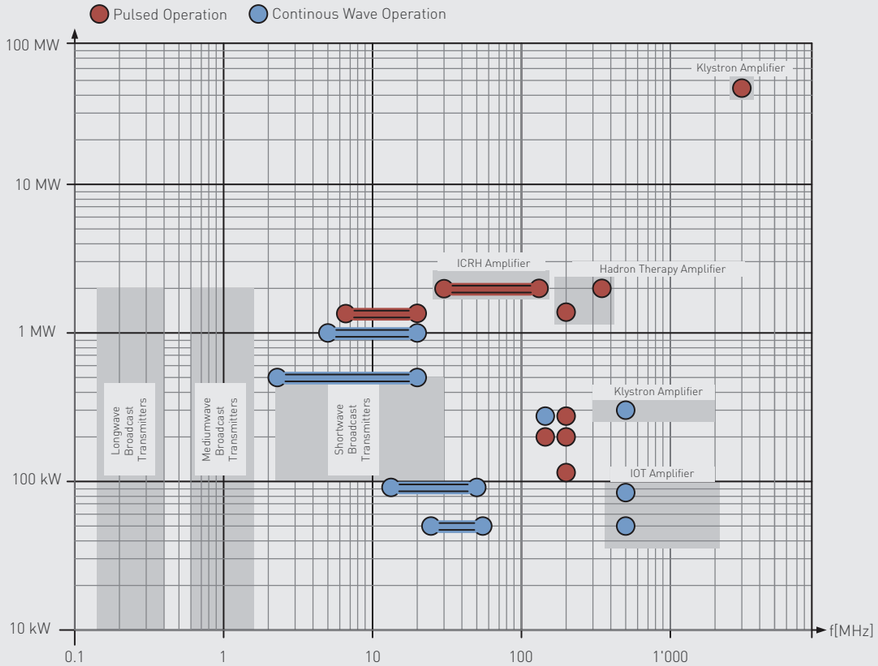
Past Performance | Ampegon Reference List of Special Amplifiers

Customer	Country	Application	Units Delivered	Power in kW	Frequency in MHz	Contract Date
GSI Darmstadt	Germany	Heavy Ion Synchrotron	14	120	0.9 – 3.2	2014
MedAustron	Austria	Linear Accelerator	1	250	216.8	2010
		Linear Accelerator	1	1500	216.8	2010
Australian National Univ	Australia	Plasma Heating	2	200 puls 40 cw	3.9 – 26.1	2010
Brookhaven National Lab	USA	Synchrotron, Booster	1	90	500	2010
Brookhaven National Lab	USA	Synchrotron Light Source	2	300	500	2010
Uni Frankfurt	Germany	Amplifier	1	250	175	2010
Siemens Healthcare	Germany	Amplifier for Hadrontherapy	1	4/250/1400	217	2009
Uni Heidelberg	Germany	Amplifier	1	250	217	2009
Siemens Medical	Germany	Linear Accelerator	1	4	216.8	2007
		Linear Accelerator	1	250	216.8	2007
		Linear Accelerator	1	200	216.8	2007
		Linear Accelerator	1	1400	216.8	2007
Accel	Germany	Proton Synchrotron	1	150	72	2007



LHCD: Low Hybrid Current Drive, ICRH: ION Cyclotron Resonance Heating
IOT: Inductive Output Tube

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Science MedTech Industry Broadcast

AMPEGON

The Heartbeat of High Power

Special RF Amplifiers

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Special RF Amplifiers

Ampegon designs and delivers RF amplifier systems for high power applications

Ampegon has long experience with RF amplifier systems, high voltage as well as high current power supplies and modulators for world-class medical, industrial and research facilities. Our customers include particle accelerator and fusion research institutes, fundamental and applied physics, materials and life sciences engineering, notable providers of accelerator-based cancer treatment solutions, as well as innovative partners enhancing industrial processes. Offering its innovative and pioneering spirit with expertise of a century, Ampegon products stand for premium quality, reliability and best performance.

Unique Expertise and Innovation
Our expertise includes stand-alone high voltage power supply (HVPS) systems with voltages up to 200 kV and currents up to 2000 A, RF amplifier systems up to 55 MW power at frequencies up to s-band, short and long pulse modulators with voltages over 500 kV and currents up to 400 A, and stand-alone multi-channel digital low level RF control systems. Our technology base extends across the entire field of RF transmission.

Drawing on a century of experience in the field of high power RF engineering, Ampegon designs and delivers special RF amplifier systems based on grided tubes, klystrons, inductive output tubes (IOT) and solid state technology.

Our specialty is handling RF power ratings of up to 2 megawatts and frequencies up to 200 MHz with grided tubes, up to 500 MHz with solid state technology and even up to 1300 MHz with klystrons or IOT's. Familiar with the challenges of high power as well as of frequencies of several hundred MHz, we undertake studies, plant engineering and project assignments. Our expertise also includes digital low level RF control systems to be used together with our RF amplifiers, as well as stand-alone units to replace existing systems. Working hand in hand with tube manufacturers, systems have been designed and executed for applications with synchrotrons, cyclotrons, ion cyclotron resonance heating (ICRH) and linear particle accelerators ranging from electrons to heavy ions and high power plasma heating.

Range of Special RF Amplifiers
The application of RF amplifiers for the acceleration of charged particles or the heating of plasma is a well known and established technology. Ampegon engineers have customized solutions for a wide variety of scientific and industrial applications. Combining superior in-house RF and high power amplifier tube expertise, Ampegon is in the unique position to engineer and execute systems for a wide variety of applications up to 2 MW at 3 MHz to 1300 MHz. Ampegon amplifier systems feature customer specific solutions for either continuous wave (CW) or pulsed operation both for fixed (single) frequency applications or wide band use with automatic tuning option. Our highly specialized engineering teams apply their vast technical expertise to advise and consult our partners during all phases of project execution, beginning with the planning phase and continuing with after sales support throughout the lifetime of the system.

Digital Measurement Acquisition System
For the new generation of RF amplifiers for scientific applications Ampegon designed a new all digital measurement acquisition and protection system with the following features:

- To be used for pulsed, CW or combined operation
- Availability of snapshots of all tube parameters of pulsed amplifiers via ethernet
- Availability of selected wave forms of tube parameters of pulsed amplifiers also via ethernet
- Indication of tube parameters as bar graphs on a touch screen

Amplifier Types and Applications

Solid State based Amplifiers
The Paul Scherrer Institut (PSI) currently operates a klystron amplifier on the booster ring of the Swiss Light Source (SLS). In order to have an optional RF source for the booster cavity, PSI has developed a compact 500 MHz – 65 kW solid state RF amplifier. The amplifier design has been transferred to Ampegon under an initiative supported by Switzerland's Commission for Technology and Innovation, with the intention to industrialise and commercialise it.

Amplifiers in solid state technology offer highest reliability when maximum redundancy is given. We avoid combining on RF module level as well as central DC power supply to enhance redundancy. Each RF amplifier module is equipped with its own cooling circuit to achieve best performance. This feature allows connecting the amplifier modules directly to the combiner, which can be built in stepped lambda/4 technology or as resonant combiner. Elimination of coaxial cables at the RF output maximizes the overall efficiency and increases reliability. The frequency range is between 200 MHz and 1.3 GHz with power levels up to 150 kW. The solid state amplifier system holds all needed components including water cooling system, mains distribution and safety interlocking system. Each system can be remote controlled and equipped with customer specific interfaces such as EPICS.

Tetrode based Amplifiers
After the delivery of the RF amplifier chains for the Heidelberg Ion beam Therapy Center (HIT) and CNAO in Pavia, Ampegon has entered into a cooperation contract with Siemens for amplifiers for Siemens Particle Therapy Systems. Siemens is one of the world's largest suppliers to the healthcare industry. Ampegon's contribution to the complex accelerator for these therapy centers is the RF source for the injector Linac. This RF source consists of a chain of 3 RF amplifiers all working in pulsed mode, delivering pulses of 500 µs at a frequency of 216.816 MHz with the duty cycle being 10 Hz:

- One 250 kW RF amplifier to feed the radio frequency quadrupole (RFQ) cavity
- One 1400 kW RF amplifier to feed the induction heating (IH) drift tube Linac
- One 4 kW solid state RF amplifier to feed the debuncher cavity

All three units are driven by a master oscillator and controlled in phase and amplitude using the Ampegon digital LLRF system. Other tetrode based amplifiers for scientific Linac applications has been delivered to SOREQ for their SARAF project and to the University of Frankfurt for their FRANZ project. Both amplifiers feed a RFQ cavity and can deliver up to 300 kW at 176 MHz in continuous mode.

Klystron based Amplifiers
The 3 GLS facility Shanghai Synchrotron Radiation Facility (SSRF) is the biggest scientific platform and research facility and technology development in China. The energy of the storage ring is one of the highest values for medium-energy light sources. Its performance is optimized in the widely used X-ray energy region. Designed to have a scientific lifetime of more than 30 years, the facility intends to provide scientists and engineers access to the high stability beam during day and night for a total of more than 5000 hours each year. Ampegon worked in closed cooperation with Thales Electron Devices (TED) for the design, delivery, erection and commissioning of a total of 4 klystron amplifier systems with integrated EPICS based control system for this turnkey project:

- 1 HVPS unit (46 kV, 7.5 A), TH2161 (booster ring) (contract 2000)
- 3 HVPS units (55 kV, 12 A), TH2161B-1 (storage ring) (contract 2006)

IOT based Amplifiers
ALBA, a 3 GLS facility, is situated near Barcelona. The ALBA facility, will include a 3 GeV storage ring, 3 GeV synchrotron and 100 MeV Linac. Ampegon developed a new amplifier system to achieve high reliability and high performance at the same time. Each inductive output tube (IOT) is powered by an individual power supply (HVPS) based on Ampegon's pulse step modulator technology. The first amplifier was delivered to ALBA in summer 2007. The complete system includes 14 amplifiers. Commissioning and acceptance tests were successfully completed in 2010. The ALBA accelerator consists of 1 RF plant in the booster with 80 kW at 500 MHz and 6 RF plants in the storage ring with 150 kW at 500 MHz realized by combining two 80 kW units via a cavity combiner.

Rear view of RF amplifier with IOT.

Key Features

- RF amplifiers up to 2 MW and frequencies up to 1300 MHz
- Protection and regulation of RF power under all kinds of VSWR conditions
- Short pulse (several ms) and long pulse HV modulators available
- High power solid state or tube based solutions (triodes, tetrodes, IOT's, klystrons)
- Overall system solutions combined with power supplies, HV modulators, exciters, synthesizers, oscillators, LLRF
- Continuous wave (CW) or pulsed operation
- High RF-stability, low SNR
- Best efficiency due to high efficient power supplies
- Highest availability by design and due to redundancy of power supplies
- Easily operated via touch screen and customer specific remote access