612/625 Loop Arrays

Tailor reception performance in noisy environments.

Electrically Small Antennas

Electrically small antennas can be used toadvantage in a wide range of receiving applications. The inefficiencies inherent in small antennas have the same effect as other sources of noise on the signal-to-noise ratio. When external noise is greater than the noise from antenna inefficiency (and internal electronics, if present), an antenna is said to be “externally noise limited.” In this case, the higher level of external noise dominates the system signal-to-noise ratio, rendering the internal noise insignificant. Thus, when external noise is relatively high, small receiving antennas can work as well as full-size, fully efficient antennas. This also means that fully efficient antennas need to be located at electrically quiet sites to achieve their full potential.

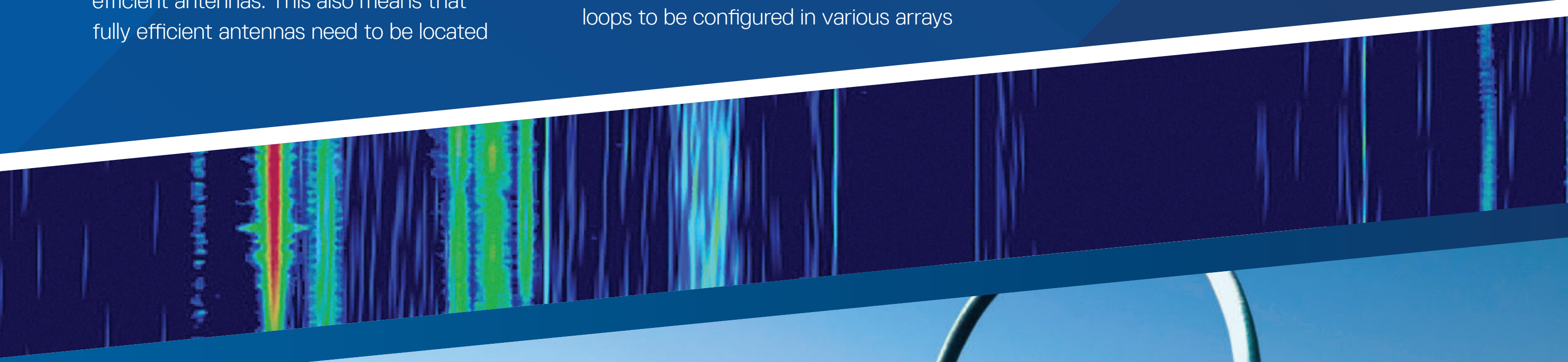
Loop Antennas

A loop antenna functions as a magnetic dipole. An incident electromagnetic wave induces a current in the loop; a matching transformer inside the loop couples the induced current into a 50Ω load, either an amplifier or a length of coax running to the receiver.

One advantage of loops over dipoles is their low input impedance. A loop’s performance is relatively unaffected by buildings, trees, snow, etc., which tend to short out radiation energy near the element. Moreover, since the radiation resistance of electrically small antennas is low, mutual effects are generally insignificant, enabling loops to be configured in various arrays that tailor their performance to particular receiving requirements. Loops are often arrayed in rows, or “arms” of four, eight, or sixteen loops to provide a great variety of radiation patterns.

KEY FEATURES

- Easy to install
- Easy to transport
- Compact, low profile
- Configurable for many different applications
- Ideal for small sites



Model 612

The Model 612, with a nominal diameter of two meters, is the smallest element in the TCI family of loop antennas. The 612 loop stands about 7 feet (2.2m) tall, depending on mounting type. Model 612 loops for temporary or transportable applications are mounted on steel tripods; for permanent or high wind/ice applications, they are mounted on aluminum posts bolted to concrete pads.

Model 625

Model 625 loops have a nominal diameter of three meters and are arrayed in the same manner as 612 loops. The 625 elements are used where their lower noise figure is advantageous, i.e., at quiet sites away from urban areas (see Noise Figure Table).

System Details

The basic loop is a low-inductance aluminum tube, fed at its upper midpoint via a broadband, passive matching network. The network output feeds a coaxial cable that runs through one of the tubes to the base where it exits the loop, assuring electrical balance at all frequencies. The broadband matching network is designed to provide an optimum impedance match for maximum power transfer over the 2–32 MHz bandwidth. All components are waterproof and impervious to the effects of salt spray and ultraviolet radiation.

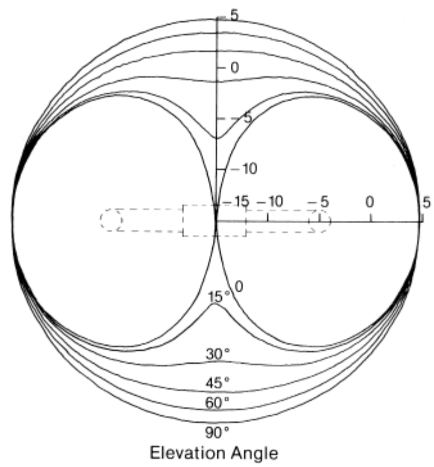
Radiation Patterns

The azimuthal pattern of a single loop (Model 612-1) is a figure-eight at the horizon, increasingly omnidirectional at higher angles of arrival, and virtually independent of azimuth at angles of arrival above 45 degrees. The maximum gain of a single loop at the horizon is 5 dBi, the same as that of a vertically polarized whip. The overhead gain is also 5 dBi, making the single loop an excellent choice for short-range communications. (The whip has a null overhead, limiting its usefulness for short ranges.) The signal from two orthogonal loops (612-2 or TCI Model 625L) can be combined to provide a perfectly omnidirectional pattern at all azimuths ($\sin^2 Q + \cos^2 Q = 1$) with a gain of 2 dBi.

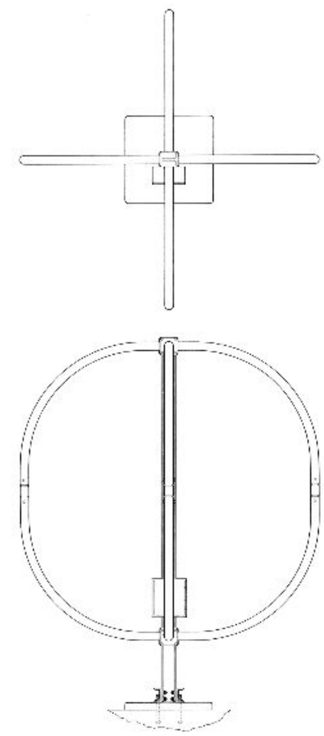
Beam Forming

Signals from multiple loops can be combined in phase, or "beamformed," with a resulting directional pattern having a maximum gain at some angle below the zenith. Adding loop elements increases gain and directionality. Beamforming is accomplished by bringing the feed cables from each element in an array to a delay/combiner unit, or beamformer, located at the array's physical center. In unidirectional beam forming, signals from each element are delayed by means of appropriate lengths of coaxial cable, or delay lines, then summed in a hybrid combiner. In bidirectional beam forming, the signals are split and fed into two separate sets of delay lines, then summed in two separate combiners.

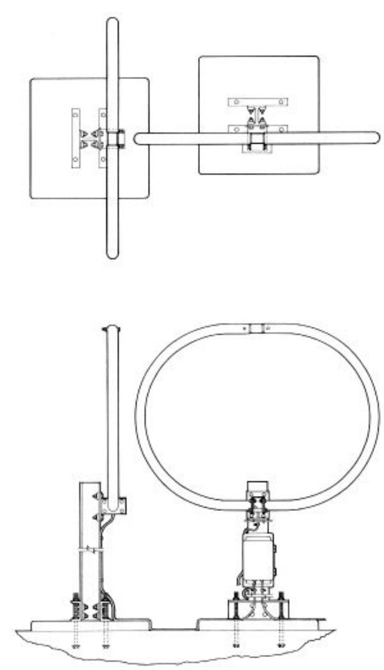
› Radiation Pattern for Model 612-1 and 625-1 (directive gain in dBi)



› Plan and Elevation View Model 625 L Specifications shown in tables



› Plan and Elevation View
Model 612-1 one element only
Model 612-2 both elements



Amplifiers

Amplifiers are often used with loop arrays to boost the signal prior to insertion into the cable run. They are generally recommended when attenuation is excessive owing to long runs of feeder or inadequate receiver sensitivity. Amplifiers follow the hybrid combiners and determine the system noise level at that point.

The standard amplifier used by TCI in loop arrays has 17 dB of gain; other values are available to meet specific requirements. DC power is furnished to the amplifier through the RF coax. High-pass filters to block interference from MF stations or low-pass filters to block TV and FM signals can be incorporated into the amplifier as required.

TCI uses the best amplifiers available; nevertheless, amplifiers are susceptible to overload, sometimes generate intermodulation products, and always add to system noise. Unless amplifiers are required, conversion to a passive system may be advisable.

Large Arrays of Loops

Multiple small arrays are often combined in rosette configurations. One common rosette consists of four bidirectional arms extending from a common center, with each arm consisting of eight loops. This 4-arm, 32-loop configuration can produce eight beams, one for each 45 degrees of azimuth. Some arrays use only four elements per arm; others for long-range applications use as many as sixteen for high directional gain at low angles of arrival.

Design Notes

The following design notes should be considered in planning a loop array:

- The best front-to-back ratio is achieved by making the array one-half wavelength long at its lowest frequency.
- Element spacing should not exceed one-half wavelength at the highest frequency to prevent grating lobes in the pattern.
- The gain of an end-fire array increases with the square root of its electrical length; over a range of 2 to 32 MHz the array gain increases by a factor of four (6 dB).
- Amplifiers add system noise (4 dB).

Power Supply Multicoupler Unit (PSM)

A combination power supply and HF multicoupler unit (PSM) is normally mounted in a rack in the receiver building. The PSM supplies DC for the array preamps via the user’s RF coax. The PSM also “picks off” the RF from the coax and distributes it to the station’s receivers via a number of BNC connectors (usually four) on the back of the unit. Systems without amplifiers normally retain the PSM chassis as a central source for the array’s RF output, which may include power splitters to feed multiple receivers.

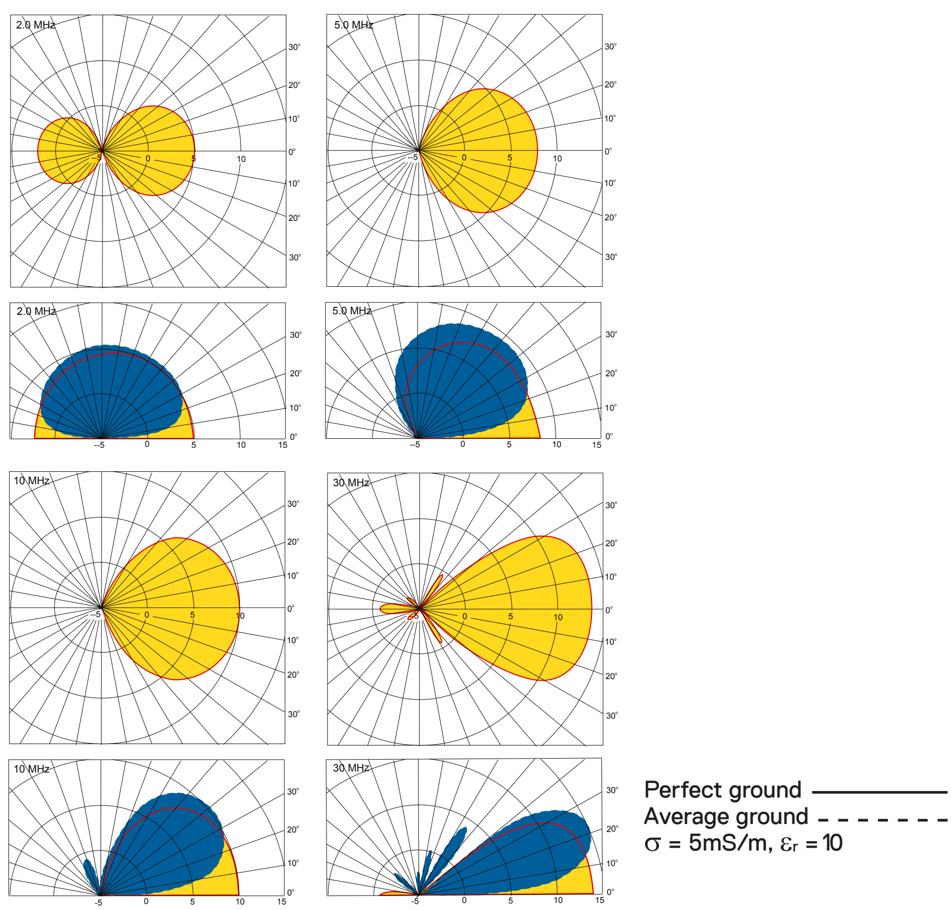
Model Numbering System

Loop elements can be arrayed in many configurations. TCI nomenclature describes them as follows:

- 1st term: number of arms in the array
- 2nd term: element type, 612 or 625
- 3rd term: number of loop elements in each arm
- 4th term: spacing between elements, in meters
- 5th term: operation mode of the element (U, unidirectional, or B, bidirectional)

Thus, an array of four bidirectional arms, each having eight elements spaced four meters apart would be designated as a Model 4-612-8-4-B. This is the 8-direction rosette described above in “Large Arrays of Loops.”

› TCI Model 1-612-8-4-U & TCI Model 1-625-8-4-U Azimuth and Elevation Directive Gain Patterns



Model 612/625 Specifications

Power Supply Multicoupler Unit

Frequency Range	2-32 MHz
RF Impedance	50Ω
VSWR	1.2:1 maximum
Connection located on rear panel	BNC–jacks
Power Requirements	115/220 V, 1.3/0.7 A, 50–60 Hz, single phase
Size	19"x3.50"x13.75" deep

TCI Bi-directional End-Fire Loop Arrays

Frequency	2-32 MHz
Polarization	Vertical
Directive Gain	2 MHz, 5 dBi 5 MHz, 8 dBi 10 MHz, 10 dBi 20 MHz, 13 dBi 30 MHz, 14 dBi
Direction of Radiation	Array is bi-directional and can receive signals simultaneously from either end-fire direction
Azuimuth Beamwidth	5 MHz, 86º
3 dB points	30 MHz, 54º
Elevation Angle at upper	5 MHz, 80º
3 dB points	30 MHz, 30º
Front-to-back Ratio (4–32 MHz)	13 dB minimum
Loops in Array	8
Array Length	612: 30 m (98 ft.) 625: 31 m (102 ft.)
Inter-Loop Spacing	4 m (13 ft.)
Element Height:	612: 2 m (6.28 ft.) 625: 3.3 m (10.83 ft.) 625L: 4.4 m (14.44 ft.)
Impedance (output):	50 ohms
Beam Former	Output Connector: 2-type-N jacks
Wind Rating	193 km/h (120 mph) no ice, standard 225 km/h (14 0 mph)no ice, optional

TCI Model 1-612-8-8-U (or B)

Frequency	2-16 MHz
Front-to-Back Ratio:	13 dB (2–16 MHz)
Directive Gain	2 MHz, 7 dBi 5 MHz, 10 dBi 10 MHz, 13 dBi 16 MHz, 14 dBi

TCI Model 612-1

Composed of a single loop w/amplifier and power supply. Multicoupled outputs available, optionally.

Frequency	2-32 MHz
Directive Gain	5 dBi

TCI Model 612-2

Composed of two single loops disposed orthogonally and fed either individually or with a hybrid combiner to form an omni azimuthal pattern. (Supplied with 1 amplifier and 1 power supply.) Multicoupled outputs available, optionally.

Frequency	2-32 MHz
Directive Gain	5 dBi when fed individually 2 dBi when fed with hybrid combiner

Noise figure (db) TCI loop arrays (systems include amplifier noise figure)

Frequency	612-1	612-8-4-B	625-8-4-B	625L
2 MHz	51.8	46.2	36.6	39.3
4 MHz	39.8	34.7	26.9	30.8
8 MHz	30.3	24.7	17.0	21.7
15 MHz	21.8	15.8	11.0	15.0
30 MHz	16.5	9.4	10.6	16.3

Effective height (m) TCI loop arrays at output of PSM 1-1 or PSM 2-1

Frequency	612-1	612-8-4-B	625-8-4-B	625L
2 MHz	0.75	0.43	1.30	0.91
4 MHz	1.5	0.81	2.00	1.45
8 MHz	2.2	1.28	3.13	2.08
15 MHz	2.9	1.50	3.31	2.23
30 MHz	2.7	2.00	1.74	1.02

Field strength incident on array required to drive amplifier to 1 dB compression point (v/m)

Frequency	612-1	612-8-4-B	625-8-4-B	625L
2 MHz	4.70	5.81	1.92	2.75
4 MHz	1.61	3.09	1.25	1.72
15 MHz	1.21	1.67	0.76	1.12
30 MHz	1.21	1.25	1.44	2.45

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