The TCI Model 723 is a compact, high-performance radio direction finder that can be easily integrated into interference-detection systems for radio-band protection applications. Cost-effective Model 723 systems can be used individually or networked together to identify the LOB or source location of interfering RF transmissions.

The 723 exclusively offers users a multi-channel architecture to provide fast and accurate signal measurements for critical safety-related applications. The system consists of the TCI Spectrum Processor, a computer/monitor, TCI’s SCORPIO client-server software and a choice of direction-finding (DF) antennas. The high-accuracy DF performance of the Model 723 is obtained by the 4095 spectrum processor through simultaneous DSP analysis of wideband receivers connected to an external, multi-element DF antenna array.

Each channel is composed of a fully synthesized, high-dynamic-range receiver, high-speed digitizer, and custom digital signal processor. The digital processing allows selection of measurement bandwidths including 6.25 kHz, 8.33 kHz, 12.5 kHz and 25 kHz. This wide bandwidth selection allows the system to be tailored to current and future channel-spacing requirements and lets it simultaneously measure and analyze multiple frequency band channels. All spectrum-processor functions are controlled by a dual-core-based CPU and contained within a single, compact VME-based 4U, 19-inch, rack-mount unit, which makes the 723 ideal for safety applications.

The 723 is designed for applications such as aeronautical radio-band monitoring, including detection of interference from other radio services and unauthorized usage.

It can serve in a border-protection role for Homeland Security, and perform ITU-recommended signal measurements for verification of compliance with license specifications. It also can be integrated easily into aeronautical traffic-management systems for automated and simultaneous monitoring of multiple frequency bands, which could include:

- Aeronautical band
- International radio distress frequency: 121.5 MHz
- Military distress frequency: 243.0 MHz
Automatically locate interference sources on RF transmissions.

**KEY FEATURES**

- Field-proven spectrum monitoring and geolocation solutions used by over 50 regulatory authorities worldwide.
- Automated channel monitoring and interference detection with alarm capability.
- Simultaneous radio direction finding (RDF) on multiple user-defined frequency channels.
- Exceptional direction-finding speed and measurement accuracy.
- 20 to 3,000 MHz coverage with the TCI Model 641 antenna.
- Optional HF monitoring coverage of 9 kHz to 30 MHz and DF coverage from 2 to 30 MHz.
- Instantaneous Bandwidth of 4 MHz.
- Client-server architecture with full networking capability over TCP/IP.
- SCORPIO client software for local or networked setup, control and display.
- Selectable measurement bandwidths include 6.25 kHz, 8.33 kHz, 12.5 kHz and 25 kHz.
- Compact antenna and spectrum processor units, suitable for mobile or transportable applications.
- Built-in self-test and calibration with alarm.
- Meets or exceeds ITU recommendations.
- Interoperable with all TCI 700 series spectrum monitoring systems.
Intercept and Location of RF Signals

TCI’s SCORPIO client is a powerful, real-time software application that monitors and locates the position of RF transmissions. SCORPIO automatically detects changes in signal activity, provides alarm notifications, records and replays measurement results and provides location information in the form of a Line of Bearing (LOB). It can be used to identify and locate interference signals, unauthorized transmitters, or emergency transmissions.

The SCORPIO client provides an operator with a complete interface and all control functions necessary to set up direction-finding (DF) measurements and receive, display and analyze DF results in real time or for post-processing. Windows®-based SCORPIO client software has a graphical user interface that operates over a TCP/IP network in true client-server architecture. The SCORPIO client provides all signal measurements and DF for spectrum monitoring recommended by the International Telecommunications Union (ITU).

Lower Life-Cycle Cost

TCI’s more than 40 years of experience in designing, installing, and maintaining spectrum-monitoring equipment makes the 723 a true best-value solution that offers the highest performance and reliability. TCI is a certified ISO 9001:2000 company that builds, tests and calibrates all its systems in accordance with all applicable ITU recommendations.

The 723 is field-repairable and self-calibrating, and does not require field or factory calibration after repair or extended use. Like all TCI 700 series systems, its Built-In Self Test (BIST) capabilities and self-calibrating antenna technology reduce maintenance costs and achieve the lowest lifecycle ownership cost.

Digital System Calibration and Correction Factors

The TCI receiving system automatically self-calibrates at regular intervals. The monitoring subsystem includes a full set of integrated calibration modules and software to characterize signal losses from the DF Switch to the Spectrum Processor. Receiver passbands are calibrated on system startup. The software automatically incorporates correction factors to include the effects of losses and gains within the RF signal paths.

The amplitude and phase of measured antenna voltages in any DF system must be representative of the characteristics of the target signal, and not corrupted by mismatch in system components. Traditional DF systems use factory-matched components and require difficult alignment procedures to maintain system performance within specifications. TCI has developed a digital calibration technique that is performed automatically each time the system is turned on. During calibration, the system measures the amplitude and phase characteristics of each channel across the operating passband and saves these correction coefficients in memory. In normal DF operation, the raw measurements from each receiver are automatically corrected by these coefficients, resulting in a near-perfect match between channels. This digital calibration technique results in overall instrument accuracy of 0.1° RMS for the TCI DF systems.
Continuous Monitoring of High-Priority Channels

SCORPIO software lets the operator define High-Priority channels to monitor for emergency transmissions or unauthorized use. If any signal activity is detected on any of the High-Priority Channels, the software can automatically alert the operator on the screen and issue a remote alarm.

Automated Spectrum Monitoring for Unattended Operation

SCORPIO software was designed for unattended operation. If more than one monitoring/DF station measures a signal, the system automatically calculates the fix and displays the results on the operator workstation map display in real-time.

Interference Detection and Alarm

SCORPIO software lets the operator specify a protected area of the frequency spectrum (e.g. the aeronautical band), and define a mask of the spectrum. Typically the mask represents the existing signals plus 5 or 10 dB, and appears as a red line in the display. The mask can also be defined by a list of known transmitters imported into the system. Once the operator enables the alarm, the software monitors signal activity in the protected area continuously, and alerts the operator when a new signal breaks through the established mask, or when direction is detected in a channel that is not supposed to have any transmitter. The system then will:

- Issue visual and audible alarms to the local operator workstation.
- Send an alarm message to a pre-established mobile cellular phone number, in SMS format.
- Include in the alarm message the identification of the monitoring station, the date and time of the occurrence, the center frequency of the detected signal, and the measured azimuth line of bearing (LOB).
- Start recording to disk the raw, I/Q vector data of the detected signal as well as the demodulated audio of the signal.

After the occurrence, the operator can retrieve and play back any portion of the recorded spectrum corresponding to the time of the reported interference.

Digital Map Display

SCORPIO software includes a Geographic Information Package (GIS), which supports digital maps in the ESRI ArcView Shapefile format, using the WGS84 or UTM projections. In addition, the GIS accepts Bing Maps and Open Street Maps.

Information Management

SCORPIO displays are configured for real-time monitoring, but the software also provides administrative screens to display continuous activity status information. In addition, all real-time information is logged to disk and the operator or administrator can then query, filter, sort, export or print the stored data or generate statistical reports after the fact, at the end of the day or the end of the shift.
Single Station or Networked Operation

SCORPIO can operate in various configurations ranging from a single site, mobile or fixed, to a nationwide network with multiple operators tasking multiple fixed and/or mobile systems. All functions of the DF equipment can be controlled either locally at a monitoring/DF station, or remotely from the DF operator workstation located at a control center. DF operators can perform the following functions from any SCORPIO workstation:

- Fully control all DF stations assigned to the operator.
- Continuously monitor signal activity, Lines of Bearing, and all operator-assigned channels, including High-Priority channels with alarms.
- The Fix Triangulation screen allows the operator to manually enter DF results measured from an external station. The results include: latitude and longitude of the external DF station and measured azimuth angle. These manual DF results will be used in triangulation computation of the fix.
- All DF measurements are automatically stored in a local database on the operator's computer.
- The operator can review and play back DF results stored on his computer.
- Built-In Self Test (BIST) triggers an alarm when equipment failure is detected.
TCI 641 Antenna

This special-purpose receiving antenna is designed specifically to support signal detection, RDF applications and ITU Measurements. To provide good DF accuracy and sensitivity over a wide frequency range in a compact package, the 641 combines specially designed DF elements into an array that is electronically commutated by solid-state switching circuits for DF measurements. The 641’s built-in self-test equipment (BIST) automatically tests and verifies its operational status, and the antenna supports calibrated signal amplitude measurements over the full frequency range. The 641 houses its nine fan dipole elements and biconical reference antenna in a protective radome, along with a broadband RF switch/calibration unit. The antenna dome includes a lightning rod with static dissipator.

High-dynamic-range components in the 641’s RF switching and pre-amplification circuits provide a mid-band gain of 6 dB, typical noise figure of 8 dB, a +40 dBm 3rd-order and +60 dBm 2nd-order output intercept. This means the antenna can tolerate reasonably strong signals, without compromising sensitivity when measuring weak signals. In extreme cases, in the presence of strong local interference from radar or other high-power transmitters, appropriate protective filters can be inserted in front of the pre-amplifiers.

The TCI 641 is built, tested and calibrated in accordance with applicable ITU recommendations, and the corresponding antenna factors are stored in processor memory and automatically applied to signal measurements in real time.

Note: * Field strength required for 10 dB SNR @ receiver output when 641 is installed in a typical SMS system, including typical coax cable losses and receiver noise figure; referenced to 1 Hz bandwidth.

▲ SCORPIO displays DF results in real-time or from stored data for selected channels.

▲ TCI Model 641 Fixed Antenna
# Model 723 Specifications

## Direction Finding

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DF Accuracy</strong></td>
<td>0.1° RMS (Instrument accuracy)</td>
</tr>
<tr>
<td></td>
<td>2° RMS typical</td>
</tr>
<tr>
<td></td>
<td>1° RMS in scatter free environment</td>
</tr>
<tr>
<td><strong>DF Resolution</strong></td>
<td>0.1°</td>
</tr>
</tbody>
</table>

## DF System Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency range</strong></td>
<td>20 to 3,000 MHz</td>
</tr>
<tr>
<td><strong>Azimuth Coverage</strong></td>
<td>360</td>
</tr>
<tr>
<td><strong>Antenna Polarization</strong></td>
<td>Vertical</td>
</tr>
<tr>
<td><strong>Channel bandwidths</strong></td>
<td>Selectable, including 6.25 kHz, 8.33 kHz, 12.5 kHz and 25 kHz</td>
</tr>
<tr>
<td><strong>DF technique</strong></td>
<td>Multi-channel, multi-element, TCI-proprietary Correlative Interferometry DF algorithm</td>
</tr>
<tr>
<td><strong>DF receiver</strong></td>
<td>Two-Channel DF Receiver</td>
</tr>
<tr>
<td><strong>Modulations mode for DF</strong></td>
<td>All signal modulations</td>
</tr>
<tr>
<td><strong>DF measurements:</strong></td>
<td>Line of bearing (single station) Triangulation Fix with multiple stations on the network. Triangulation with manual entry of external bearings.</td>
</tr>
<tr>
<td><strong>DF results</strong></td>
<td>2D diagram of RF level versus frequency (pan display) Polar plot Azimuth Histogram.</td>
</tr>
</tbody>
</table>

## Map Display:
- Presentation of results on a digital map with the following information:
  - Locations of Monitoring Stations
  - Lines of Bearing of measured azimuth from each station
  - Triangulation result with location ellipse

## Three Dimensional Displays:
- Level vs. Frequency vs. Time
- Azimuth vs. Frequency vs. Time

## GPS Time and Frequency Standard

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GPS receiver type</strong></td>
<td>12 channel L1 with time and location data output</td>
</tr>
<tr>
<td><strong>Timing output</strong></td>
<td>1 PPS with ± 0.2 µs accuracy relative to UTC</td>
</tr>
<tr>
<td><strong>Position determination</strong></td>
<td>Latitude, longitude and altitude. Error &lt; 10 meters.</td>
</tr>
<tr>
<td><strong>Position update rate</strong></td>
<td>Once per second</td>
</tr>
<tr>
<td><strong>Frequency standard</strong></td>
<td>10 MHz, low-noise, digitally controlled crystal oscillator, disciplined to GPS</td>
</tr>
<tr>
<td><strong>Frequency and time reference</strong></td>
<td>5 x 10⁻¹⁰</td>
</tr>
</tbody>
</table>

## Processor Physical Characteristics

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimensions</strong></td>
<td>4U high, 19” rack mount (7H x 19W x 22D inches)</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>20 kg</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>250W</td>
</tr>
<tr>
<td><strong>AC Voltage</strong></td>
<td>110/120/230 V, 50-60 Hz</td>
</tr>
</tbody>
</table>

**OPTIONS**: Please consult the factory for option configurations and datasheets.
Specialized Expertise in a Global Family

TCI International, Inc., a leading supplier of end-to-end, ITU-compliant RF spectrum monitoring and management products, is a wholly-owned subsidiary of SPX Corporation. Based in Charlotte, North Carolina, SPX Corporation (NYSE: SPXC) is a global, multi-industry manufacturing leader. SPX team members collaborate across business segments and borders to deliver greater efficiencies and better ideas for helping customers succeed.

At TCI, this commitment to innovation supports an array of customers whose missions depend on having a clear picture of their electromagnetic environment. For over 45 years, TCI’s technical developments and advanced production capabilities have earned it a reputation for excellence in high-performance communications, spectrum monitoring and signals intelligence systems.

TCI’s diverse hardware and software engineering capabilities provide proven solutions for regulatory compliance, monitoring and security, and communications intelligence applications. With advanced spectrum mapping and analytics, data recording and precision geolocation technology, TCI systems provide vital data for government and military agencies in over 100 countries worldwide.