating Band [GHz]	Insertion Loss [dB max]	TNC Port Return Loss [dB max]	Isolation Loss [dB min]	Forward / Reverse Power [W CW]	Comment
1.1 to 1.2	0.15	21	21	105	Isolator & Circulator
1.2 to 1.3	0.15	21	21	105	Isolator & Circulator
1.4 to 1.5	0.15	21	21	105	Isolator
1.25 to 1.35	0.15	21	21	105	Circulator
1.5 to 1.6	0.15	21	21	117	Isolator
2.0 to 2.1	0.15	21	21	117	Isolator & Circulator
2.1 to 2.2	0.15	21	21	117	Isolator & Circulator
2.4 to 2.5	0.15	21	21	80	Isolator
3.7 to 4.2	0.15	21	21	100	Isolator
4.2 to 4.8	0.15	21	21	100	Isolator

Capability

TRAK's comprehensive product portfolio means there is a wide range of qualified product solutions available. However, TRAK believes its customers deserve the most electrically & mechanically optimized product practically possible. Based on the solid junction as a core starting point customers may specify any combination of RF connector including barrel length, load, mounting arrangement and finish.

Flight design, manufacture, test & screening are undertaken using TRAK's comprehensively equipped product development & manufacturing test facility. Screening is undertaken using customer defined flows or TRAK suggested adapted flows designed to reflect the intended environment and mission requirements.

Screening & Lot test flows will typically include:

- Hi, Lo & ambient electrical test
- Continuous IL monitoring
- Random vibration
- Thermal cycling & burn-in
- X-ray and Optical inspection
- Mechanical shock
- Sine vibration
- Thermal shock
- RF Burn-in
- TVAC conditioning & RF test

TRAK is equipped to support the customer prior to the sale using a suite of design and analysis tools. Designs are undertaken in close co-operation between TRAK's and the end user's RF & Mechanical team. Typically shared information includes 3D models, finite element analysis, and other thermal and mechanical data.

Heritage

TRAK coaxial isolators and circulators have been used on most equipment commonly used aboard spacecraft including:

- SSPAs
- TR Modules
- Beam forming networks
- IMUXes
- LNAs & Converters
- Transitions from guide to coax

TRAK has supplied a broad range of waveguide passive components and sub-assemblies for space applications. Listing each LEO communications, EOS, MEO communications, GEO FSS & GNSS payloads would require several pages. This detailed information is available and will be supplied to existing and prospective customers. However, the following table includes a short selection of scientific missions and interplanetary probes that TRAK products have been integrated into.

Program	Launch Date	Program	Launch Date	Program	Launch Date
CASSINI (Saturn)	1994	VENUS EXPRESS	2005	JUNO (Jupiter)	2011
SOHO (Sun)	1995	GIOVE A	2005	METOP B	2012
ERS 2	1995	ALOS-1	2006	GAIA	2013
CLUSTER 2 (Sun)	1996	SOLAR-B (HINODE)	2006	PROBA V	2013
NEAR (Asteroid)	1996	METOP A	2006	SWARM	2013
MARS PATHFINDER (Mars)	1996	COROT	2006	SPRINT-A (HISAKI)	2013
HUYGENS (Titan)	1997	SELENE (KAGUYA) (Moon)	2007	SENTINEL 1a	2014
ARD	1998	GIOVE B	2008	EARTHCARE	2014
XMM NEWTON	1999	CHANDRAYAAN-1 (Moon)	2008	ALOS-2 (DAICHI)	2014
ARTEMIS	2001	PROBA 2	2009	LISA PATHFINDER	2014
PROBA 1	2001	SMOS	2009	GALILEO	2014
INTEGRAL	2002	GOCE	2009	ADM AEOLUS	2015
ENVISAT	2002	HERSCHEL & PLANCK	2009	BEPI COLOMBO (Mercury)	2015
SMART 1	2003	GOSAT (IBUKI)	2009	ASTRO-H	2015
MUSES-B (HAYABUSA) (Comet)	2003	CRYOSAT 2	2010	EXOMARS (Mars)	2016
ROSETTA (Comet)	2004	PLANET-C (AKATSUK)	2010	SOLAR ORBITER (Sun)	2017

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