



R.F. DIRECTION INDICATOR

Direction finding attachment for use with existing narrow band FM receivers and transceivers.



MODEL DF

**DISPLAY UNIT PLUS SPECIAL ANTENNA COMBINER
CONVERTS ANY NBFM TRANSCEIVER INTO A RADIO
DIRECTION FINDER. BUILT-IN R.F. ACTIVATED
ANTENNA RELAY DIVERTS TRANSCEIVER OUTPUT
TO NORMAL ANTENNA DURING TRANSMIT OR
WHEN D.F. ATTACHMENT IS SWITCHED OFF.**

FEATURES

- Works with any existing narrow-band FM receiver or transceiver. No modifications are needed. The only connections required are to the external speaker and antenna jacks.
- Gives a clear directional readout on a circular array of sixteen bright green LEDs.
- Display holds last reading when signal drops out.
- Very easy to use and install.
- Only a single coaxial cable needed between display unit and antenna combiner.
- Antenna combiner unit connects to four omnidirectional antennas to simulate a spinning antenna. Depending on the choice of antennas, operation is possible from 20 to 200 MHz.
- Professional quality at remarkably low cost. Display unit is based on two P.T.H. circuit boards. Gasket sealed combiner unit houses two conventional double sided PCBs.

SYSTEM DESCRIPTION

Model DF is a Radio Direction Finding (RDF) system which is designed as an add-on accessory for any existing narrow band FM communications receiver or transceiver. The only connections required to the receiver are to the antenna input and the external loudspeaker jack.

The system comprises two separate units. One contains control and display electronics and is located at the receiver; the other is a special antenna combining unit containing its own drive electronics and requiring only a single coaxial cable to connect to the control unit.

Directional read out is via sixteen green LEDs arranged in a circle at $22\frac{1}{2}^\circ$ intervals.

When a signal is received its bearing relative to the antenna is indicated by whichever of the sixteen LEDs illuminates. In mobile applications this permits "homing" onto the signal, and at fixed stations when the antenna has been correctly aligned the compass bearing of the signal is directly indicated.

When used with transceivers an RF activated relay built into the control unit allows 'talk through' by diverting the transmitter signal to the normal antenna.

Model DF will work with FM receivers ranging from pocket scanners to mobile or marine radio telephones and including VHF amateur radio and CB transceivers.

In addition to the display unit and the antenna combiner unit, a complete system needs four omnidirectional antennas (e.g. conventional quarter wave whips or half wave dipoles) mounted in a square array (see later sections).

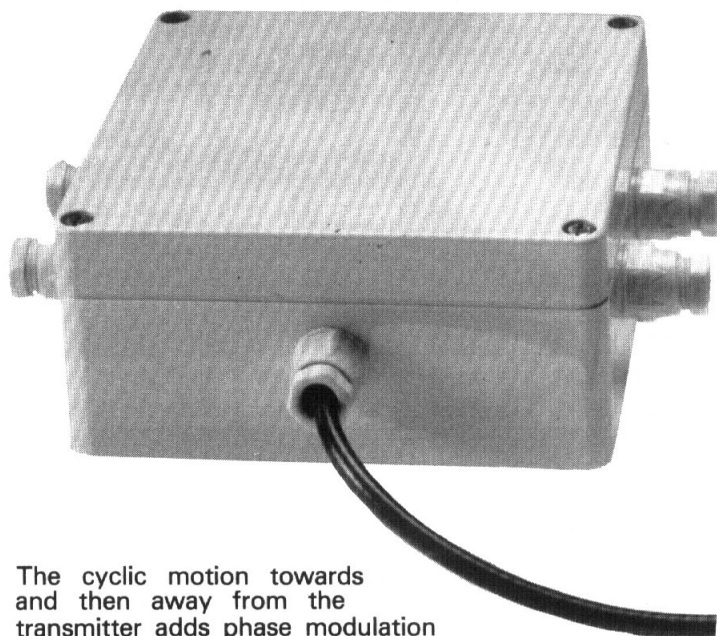
APPLICATIONS

Model DF costs between ten and a hundred times less than conventional RDF systems, and therefore opens up new application areas for both professional and hobby users.

Applications include: VHF amateur radio, Citizen's Band radio, aircraft spotting, tracking gliders and light aircraft, locating lost model aircraft, private mobile radio systems, coastal and marine radio, tracking and locating anti-social radio operators, locating 'tagged' animals in the wild, helping to identify or trace unknown transmissions, law enforcement.

HOW IT WORKS

Model DF uses the so called Doppler principle in which a single antenna moves rapidly in a horizontal circular path.



The cyclic motion towards and then away from the transmitter adds phase modulation to the received signal and after demodulation in the detector of an FM receiver followed by filtering, a sinusoidal signal is obtained. The frequency of this signal is equal to the rotation rate of the antenna, and its phase relative to the antenna rotation is related to the direction of arrival of the radio signal.

To avoid the obvious drawbacks of mechanical rotation, Model DF simulates a rotating antenna electronically. Four quarter wave whip or half wave dipole antennas are mounted at the corners of a square, the separation being between about 0.05 and 0.3 of a wavelength. A special electronically controlled attenuator using PIN diodes smoothly transfers the receiver connection from one antenna to another. The resulting signal is then similar to that obtained from an antenna actually moving in a circle yet without any mechanical complications.

TECHNICAL DETAILS

The Model DF system has been designed using the latest technology to give excellent performance at remarkably low cost.

Installation is greatly simplified by the fact that only a single coaxial cable is needed to connect the display unit to the antenna combining unit. The normal control cables associated with Doppler D.F. systems have been eliminated by placing a phase locked loop system plus drive electronics at the antenna. This reduces installation costs, especially where the antenna is remotely located, and also means that existing coaxial cable runs can be used if desired.

It also means that alternative special purpose antenna systems can be easily used with the system as and when they become available.

A major technical feature of Model DF is the smooth switching technique used in the head unit. This avoids one of the problems associated with conventional non-mechanical Doppler DF systems. Typically these use abrupt switching techniques to step from one antenna to the next in the circular array of antennas. With this technique the phase modulation waveform is stepped instead of smooth, and therefore all incoming signals have sidebands added corresponding to harmonics of the switching frequency. High order sidebands from a strong adjacent channel signal can often be sufficiently strong to cause serious interference to the desired signal. The PIN diode smooth-switching technique used in the Datong system was optimised using computer simulation methods and reduces such effects to a very low level.

Two commutated capacitor filters are used in the signal processing circuits. One of them extracts the modulation signal from speech and noise prior to the digital phase

comparison circuits. The bandwidth of this filter is controlled by the knob labelled "RESPONSE" and determines the speed of response of the display to a changing bearing. The second filter notches out the superimposed modulation signal so that it does not disturb normal reception. After notching, the signal passes via the "VOLUME" control to a 2 watt audio power amplifier (LM380) which then drives an external loudspeaker.

INSTALLATION AND OPERATION

A complete RDF system requires the following items of equipment.

1. A narrow band FM receiver for the desired frequencies.
2. Model DF control and display unit.
3. Model DFA1 or DFA2 antenna combiner unit. (These are identical except that Model DFA2 is fitted with a magnetic base for car roof installations and with a four metre output lead - see below).
4. Four identical antennas with coaxial cables to connect to item 3.
5. An external loudspeaker to plug into the display unit.

In addition a coaxial cable jumper lead (e.g. Datong LEAD D) will be required to connect between the receiver and the control unit. The control unit requires an external power source of 12 volts DC (from the car electrical system in mobile applications or from a mains power supply such as the Datong Model MPU).

The nature of the antennas mentioned in item 4 will depend on the application. For mobile use four magnetically mounted quarter wave whip antennas are ideal, and in this case Model DFA2 combiner unit would be appropriate since it can be conveniently mounted between the antennas on the car roof. For fixed station use, four ground plane antennas or four vertical dipoles should be mounted symmetrically on a vertical mast together with Model DFA1 combiner unit.

In either case the distance between adjacent antennas should be between about 0.05 and 0.3 wavelengths.

The connectors fitted to the Display Unit are as follows: Audio input (Phono), Loudspeaker output (Phono), R.F. output to receiver (SO239 coaxial), R.F. input from D.F. antenna (SO239 coaxial), R.F. input from normal antenna (SO239 coaxial). Power supply (3.5mm jack, and concentric type DC connector wired in parallel).

Connection to the antenna combiner unit is via five two-pole screw connector blocks mounted on an internal PCB. Each connector accepts a coaxial cable which enters the box via one of five waterproof compression glands. Model DFA1 is supplied without any cable, while the magnetic version, Model DFA2, is supplied fitted with a four metre coaxial output lead terminated in a PL259 plug to suit the Display Unit.

TECHNICAL INFORMATION

Supply voltage:	10 to 15 volts DC
Supply current for display unit only:	400 mA (full audio volume) 70 mA (quiescent)
Supply current for antenna combiner:	10 mA. The supply is automatically fed together with synchronising signals from the display unit via the coaxial antenna feeder.
Current limit:	the display unit is protected against damage due to short circuits in the coaxial cable feeding the combiner unit.
Frequency range:	20 to 200 MHz, depending on the chosen antennas.
System accuracy:	± 5 degrees. Initial zero trimming (via knob at centre of display) on a known signal is needed to compensate for any audio phase shifts in the receiver.

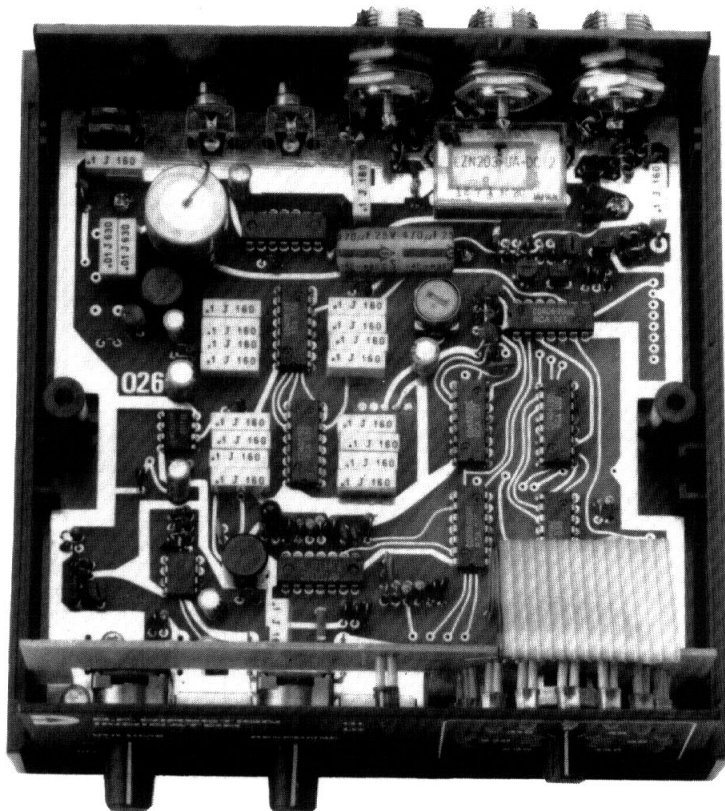
Readout:	16 bright green LED's at 22½ degree intervals, giving a resolution of + 11¼ degrees.
Audio power output:	1.2 watts into 8 ohms, 2 watts into 4 ohms (assuming 3% distortion and 12.5 volt supply).
Controls:	Audio volume, response time, phase trim, CONT/BLANK (display either stays on continuously or goes out approx 5 seconds after signal ceases), NML/INV (allows for odd or even number of stages in the receiver's audio system).
Antenna commutation frequency:	876Hz
Dimensions:	Model DF (Display Unit), width 153mm (6 inches), height 64mm (2.5 inches), depth 158mm (6.2 inches). Knob and connector projections add 18mm (0.7 inches) to depth. Model DFA1 and DFA2, 120 x 120 x 55 mm (4.7 x 4.7 x 2.2 inches) Cable glands protrude 20mm (0.75 inches). Magnet adds 15mm (0.6 inches) to height.
Approx. weights:	Model DF 500 gms (18 ounces) Model DFA1 340 gms (12 ounces) Model DFA2 700 gms (25 ounces)

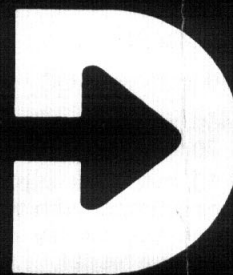
ACCESSORIES

Model DF (Display Unit) is supplied with two power supply connectors, and two 1 metre screened leads with phono plugs at one end, the other end being unterminated. The leads allow easy connection to receiver and loudspeaker.

OPTIONAL ACCESSORIES

Model MPU:	mains power unit.
LEAD D:	coaxial jumper lead 1 metre long with PL259 coaxial plug at each end.
Model MA1:	a good quality quarter wave whip antenna with magnetic mount and four metres of coaxial cable. (Four are needed for a DF system).





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