

Vector LP Theory of Operation

The Vector LP is an amplitude modulated non-direction radio beacon (NDB) transmitter designed to transmit Omni-directional signals, which are identified by specific beacon identification (Morse) codes at pre-selected repetition rates. The NDB transmitter is used as an aviation and marine navigation aid, whereby the pilot of an aircraft equipped with direction-finding equipment can determine their bearing to or from the radio beacons fixed location.

The Vector LP operates in the LF/MF band at a fixed carrier frequency between 190 kHz to 535 kHz for standard band and 536 kHz to 1250 kHz or 1600 kHz to 1800 kHz for extended band operation. The carrier frequency is internally generated on the RF Synthesizer PWB using direct digital synthesis (DDS) which is referenced to a 10 MHz crystal oscillator. The temperature compensated crystal oscillator (TCXO), which has a frequency stability of 2ppm, along with the DDS design, provides for a total carrier frequency tolerance of +/- 0.0003% over the full operating environmental range.

Three types of modulation are available in the Vector LP; Continuous Carrier (CW), Continuous Tone (MCW) and MCW plus Voice. The modulation depth is user adjustable, via the transmitter's front panel graphical user interface (GUI), from 10% to 100%. Modulating tone frequencies of 400 Hz and 1020 Hz, also selected via the front panel GUI, are internally generated on the Exciter Monitor/Generator PWB using DDS, which provides for a frequency tolerance of +/- 5%.

Emission modes consist of; continuous carrier (NON), beacon keyed identification tone (A2A) and beacon with voice (A2A/A3E). Note however that emission modes using voice (A3E) are not authorized for use in FCC compliant systems.

In emission mode A2A, the keyed identification code is continuously repeated until the transmitter is switched off. The total length of the identification code (Frame) is user adjustable from 4.0 seconds to 20.0 seconds. After each frame ends, a new frame occurs and the code repeats. Since the Vector LP can be programmed from one to six alphanumeric characters, the rate of transmission depends on the keyed string itself (ICAO). The rate of transmission is outlined in the table below.

Keyed String	Bit Rate
<= 3 Characters with 0 numerals	64 bits/frame
<= 3 Characters with 1+ numerals	80 bits/frame
4 Characters with 0 numerals	80 bits/frame
4 Character with 1+ numerals	96 bits/frame
5 Characters with 0 numerals	96 bits/frame
5 Character with 1+ numerals	120 bits/frame
6 Characters with 0 numerals	112 bits/frame
6 Character with 1+ numerals	144 bits/frame

The transmitter's RF output power is manually adjusted via the front panel power increase/decrease buttons and front panel GUI. The power can be adjusted from 10% to 100% of rated power for 125W (NON), 187.5W_{peak} (A2A @ 100% modulation). However, the transmitter's absolute maximum output power is factory set and software limited to 10W above its rated power level. This 10W headroom allows for a small power increase when the system is operating in combination with a Nautel ATU providing constant antenna current. Spurious radiation is limited through the use of a band-pass filter at the transmitter's output. The ATU, which is required for matching the transmitter's impedance to the antenna's, provides further suppression of the spurious signals.

The transmitter's output power is generated in the RF Power Module assembly. A Switch Mode Power Supply PWB (SMPS) converts the AC input supply voltage to a high level DC voltage (B+) which is used by the Modulator and Power Amplifier PWB's to generate the RF output signal. To help improve efficiency, the SMPS generates one of three B+ voltages (55V, 97V & 167V). The B+ voltage that is generated depends on the operating power level. Thus the DC current draw from the SMPS into the amplifying stage also depends on the operating RF power level. The table below shows a comparison between various B+ voltages, DC currents, modulator duty cycle and RF power levels.

B+ Voltage	Measured B+ Voltage	Duty Cycle	DC Current (SMPS)	RF Output Power
56 V	57.0 V	43.1 %	0.33 A	15.5 W
97 V	98.1 V	42.3 %	0.55 A	45.5 W
167 V	168.5 V	42.3 %	0.94 A	136.7 W

Vector LP Model Variants

The Vector LP NDB series transmitter is an amplitude modulated non-direction beacon operating in the 190 kHz to 535 kHz frequency band. The transmitter consists of a number of model variants; however, with the exception of a few optional items, the physical appearance, construction and operation of each model is the same. These optional items include a DC backup option and the duality of specific components.

Nautel's submission for FCC Type Approval pertains to the VR125 model of the Vector LP family. This includes model variants, the VR125S (Single Side System) and the VR125D (Dual Side System) and also includes the DC backup option.

The VR125 has a maximum operating power level of 125W (N0N, no modulation) or 187.5W (A2A, 100% modulation). A universal AC input allows the VR125 to operate from 90Vac to 270Vac supply, but it also has the option to operate from a 24Vdc or 48Vdc DC backup supply. The DC supply option consists of a battery boost assembly along with a DC/DC low voltage power supply. If installed, the transmitter will automatically switch to the DC backup option if the AC falls below a set threshold value. The Vectors switch mode power supply (SMPS), which uses the AC supply option, and the battery boost assembly, which uses the DC supply option, produce a high DC voltage at their output. These voltage's, which are identical between the two supply options, are OR'd together within the power module and then used by the modulator and power amplifier to produce RF power. At all times, the non operating supply option, either the SMPS or battery boost assembly, is inhibited so they both do not produce an output at the same time.

The VR125 can be broken down into a two model variants. These variants include a single side system, the VR125S or dual side system, the VR125D. The dual system includes a full standby side transmitter within the same transmitter assembly, so from the outside the appearance has not changed. The dual system includes a second, but identical; RF Synthesizer PWB, PDM Driver PWB, Exciter Monitor Generator PWB, Power Module and AC/DC low voltage power supply. In a single system these extra components are removed. The control software is identical between the single and dual system and thus the operation of each model variant is the same. The exception is that the dual system allows the transmitter to switch to the standby side in the event of failure on the main operating side.

In the dual side system, both the main operating side and standby side share the same Control PWB, Remote Interface PWB, Harmonic Filter PWB and Power Probe PWB, but the frequency generation and RF power generation is independent of each other. Also, dual monitoring allows each side to monitor the other side's operating parameters. In a dual side system, one side is always inhibited from operating via software controlled relays. When the transmitter switches to the standby side, these relays allow power to the standby side PWB's as well as connecting the standby side power module to the Harmonic Filter and Power Probe at the transmitter's output.

Due to the same physical construction, operation and software, the model variants of the Vector LP family are not considered discrete models on their own and any suffixes, such as "S" or "D", appearing at the end of the model name are for internal use only and do not appear on the model label affixed to the transmitter.