InP HBT Foundry Services

Teledyne Scientific is pleased to offer Foundry access to our high-performance 250 nm InP HBT process, a proven technology for state-of-the-art mmWave and high-speed mixed-signal integrated circuits. The technology has been developed over the past decade through DoD and internal investments and has a proven track record with internal and external circuit designers. Design services and consultation into the technology are offered through Teledyne’s MMIC and mixed-signal design teams.

Technology attributes include:

- Outstanding transistor RF figures-of-merit:
  \[ f_t > 350 \text{ GHz}, \quad f_{\text{max}} > 600 \text{ GHz} \]
- High-power handling and large safe-operating area
  \[ BV_{\text{CEO}} > 4 \text{ V}, \quad P_{\text{DC,max}} > 10 \text{ mW/\mu m}^2 \]
- Four-levels of thin-film interconnects capable of LSI-levels of integration
- Proven Keysight ADS and Cadence design kits with accurate device models
- Supports dedicated and multi-project wafer Foundry runs

Circuit demonstrations:

- mmWave and sub-mmWave transceiver components operating to > 300 GHz
- High-efficiency and wide bandwidth mmWave power amplifiers operating from Q-band (40 GHz) to > G-band (220 GHz)
- High dynamic range microwave digital-to-analog converters
- High bandwidth (50 GHz) track-and-hold circuits

Contact: 805-373-4483
Pamela.flores@teledyne.com
Semiconductor Fabrication Services

Teledyne Scientific & Imaging Fabrication Services combines uniquely multidisciplinary and flexible processing capabilities with process control discipline to enable a path from development to production in a wide range of technologies. Our Fabrication Services have a proven track record of delivering record device performances and working with customers to take their technologies from R&D to production.

Our comprehensive fabrication service capabilities include:
- CAD layout
- MBE growth of arsenide and antimonide semiconductor materials
- E-beam lithography for T-gates, gratings, lenses
  JEOL6000FS/E, resolution ≥ 20nm
- Photolithography
  ASML 5500/300 (UV-248nm) stepper, ≥ 0.20 um resolution
  ASML 5500/60 (i-line) stepper, ≥ 0.40 um resolution
  GCA 8500 (i-line) stepper, ≥ 0.60 um resolution
  Karl Suss MA6 contact aligner, ≥ 1 um resolution
- Dielectric deposition
  PECVD nitride, oxide
  Sputtered nitride
  LPCVD nitride, wet/dry oxide
  ALD Al2O3
  Spun-on BCB
- Metal deposition
  Evaporated metals: Ag, Al, Au, Cr, In, Mo, Ni, NiCr, Pd, Pt, Si, Ti
  Sputtered metals: Al, Au, Cr, Mo, Ni, Pt, Si, TaN, Ti, W
  Plated thick Au

Contact: 805-373-4483
pamela.flores@teledyne.com
SEMICONDUCTOR FABRICATION SERVICES

- **Dry Etch**
  8 RIE, 6 ICP, and 5 resist ashers with established processes for etching dielectrics, semiconductors, deep Si, some metals, and resists

- **Wet etch processes** for metal liftoff, and etching dielectrics, metals, and semiconductors

- **Thermal Anneal**
  Maximum temperature 1200°C
  Process gases – N₂, Ar, O₂

- **Ion implant**
  Energy <400 KeV
  Species – O₂, As, He

- **Backside processing**
  3 Logitech wafer lappers
  Brewer wafer bonder

- **Metrology / testing**
  SEM (3) with EDX, AFM, ellipsometry, profilometry, wafer stress measurement
  Electrical characterization with manual probe stations, Electroglas autoprobe, HP4145 parameter analyzers, and HP8510 network analyzers

We customize our fabrication services to fit the individual needs of our customers. Please contact us for further information about the services we can provide to meet your processing requirements.

Contact: 805-373-4483
pamela.flores@teledyne.com
Teledyne Scientific V-, W-, D-, and G-band PA's

50-250 GHz Broadband, High Power Amplifier MMICs in InP HBT

- Amplifier ID: **TSC 70-130G-4S2C**
  - 22-25 dB $S_{21}$ gain from 55-130 GHz, typical.
  - 100-120 mW saturated RF output power, $P_{sat}$.
  - 16-18 dB power gain at $P_{sat}$ with 7.5-8% PAE.
  - DC bias, $P_{DC} = 1.4$-W. Size: 1.86-mm x 0.64-mm.

- Amplifier ID: **TSC 70-130G-3S4C**
  - 16-20 dB $S_{21}$ gain from 70-130 GHz, typical.
  - 160-240 mW saturated RF output power, $P_{sat}$.
  - 13-14 dB power gain at $P_{sat}$ with 7-10% PAE.
  - DC bias, $P_{DC} = 2.1$-W. Size: 1.86-mm x 0.92-mm.

- Amplifier ID: **TSC 115-145G-5S4C**
  - 23-25 dB $S_{21}$ gain from 115-145 GHz, typical.
  - 210-225 mW saturated RF output power, $P_{sat}$.
  - 14-16 dB power gain at $P_{sat}$ with 5-6.5% PAE.
  - DC bias, $P_{DC} = 3.5$-W. Size: 2.05-mm x 0.92-mm.

- Amplifier ID: **TSC 125-185G-5S2C**
  - 20-22 dB $S_{21}$ gain from 125-185 GHz, typical.
  - 75-100 mW saturated RF output power, $P_{sat}$.
  - 13-14 dB power gain at $P_{sat}$ with 5-7.5% PAE.
  - DC bias, $P_{DC} = 1.4$-W. Size: 1.86-mm x 0.64-mm.

- Amplifier ID: **T04 3S4C-G1-P1 (190-245 GHz)**
  - 23-28 dB $S_{21}$ gain from 190-245 GHz, typical.
  - 50-80 mW saturated RF output power $P_{sat}$.
  - 16-18 dB power gain at $P_{sat}$ with 3-4.5% PAE.
  - DC bias, $P_{DC} = 1.6$-W. Dimensions: 1.92-mm x 0.80-mm.

For additional information, pricing and quotation, and to order, contact Teledyne at tsi.electronics@teledyne.com

For custom PA design services using the InP HBT technology, contact Teledyne at zach.griffith@teledyne.com


For additional packaged power amplifier information from Virginia Diodes (VDI), contact: vdirfq@vadiodes.com

2020-May  Amplifier datasheet subject to change without notice  Amplifier MMIC ECCN: 3A001.b.2.h
Teledyne Scientific V-, W-, D-, and G-band PA’s

Additional amplifier MMICs from Teledyne:

TSC 70-130G-3S2C power amplifier. Its performance is very similar to the TSC 70-130G-4S2C PA, only lower gain.
- 16-20 dB $S_{21}$ gain from 70-130 GHz, typical.
- 100-120 mW saturated RF output power, $P_{sat}$.
  - 13-14 dB power gain at $P_{sat}$ with 10-11% PAE.
- DC bias, $P_{DC} = 1.1$-W. Size: 1.86-mm x 0.64-mm.

TSC 70-130G-3S1C power amplifier. Its performance is very similar to the TSC 70-130G-3S2C PA, less output power.
- 16-20 dB $S_{21}$ gain from 70-130 GHz, typical.
- 55-60 mW saturated RF output power, $P_{sat}$.
  - 14.5-15 dB power gain at $P_{sat}$ with 10.5-11% PAE.
- DC bias, $P_{DC} = 0.55$-W. Size: 1.30-mm x 0.50-mm.

TSC 94G-3S2C-E20 power amplifier. An 88-104 GHz, 26-30 dB gain, high-efficiency power amplifier.
- 26-30 dB $S_{21}$ gain from 88-104 GHz, typical.
- 100-110 mW saturated RF output power, $P_{sat}$.
  - 18-20 dB power gain at $P_{sat}$ with 19-23% PAE.
- DC bias, $P_{DC} = 0.42$-W. Size: 1.86-mm x 0.64-mm.

TSC 190G-5S1C amplifier. A 190-GHz, 25-dB gain, low-power amplifier.
- 23-25 dB $S_{21}$ gain from 185-200 GHz, typical.
- 9-10 dBm saturated RF output power, $P_{sat}$.
  - 16 dB power gain at $P_{sat}$ with 9-9.5% PAE.
  - Output 1-dB gain compression power, $OP_{1dB} = 3$-dBm.
- DC bias, $P_{DC} = 80$-mW. Size: 0.93-mm x 0.48-mm.

Publication list summarizing Teledyne’s 50 – 250 GHz power amplifiers:

8. Z. Griffith et al., “A 50-80 mW SSPA from 190.8-244 GHz at 0.5-mW $P_{in}$”, IEEE MTT-S International Microwave Symposium, Tampa, FL, June 1-6, 2014.
Silicon Beamformer Design Services

Teledyne Scientific is pleased to offer Silicon Germanium Phased Array Beamformer design services. Teledyne has pioneered the use of SiGe technology for millimeter-wave core beamformer ICs since our first demonstration chip in 2009. Design successes from C-band to W-band demonstrate a proven track record of providing turnkey solutions including packaging and test.

Fast Design Services Leverage Proven Circuit IP:

- Demonstrated 4 to 110 GHz Beamformer designs with up to 256 channels.
- Proven IP blocks to reduce design risk and time to market.
- Up to 7-bit Vector based and L-C based phase shifters and true-time delay phase control solutions.
- Up to 6-bit programmable variable gain amplifiers, LNAs, PAs, Attenuators, Delay lines.
- Onboard Serial LVDS/LVCMOS digital command / control (fast - up to 300 Mbps).
- Onboard regulation, temperature/power monitoring, global PTAT, external LNA/PA control.
- Onboard state memory for rapid state switching.
- ADCs, DACs (custom transfer functions).
- Chip Addressing for simplified array control.

Complete Solutions Including Packaging and Test:

- BGA interposer based packaging solutions where the highest RF performance is critical.
- Low-cost QFN packaging solutions for economical applications.
- Turnkey test solutions, off the shelf control software, integrated test and measurement.
- Evaluation boards, user training modules.

Contact: 805-373-4483
Pamela.flores@teledyne.com
Teledyne Ultra Wideband Track and Hold Allows (DC-50GHz) Direct Down Conversion

Teledyne Scientific Company is introducing a family of new ultra wideband Track and Holds for the instrumentation and RF markets. The RTH110 has a sampling clock from 100MHz to 300MHz, and the RTH130 operates with a sampling clock up to 6GHz. Both Track and Holds have a bandwidth of 50GHz with 40dBc SFDR at 20GHz and 33dBc at 40GHz.

With its ultra wide bandwidth and high sampling rate the RTH130 can eliminate the need of downconverters in RF receivers reducing the number of components in high frequency acquisition systems. An example is shown below where a conventional receiver uses Local Oscillators (LO) and mixers to downconvert the signal to baseband.

This example shows two LO and mixers which can be eliminated when a Track and Hold is used, requiring no more than filters and the correct sampling frequency to bring the signal image to baseband. Also a system using a Track and Hold is not bound to a specific frequency band compared to the narrow band mixers used in the down converting systems. By using a programmable clock generator, such as a Digital Frequency Synthesizer, the sampling frequency can be quickly adjusted to cover different bands.
RTH110

50 GHz Bandwidth High Linearity Track-and-Hold

Features

- 50 GHz Input Bandwidth
- 40dBc SFDR up to 30GHz and 35dBc up to 50GHz
- -40dBc THD up 30GHz and -35dBc up to 50GHz
- 100 - 300 MHz Sampling Rate
- Differential Analog Input/Output
- Output Clock
- 1.9W Power Dissipation
- Single Power Supply
- QFN Package

Product Description

RTH110’s bandwidth and aperture jitter enable accurate sampling of DC to multi-GHz signals. The differential-to-differential track-and-hold cascades three track-and-hold circuits, TH1, TH2, and TH3. TH1 capture the input signal and TH2/TH3 provide a longer sampling time for the subsequent circuit. The requirement of only one clock and the fact the RTH110 provides an output clock, eases the clock distribution for the sampling and digitizing circuitry relative to the case of a track-and-hold (TH) with dual clocks.

Ordering information

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTH110-QN</td>
<td>20 I/O QFN Package</td>
</tr>
<tr>
<td>RTH110-DI</td>
<td>Die</td>
</tr>
<tr>
<td>EVRTH110</td>
<td>Evaluation Board</td>
</tr>
</tbody>
</table>

Teledyne Scientific Company reserves the right to make changes to its product specifications at any time without notice. The information furnished herein is believed to be accurate; however, no responsibility is assumed for its use.
RTH120

24 GHz Bandwidth High Linearity Track-and-Hold

Features
- 24 GHz Input Bandwidth
- -45 dBc THD with Fin = 3 GHz, 1 Vpp Diff
- -35 dBc THD with Fin = 5 GHz, 1 Vpp Diff
- 1000 - 4000 MHz Sampling Rate
- Differential Analog Input/Output
- Output Held more than Half Clock Cycle
- Selectable One or Two Clock Operation
- 0.8W Power Dissipation
- Single Power Supply

Product Description
RTH120’s bandwidth and aperture jitter enable 2 to 4 GS/s accurate sampling of DC to multi-GHz signals. The differential-to-differential dual track-and-hold cascades two track-and-hold circuits, TH1 and TH2. The RTH120 provides a held output for more than half a clock cycle, easing bandwidth requirements of subsequent circuitry relative to the case of a single track-and-hold (TH). The option to independently clock TH1 and TH2 further relaxes this requirement for sub-sampling applications.

Ordering information

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTH120-HQ</td>
<td>24 Pin QFP Package</td>
</tr>
<tr>
<td>RTH120-DI</td>
<td>Die</td>
</tr>
<tr>
<td>EVRTH120</td>
<td>Evaluation Module</td>
</tr>
</tbody>
</table>
RTH130

50 GHz Bandwidth 14 GS/s Track-and-Hold

Features

♦ 50 GHz Input Bandwidth
♦ Better than -35 dBc THD Over the Total Bandwidth with Small Signal Input
♦ Better than -35 dBc SFDR Over the Total Bandwidth with Small Signal Input
♦ 1 to 14 GHz Maximum Sampling Rate
♦ Differential Analog Input/Output
♦ Output Held more than Half Clock Cycle
♦ Selectable One or Two Clock Operation
♦ 1.5W Power Dissipation
♦ Single Power Supply
♦ 4mm x 4mm QFN package

Product Description

RTH130’s bandwidth and aperture jitter enable 1 to 14 GS/s accurate sampling of DC to multi-GHz signals. The differential-to-differential dual track-and-hold cascades two track-and-hold circuits, TH1 and TH2. The RTH130 provides a held output for more than half a clock cycle, easing bandwidth requirements of subsequent circuitry relative to the case of a single track-and-hold (TH). The option to independently clock TH1 and TH2 further relaxes this requirement for sub-sampling applications.

Ordering information

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTH130-QN</td>
<td>20 I/O QFN Package</td>
</tr>
<tr>
<td>RTH130-DI</td>
<td>Die</td>
</tr>
<tr>
<td>EVRTH130</td>
<td>Evaluation Board</td>
</tr>
</tbody>
</table>

Teledyne Scientific Company reserves the right to make changes to its product specifications at any time without notice. The information furnished herein is believed to be accurate; however, no responsibility is assumed for its use.