

**HUMAN EXPOSURE TO RADIO FREQUENCY ELECTROMAGNETIC FIELDS WITH MCC 545C/B  
RADIOS  
ENGINEERING STATEMENT  
4/13/01**

**TX Duty Cycle AND Tx power**

The MCC 545B/C radios operate in the low band VHF frequency region (37-50 MHz), with maximum transmit power levels of 100 watts, and with a maximum TX duty cycle of 10%.

The Packet Data Radio is operated in ½ duplex using a solid state PIN diode T/R switch. Maximum TX time and duty cycle is governed by the RF protocols used to transmit and receive RF packets. The maximum transmission time for any packet is limited to less than 100-milli sec. Most frames are ½ of this. Typical duty cycles are less than 1 % (transmit a position report (every 30 seconds) or weather data report (every 5 minutes)).

To prevent the transmitter from over heating software in the control processor limits the maximum number of transmissions in a fixed period of time (typically 2 –3 seconds) such that the maximum duty cycle is less than 10%. This duty cycle limit effectively reduced (for purposes of the MPE calculation) the average transmitted RF power to 10 watts or less.

**Calculations of MPE (Maximum Permitted Exposure) Distance**

The FCC guidelines limit the maximum permitted exposure for Occupational/Controlled Exposure to 1 mw/sq. cm for frequency ranges of 30-300 MHz. This limit and the following equation for calculating field strength (obtained from OET Bulletin 65) is used to calculate the minimum separation between humans and the transmit antenna based on MPE

$$S = P * G * DC / (4 * \pi * R^2)$$

P = Transmit power in milliwatts = 100,000

G = Antenna gain referenced to an isotropic radiator

= 1.68 (2.2dbi) mobile                      quarter wave dipole mounted to fender or roof of automobile

= 10.0 (10.0 dbi) fixed                      5 element yagi mounted to top of fixed antenna tower

= 3.3 (5.2 dbi) fixed                      half wave dipole mounted to fixed antenna tower leg

R = separation required      cm

DC = Maximum duty cycle of transmitter = 10 %

S = Power density = 1 milliwatt/square cm

This equation is accurate for the far field of an antenna, but will over-predict power density in the near field. Thus, the near field MPE distances calculated here are “worst case” or conservative.

Mobile application                      R = .36 meters (14 inches) with quarter wave dipole

Fixed applications                      R = .90 meters with 5 element yagi

R = .52 meters with side mount half wave dipole

## **Proposed manual wording**

The mobile applications:

The antenna used for mobile application must have a maximum antenna gain of less than 2.2 dBi ( $\frac{1}{4}$  wave dipole or  $\frac{1}{2}$  wave dipole) and must be mounted such that the separation between the antenna and any human occupants of the vehicle exceeds .36 meters (14"). The best location for antenna mounting is the center of the vehicle roof. This will provide additional RF shielding between the antenna and the human occupants that reduces the RF exposure to levels well below that specified in FCC OET Bulletin 65.

When working on the antenna and or co-ax cable always disable the transmitter by turning its power off.

For fixed applications

For fixed applications, antenna gains and mounting techniques can vary depending on the application. For Yagi antennas whose gain does not exceed 10 dBi, that antenna must be mounted a minimum of .90 meters from any human occupants. Lower gain antennas, such as side mount dipoles, exhibit lower gain (5.2 dBi) allow closer separations (.52 meters for 5.2 dBi antennas). This will provide RF shielding between the antenna and the human occupants that reduce the RF exposure to levels below that specified in FCC OET Bulletin 65.

When working on the antenna and or co-ax cable always disable the transmitter by turning its power off.

Antenna Specs

The enclosed JPEG files give the specifications for the various antennas that can be used in the mobile and in the fixed applications.

## Larsen® Kūlrod® Mobile Antennas LOW BAND

*Larsen base loaded mobile antennas: high performance for all low band frequencies.*

### **NLA SERIES**

*Low-profile, easy 3/8" snap-in installation*

### **NMO SERIES**

*Compatible with Motorola TAD/TAE type 3/4" hole mount products*

### **PO SERIES**

*For SO-239 type female connector or Larsen PO mount*

*27-30 MHz, 30-35 MHz,  
34-40 MHz, 40-50 MHz,  
47-54 MHz, 52-88 MHz &  
88-136 MHz*

Larsen low band antennas are designed and built to deliver a difference you can hear and an improved appearance you can see. They have the exclusive Kūlrod plating that assures you maximum radiation efficiency without loss of power in rod resistance and heating. They are compatible with a variety of permanent and temporary vehicle mounts.

Count on Larsen low band antennas to come through loud and clear with these superior performance advantages:

- Handles full 200 watts of power.
- Low V.S.W.R. - 1.5 to 1 or less.
- Rugged, heavy duty base coils are *air wound* to prevent RF loss.
- Tough 17-7PH stainless steel Kūlrod plated whip for a sleek finish and maximum radiation efficiency. Available in black or chrome.
- Optional narrow diameter shock spring that is internally shorted with highly flexible insulated wire to eliminate distortion.
- Simplified tuning - just cut the rod for the required frequency.
- Choice of black or gray high impact plastic coils/bases guaranteed weather resistant.

Turn the page for complete details on individual Larsen low band antenna series.



NMO 27B

NLA 27B

PO 27B

MOBILE ANTENNAS - QUARTER WAVE LOADED (UNITY GAIN)  
MNO SERIES 3/4" HOLE

# Larsen® Kulrod® Mobile Antennas LOW BAND

## NMO Series

Larsen NMO antennas are our most popular series. They were designed for compatibility with the Motorola TAD/TAE mounting hardware for a 3/4" hole. Their proven superior performance, rugged dependability and low silhouette design delivers the desired gain that makes an important difference you can hear.

- Models available to cover all popular low band frequencies.
- Electrical types - 1/4 wave and loaded 1/4 wave designs provide unity gain.
- Mates with NMO permanent or temporary mounts for complete installation on the roof, trunk or fender.
- Optional NMO THK 3/8" hole mount is available for specialized mounting on thicker surfaces.
- Whips feature Larsen's durable and exclusive Kulrod finish for long life and top performance.
- Most models available in black or gray.
- NMO WB40 provides complete coverage of the 35-50 MHz frequency range. Sold as a complete unit including base/coil, whip, permanent mounting kit and coupler.

## 27-136 MHz

NMO 27	27-30 MHz
NMO 30	30-35 MHz
NMO 34	34-40 MHz
NMO 40	40-50 MHz
NMO 50	47-54 MHz
NMOQ 52	52-88 MHz
NMOQ 88	88-136 MHz
NMO WB40	35-50 MHz

(Complete low band product listing on pages 13 & 14)

- Each antenna is supplied with cutting instructions for precise tuning at your desired frequency. Allen wrench included for whip mounting.



FIG A



FIG B



FIG C



FIG D



FIG E

## MOUNTING OPTIONS

MODEL NUMBER	FIG.	MOUNTING TYPE	COAX SUPPLIED	CONNECTOR SUPPLIED	APPLICATION NOTES
NMO B	C	3/4" HOLE	NONE	NONE	MOUNTING HARDWARE ONLY
NMO B THK	D	3/8" HOLE	NONE	NONE	MOUNTING HARDWARE ONLY
NMO K	C	3/4" HOLE	12' RG-58 A/U	PL 259**	COMPLETE W/COAX & CONNECTOR
NMO K THK	D	3/8" HOLE	12' RG-58 A/U	PL 259**	COMPLETE W/COAX & CONNECTOR
NMO MM	A	MAGNETIC MOUNT	12' RG-58 A/U	58FCP**	COAX & CONNECTOR ATTACHED
NMO TLM*	B	TRUNK LID MOUNT	12' RG-58 A/U	PL 259**	COMPLETE W/COAX & CONNECTOR
NMO TMB*	E	TRUNK GUTTER MOUNT	12' RG-58 A/U	PL 259**	COMPLETE W/COAX & CONNECTOR

\*Also available in black

\*\*Connector Options-BNC, BNC CRIMP, 58FCP, MPL, N, N CRIMP, PL 259, PL 259T, TNC, TNC CRIMP

MOBILE ANTENNAS - QUARTER WAVE LOADED (UNITY GAIN)  
MNO SERIES 3/4" HOLE

## ELECTRICAL TYPES

To determine the best mobile antenna type to use in a particular installation, you should first be acquainted with all the electrical types available. Keep in mind that not all types are available in all mechanical configurations and frequencies.

### Loaded 1/4 wave (NLA, NMO & PO series)

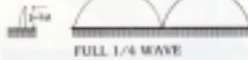
The loaded 1/4 wave type antenna is electrically a 1/4 wave, while being shorter than a full size 1/4 wave antenna. This is accomplished with a loading coil that places a portion of the electrical length of the antenna in a coil located at the base of the radiating element. The efficiency of the antenna depends on how much of the electrical length is inside the coil (and therefore not radiating). Typical gain is comparable to a full 1/4 wave where the full 1/4 wave is mounted on the fender and the loaded 1/4 wave is mounted on the roof. Typical length at lowest recommended frequency is 49".



LOADED 1/4 WAVE

### Full 1/4 wave (all series except KG)

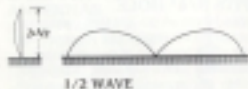
The 1/4 wave is a single radiating element 1/4 wavelength long. It is the simplest and least expensive type of antenna. Length varies from 34" long at 46 MHz to 3" long at 800 MHz. The 1/4 wavelength antenna requires no loading or matching coil. Typical gain is 0 dBi when mounted on a suitable ground plane.



FULL 1/4 WAVE

### 1/2 wave (KG, MHW, NLA, NMO, OM & PHW series)

The 1/2 wave antenna is a single radiating element 1/2 wavelength long. Because the end fed impedance of the antenna is not suitable for matching the radio, an impedance matching transformer is used at the base of the radiating element. Length varies from 49" at 120 MHz to 12" at 450 MHz. The 1/2 wave antenna is suitable for use where no ground plane exists. The gain with no ground plane is 0 dBi. Gain with suitable ground plane is 2.4 dBi.



1/2 WAVE

### 5/8 wave (LA, LM, NLA, NMO & PO series)

The 5/8 wave antenna is a single radiating element 5/8 wavelength long. In single element antennas the 5/8 wave antenna has the best performance (3 dBi) when mounted on a suitable ground plane. Element length varies from 34" at 136 MHz to 32" at 220 MHz. Since the end fed impedance of a 5/8 wave antenna is unsuitable for interface with a radio, an impedance transformer is used at the base of the rod. The antenna must be mounted on a suitable ground plane.



5/8 WAVE

### Collinear 5/8 over 1/2 wave (all series)

### Collinear 5/8 over 1/4 wave (all series)

These collinear designs have two elements separated by a phasing coil. The top element is a 5/8 wave and the bottom element is either a 1/2 wave or 1/4 wave. Gain is typically 5 dBi for the 1/2 wave lower element and 3-4 dBi with the 1/4 wave lower element when mounted on a suitable ground plane. Antenna length is 25" to 29" at 450 MHz depending on the lower element. The end fed impedance matches the transmitter's impedance, so no transformer is used.



5/8 OVER 1/2 WAVE  
5/8 OVER 1/4 WAVE

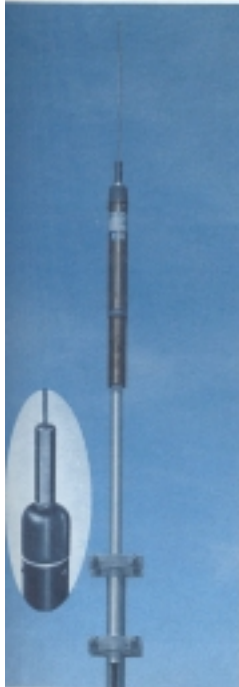
### Collinear 5/8 over 5/8 wave (MHW, NLA, NMO, OM & PHW series)

This collinear design has two elements separated by a phasing coil. Both top and bottom elements are 5/8 wavelengths. Gain is typically 5 dBi when mounted with or without ground plane. Collinear element length is 33" at 450 MHz. The end fed impedance does not match the transmitter's impedance, so a transformer is used.



5/8 OVER 5/8 WAVE

## DB205 COAXIAL ANTENNA UNITY GAIN, 33-174 MHz

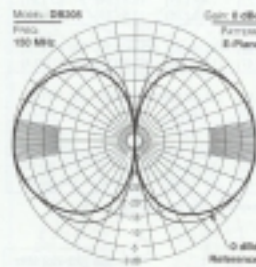


An excellent performer in extreme conditions, the DB205 is a heavy-duty unity gain omni antenna for 33-174 MHz. Models are cut to frequency and tested at the factory; however, uncut models are available.

- **Rugged** - Absorbs severe vibration and withstands rough handling; ideal for all well drilling and similar applications.
- **Effective Design** - Includes a coaxial half-wave dipole antenna with an upper quarter-wave whip radiator, a center insulator and lower quarter-wave skirt radiator, isolated from the antenna support pipe.
- **Tough Insulator** - Molded of durable epoxy and virtually unbreakable.
- **Moisture Resistant** - A feed-through connector and top mounting stud are inserted into the insulator, which also simplifies the replacement of the radiator or feeder cable.
- **Enduring Metals** - The upper radiating element is spring-tempered stainless steel, the lower skirt is non-corroding brass.
- **Easy Mounting** - Galvanized steel DB205-OS Mount is furnished for mounting atop a tower, pole or building.

**Ordering Information** - Use model number for correct frequency and specify termination if non-standard.

Models F and M are UPS Shippable.



Electrical Data	
Frequency Ranges - MHz:	A = 33-60, B = 60-72, C = 72-88, E = 180-144, F = 144-175
Uncut models:	L = 33-58, M = 150-174
Bandwidth:	2% of frequency
VSWR:	1.5 to 1 or less
Nominal impedance - ohms:	50
Gain (over half-wave dipole) - dB:	Unity
Maximum power input - watts:	500
Vertical beamwidth (full power points):	75°
Lightning protection:	Direct ground
Standard Termination: Captive Type N-female attached to end of flexible lead. Other fittings are available on special order. If LRF connector is required, an adapter is provided.	

Mechanical Data				
	35 MHz	60 MHz	75 MHz	160 MHz
Whip radiator	17-7 PH stainless steel rod	17-7 PH stainless steel rod	17-7 PH stainless steel rod	17-7 PH stainless steel rod
Whip insulator	Molded epoxy	Molded epoxy	Molded epoxy	Molded epoxy
Skirt - in. (mm)	Brass, 2 (50.8) diameter	Brass, 2 (50.8) diameter	Brass, 2 (50.8) diameter	Brass, 2 (50.8) diameter
Support pipe - in. (mm)	Galvanized steel, 1 (25.4) dia., 24 (609.6) or more available for mounting	Galvanized steel, 1 (25.4) dia., 24 (609.6) or more available for mounting	Aluminum, 1 (25.4) dia., 24 (609.6) or more available for mounting	Aluminum, 1 (25.4) dia., 24 (609.6) or more available for mounting
Minimum exposed area (flat plate equivalent) - ft <sup>2</sup> (m <sup>2</sup> )	5.2 (.11)	5.0 (.89)	8.7 (.87)	3 (.00)
Wind thrust at 100 mph (161 km/hr) - lbs. (kg)	50 (22.68)	43 (19.50)	29 (13.18)	13 (5.90)
Wind moment, 12' (3.66 m) below skirt, at 100 mph (161 km/hr) - ft. lbs. (kg m)	180 (26.82)	135 (18.88)	58 (8.02)	19 (2.63)
Survival without ice - mph (km/hr)	over 118 (177)	over 128 (201)	over 125 (201)	over 125 (201)
Survival with 3" (76.2 mm) radial ice - mph (km/hr)	118 (177)	over 125 (201)	over 125 (201)	over 125 (201)
Overall length - in. (mm)	217 (5511.8)	208 (5232.4)	119 (3022.6)	71 (1803.4)
Wt weight (whirlwinds) - lbs. (kg)	30 (17.24)	36 (16.33)	27 (12.25)	19 (8.62)
Shipping weight (whirlwinds) - lbs. (kg)	52 (23.58)	50 (22.68)	35 (15.88)	28 (11.79)
Mounting clamps (galvanized steel)	DB205-OS	DB205-OS	DB205-OS	DB205-OS

MOBILE ANTENNAS (MARINE) DIPOLE END FED UNITY GAIN

## DB212 SIDE MOUNT ANTENNA UP TO 12.2 dB GAIN, 30-88 MHz



DB212 center-fed antennas, when mounted on the side of a tower, provide the optimum in gain, tower utilization, lightning protection and precipitation static reduction.

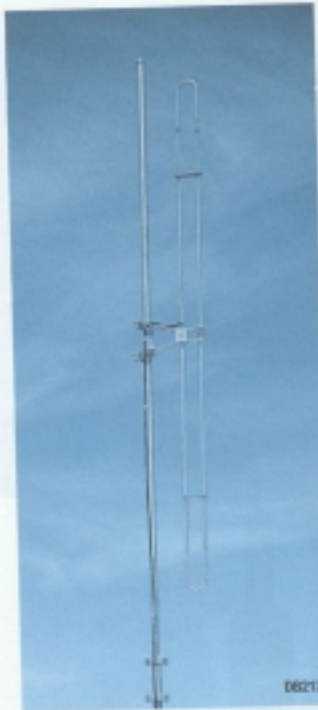
- **Flexibility** - Models of the DB212 are offered with one, two, three, four or six elements, indicated by the suffix number at the end of the model number.
- **Tower Mounted** - Antennas must be mounted on, and work against, a metal tower leg or pipe parallel to and longer than each folded radiator. Gain will be reduced on towers with faces larger than 18 to 35 inches (457.2 to 889 mm).
- **Offset Pattern** - Get maximum directional gain by mounting all elements collinearly on one leg of the tower.
- **Circular Pattern** - Achieved by mounting elements on all legs of the tower.
- **Weather Resistant** - Side mounted antennas have fewer lightning and static problems than top mounted ones. Metal elements operate at DC ground. Additional protection from static is available by wrapping the antenna with electrical grade poly tape.
- **Easy Mounting** - Mounting clamps and interconnecting cables for tower faces up to 5" (1.52 m) are included. Larger clamps and cables are also available.

**Ordering Information** - Specify DB212 plus the number of elements, i.e., DB212-4, plus frequency -A, -B, -C or -D.

Minimum Tower Height Recommendations					
Frequency (MHz)	DB212-2	DB212-3	DB212-4	DB212-5	DB212-6
Vertical span on tower (approx.) - ft. (m)	35 10	40 (12.19) 31 (9.45)	67 (20.42) 51 (15.54)	86 (26.21) 69 (21.03)	134 (40.84) 106 (32.30)
Maximum exposed area - ft <sup>2</sup> (m <sup>2</sup> )	35 10	2.9 (.27) 1.9 (.18)	4.4 (.41) 2.8 (.26)	5.8 (.54) 3.8 (.35)	8.7 (.81) 5.7 (.53)
Wind load at 100 mph (161 km/h) - lbs. (kg)	35 10	116 (52.62) 76 (34.47)	176 (79.83) 112 (50.80)	232 (105.23) 152 (68.94)	348 (157.18) 228 (103.4)
Minimum recommended tower height - ft. (m)	35 10	110 (35.53) 80 (24.23)	130 (39.62) 105 (32)	260 (79.25) 190 (57.21)	400 (121.92) 295 (89.92)
Net weight - lbs. (kg)	35 10	31 (14.06) 27 (12.25)	65 (29.48) 43 (19.5)	74 (33.52) 60 (27.22)	130 (58.97) 86 (39.04)
Shipping weight - lbs. (kg)	35 10	47 (21.32) 35 (15.88)	89 (40.37) 70 (31.75)	106 (48.08) 76 (34.47)	178 (80.74) 140 (63.50)

Note: The stable height of a tower includes the height of the site above the average terrain at the base of the tower.

See 220-222 MHz  
Special Section



### Electrical Data

Frequency Ranges - MHz	A = 30-33, B = 33-40, C = 42-50, D = 72-88
Bandwidth	2% of frequency
VSWR	1.5 to 1 or less
Nominal impedance - ohms	50
Gain (over half-wave dipole)	See patterns
Maximum power input - watts	500
Lightning protection	Direct ground
Standard Termination	Captive Type N-Male attached to end of flexible lead. Other fittings are available on special order. If UHF connector is required, an adapter is provided.

### Mechanical Data

Radiating elements - in. (mm)	Aluminum 75 (19.1) dia. with .875 (22.3) dia. socket
Mounting bracket	Cast aluminum
Wind rating:	
Survival w/o ice - mph (km/hr)	125 (201)
Survival with .5" (12.7 mm) radial ice - mph (km/hr)	80 (129)
Mounting	Stainless steel banding straps are supplied with 30-50 MHz antennas. V-Bolt mount is included for 72-88 MHz range. Other size straps can be supplied on special order, also sway braces.



**DB212-1 (1 Element)**



**DB212-4 (4 Elements)**



Triangular tower

**DB212-3 (3 Elements)**



Triangular tower

**DB212-2 (2 Elements)**



Triangular tower



Square tower



Collinear mounting



Square tower



Collinear mounting

**DB212-6 (6 Elements)**



Triangular tower



Collinear mounting



Collinear mounting

The graphs show the radiation patterns, in dB referenced to a vertical half-wave dipole, for several models of the DB212 antenna when mounted on triangular and square 19-24 inch (487-610 mm) towers as measured across the face of the tower.

# SCALA

PROFESSIONAL ANTENNA SYSTEMS FOR  
BROADCAST AND COMMUNICATIONS

## METEOR BURST ANTENNAS

4 to 7.5 dBd gain  
40-50 MHz  
Horizontally polarized



MBY-5

### MBY series yagi

The MBY series of antennas for meteor-burst communications include 2, 3, and 5 element ruggedized center-mount yagis. Elements and booms feature a two-piece design to facilitate transport to remote sites, with quick and convenient assembly for installation.

All of the MBY series of antennas use heavy-wall seamless drawn aluminum pipe, ruggedized aluminum castings and stainless steel hardware. Anodizing further assures corrosion resistance and extended service life in difficult environmental conditions.

### MBO dipole

The Scala MBO is an extra-heavy dipole antenna, featuring a sealed cast housing for the feedpoints and a laminated dipole structure for superior strength and durability.



MBO

### MBO cross

The Scala MBO is a very heavy-duty crossed-dipole (turnstile) array of two Scala MBO dipoles providing an omnidirectional pattern. The antenna features a sealed cast housing for the feedpoints and laminated dipoles for superior strength and durability.



MBO

### CAS-40 yagi

The Scala CAS-40 is an extra heavy-duty five-element yagi antenna with a 1,000 watt input rating. Laminated elements and double booms provide maximum strength and long term reliability. Stainless steel hardware and anodized aluminum components assure a high level of corrosion resistance.

A two-bay stacking harness is available, providing increased gain and directivity by vertically stacking two yagis.



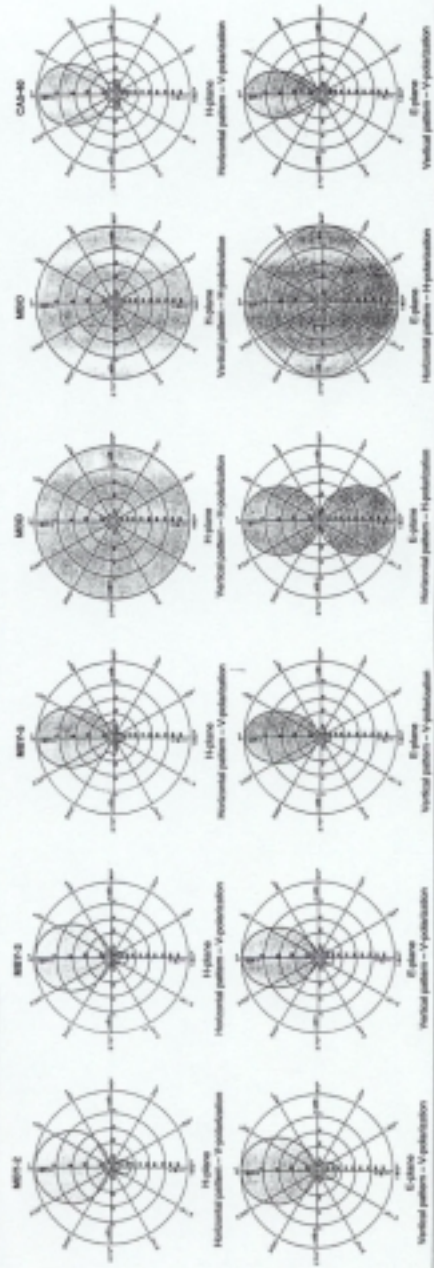
CAS-40

FIXED STATION ANTENNAS (2,3 AND 5 ELEMENT YAGI'S)

# **SCALA** **METEOR BURST ANTENNAS** 4 to 7.6 dBd gain 40-50 MHz Horizontally polarized

Specifications:	MBT-2	MBT-3	MBT-4	MBO	MBL-40
Frequency range	40-50 MHz (specify frequency)	40-50 MHz (specify frequency)	40-50 MHz (specify frequency)	40-50 MHz (specify frequency)	40-50 MHz (specify frequency)
Gain	4 dBd	5.5 dBd	7 dBd	8 dBd	7.5 dBd
Impedance	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms
VSWR	<1.5:1	<1.5:1	<1.5:1	<1.5:1	<1.5:1
Polarization	Horizontally or vertically	Horizontally or vertically	Horizontally or vertically	Horizontally	Horizontally or vertically
Feed-to-back ratio	>11 dB	>13 dB	>15 dB	>16 dB	>14 dB
Maximum input power	500 watts (at 50°C)	500 watts (at 50°C)	500 watts (at 50°C)	500 watts (at 50°C)	500 watts (at 50°C)
H-plane beamwidth	84 degrees (half power)	78 degrees (half power)	68 degrees (half power)	58 degrees (half power)	58 degrees (half power)
E-plane beamwidth	14 degrees (half power)	14 degrees (half power)	14 degrees (half power)	14 degrees (half power)	14 degrees (half power)
Termination	14 or 27 ohm (50 ohm)	14 or 27 ohm (50 ohm)	14 or 27 ohm (50 ohm)	14 or 27 ohm (50 ohm)	14 or 27 ohm (50 ohm)
Weight	13.5 to 25.5 kg	20 to 30 kg	30 to 40 kg	30 to 40 kg	30 to 40 kg
Dimensions	140 x 41.8 inches (3556 x 1064 mm)	140 x 41.8 inches (3556 x 1064 mm)	140 x 41.8 inches (3556 x 1064 mm)	140 x 41.8 inches (3556 x 1064 mm)	140 x 41.8 inches (3556 x 1064 mm)
Equivalent for plate area	1.37 sq ft (12.6 sq m)	1.37 sq ft (12.6 sq m)	1.37 sq ft (12.6 sq m)	1.37 sq ft (12.6 sq m)	1.37 sq ft (12.6 sq m)
Wind survival rating	130 mph (205 km/h)	130 mph (205 km/h)	130 mph (205 km/h)	130 mph (205 km/h)	130 mph (205 km/h)
Climbing dimensions	86 x 8 x 5 inches (2184 x 203 x 127 mm)	86 x 8 x 5 inches (2184 x 203 x 127 mm)	86 x 8 x 5 inches (2184 x 203 x 127 mm)	86 x 8 x 5 inches (2184 x 203 x 127 mm)	86 x 8 x 5 inches (2184 x 203 x 127 mm)
Shipping weight	20 to 30 kg	20 to 30 kg	20 to 30 kg	20 to 30 kg	20 to 30 kg
Mounting	For mounts at 2.25% back (80 mm) O.D.	For mounts at 2.25% back (80 mm) O.D.	For mounts at 2.25% back (80 mm) O.D.	For mounts at 2.25% back (80 mm) O.D.	For mounts at 2.25% back (80 mm) O.D.

Order Information:  
Contact Scott Customer Service for complete order information.



FIXED STATION ANTENNA PATTERNS & SPECS (2,3,AND 5 ELEMENT YAGI'S)