

C-Band Trailer



C-Band Trailerized Earth Station



1 TECHNICAL DESCRIPTION

Physical Description: This Satcom Scientific trailerized HD/SD earth station is designed to be a self-contained C-band mobile earth station terminal that can be delivered as a turnkey system or a rack-ready unit for customer integration of his own equipment. The trailer is capable of being towed by any ¾-ton (or larger) pickup truck or commercial flatbed vehicle that is equipped with a gooseneck hitch and a 2 -5/16 inch ball. Satcom Scientific recommends the Draw-Tite® DT-6300 or equivalent hitch when pulling the trailer. Two 48-inch toolboxes -- one on each side of the trailer just forward of the front tires -- are available as an option. These boxes are intended for storage of power cables, tools, and other ground tackle.

Size: This trailerized C-Band earth station is built on a dual-axle, steel transport frame that has a 96-inch gooseneck and a 293-inch mounting deck. The transport frame also has a 30-inch fantail that acts as a bumper. The overall unit length, including the gooseneck, is four hundred-nineteen (419) inches. The transport frame is ninety six (96) inches wide and features two spring suspension-type axles rated at 7,000 pounds each. The axles are equipped with four 235/85R16E heavy-duty trailer tires with a capacity of 3,500 pounds each. The tires should be inflated to 80 psi. The maximum overall height of the unit when the antenna is stowed is one hundred thirty-two (132) inches. The lowest part of the trailer deck is nineteen (19) inches above ground level to provide a low center of gravity and improved handling stability during high-speed travel.

Weight: The trailer transport frame weighs 4,400 pounds and has a GVWR of 16,000 pounds. The completed (rack ready) trailerized Racetrack earth station weighs approximately 12,000 pounds depending on the specific equipment configuration and options.

Composition: A major design goal in the development of the trailerized Racetrack earth station product was to achieve a high degree of structural strength and integrity at a low weight. The trailer frame is constructed of ten-inch structural steel I-beam channel framed on 3x5-inch steel deck angle. The cross members are constructed of 3-inch steel channel set on 16-inch centers. The trailer deck is ¼-inch steel diamond deck plating that is welded to the cross members and the surrounding deck angle frame.

The equipment shelter is framed with two-inch (2" x 2" x .125") 6063-T5 square aluminum tubing and covered with a non-riveted skin of .090 aluminum. The interior wall section is then filled with blown-in urethane foam that provides an R-factor of +15. Another .090 aluminum skin is used to seal the inside wall section. Each wall section and the roof rails are fitted to locking extrusions, and are welded in place to add strength and rigidity to the shelter. The roof section corners are also fitted with welded caps. The resulting structure not only provides superior rigidity, but also increases insulation and



improves structural integrity. The entire trailer is etched, primed, and painted with two coats of white polyurethane enamel.



Towing: At a minimum, a $\frac{3}{4}$ -ton pickup truck with heavy-duty suspension and an electric brake converter is required to tow this trailer. However, Satcom Scientific recommends the use of a 1-ton pickup with dual rear wheels for maximum safety and performance. The trailerized C-Band earth station is designed to be towed safely at speeds of up to 65 MPH on paved roads and well-maintained highways. The unit may be towed over rough terrain or unpaved roads as long as safe towing speeds are maintained. The tow vehicle manufacturer's specifications for maximum towing weight and towing configuration should always be consulted for safe roadway operation. The trailerized earth station meets or exceeds all Federal Highway Administration regulations for interstate transport and Department of Transportation guidelines as set forth in Title 49, subparts B, C, E, F, and J.

Suspension: The trailer incorporates tandem slipper spring suspension axles rated at 7,000 pounds each. The axles are fastened to the 10-inch structural steel I-beams to provide a smooth, low vibration ride for electronic components. Tire ply and size is sufficient to support weights up to the limitations of the axles. The axles are equipped with electric brakes that will greatly reduce stopping distance and enhance over-the-road travel safety and handling. The trailer also features an emergency brake away system that applies the brakes to the trailer if the trailer should become uncoupled from the tow vehicle.

Lights: Brake lights, running lights, and turn signal indicators are included on the trailer, recessed and flush-mounted into the trailer frame and along the equipment shelter walls. A quick-disconnect, 6-pin, 12-volt DC commercial connector is supplied with each trailer for connection to the tow vehicle tail light circuit. (For military applications, vehicle MIL connectors and 24VDC lighting is standard.)

Stabilizers: Four permanently-mounted, manually-activated stabilizer mechanisms have been outfitted to the corners of the trailer to provide manual leveling of the trailer and provide additional antenna stability during high wind conditions. The stabilizers are recessed on the underside of the vehicle to assure minimum protrusion below the vehicle when retracted, but they will have sufficient displacement to level the vehicle to compensate for up to 5° of slope on any axis. In areas of very uneven terrain, the jacks can be manually adjusted for a maximum degree of level and stability. Tie-Down Rings are also provided so that the trailer can be secured to the ground for operation in winds above 45mph. The trailer will withstand winds from 65mph to 100 mph when in the stowed position with all six tie-down rings secured to the ground. See drawing labeled *Streetside View* for further detail.

2 EQUIPMENT SHELTER

Size: The standard equipment shelter with roof-mounted air conditioners measures eight (8) feet in length, eight (8) feet in width and seven (7) feet in height. If the trailer is supplied instead with the optional Bard wall-mount air conditioners (*as shown in the photo on cover page*), then the equipment shelter is the same dimensions in length and width, but is nine (9) inches taller than when the roof-mounted air conditioners are used. The equipment shelter is constructed completely in aluminum, which provides an easily maintained, non-corrosive enclosure.

Construction: Each shelter wall, floor, and roof section is framed with 2-inch by 2-inch 6063 T5 structural aluminum tube that is welded on all sides with vertical tubes set on 16-inch centers to provide an extremely strong and durable structure. The exterior walls are then covered with a non-riveted 0.090-inch aluminum sidewall skin. The skins are attached to the wall frames using a 3M VHB tape rather than rivets; therefore, the skins are never penetrated. The exterior of the roof frame is covered with 1/8-inch heavy aluminum 3003 *Treadbrite* plate which is fully welded to the roof extrusions. The *Treadbrite* plate is also taped to the roof frame tubes using the 3M VHB tape. The exterior of the floor section is covered with a 0.90-inch painted aluminum vapor barrier skin. The wall sections are then attached to each other and the floor section using proprietary aluminum extrusions which are fully welded to the wall sections.

Integrity: The roof section is then placed on top of the wall sections and fully welded into place. Welded aluminum corner caps complete the roof section, finishing the exterior of the shelter. This fully welded technique provides a rust-free unit impervious to adverse weather conditions and produces excellent EMI/RFI suppression. The shelter is watertight under all adverse weather conditions, and the roof is designed to support a snow and ice load of more than 75 pounds per square foot. The roof can be walked upon, and is strong enough to support the weight of two persons without distortion to any section of the roof.

Interior: The interior sections of the walls, ceiling, and floor are then filled with a blown-in 2-part urethane foam which provides a thermal insulation property of +15, and acts as a rigid bond between the skins and the frame tubes. The foam is then trimmed and 3/8-inch sealed marine plywood is secured to the interior of the walls and ceiling. The interior floor section is covered with 3/4-inch sealed marine plywood providing a floor that will support extremely heavy loads without using extra load frame plates. The floor is capable of withstanding more than 2,500 pounds over any 3 square foot area without distortion. The walls and ceiling are then covered with a high quality flame retardant carpet. The floor is finished using Armstrong industrial rubber tiles that are durable and easy to maintain. (*See drawing labeled Rack Placement for further equipment shelter detail.*)



Doors: The equipment compartment is fitted with a single curbside watertight door and a door to access the I/O Panel. All doors feature continuous stainless steel hinges and locking, flush-mounted handles. The personnel door has a clear opening of 35 inches in width and 75 inches in height. The I/O panel door is 14 inches wide and 16 inches high. All doors are watertight and feature 2-point striker-type latching mechanisms which can withstand a 100-pound load at the outer edge. The personnel door is equipped with a latching feature that will hold the door open if required. The overhead-hinged I/O panel door is equipped with gas shocks to hold the door up in the open position while connections are made. The I/O panel door can then be closed and locked after the audio and video connections have been made. All door hardware is made of high quality polished stainless steel.

Stairs: An aluminum stairway is provided for access to the equipment compartment. The stairway mounts to the trailer frame just below the personnel door. The mounting hardware is a set of stainless steel hangers that accept the steel “T” bracket that is mounted to the top of the stairs. The steps of the stairs are constructed using *Stairgrip* extrusions that provide sure footing and help to decrease debris buildup inside the equipment shelter. The stairs also have self-aligning adjustable feet that allow the stairs to be used even on uneven terrain. The personnel stairs will support weights of up to 450 pounds.

Environmental: Two Carrier Air-V roof-mounted air conditioning units control the equipment shelter environment. Because of the unique construction of the Carrier units, these air conditioners outperform other standard 15,000 BTU air conditioners. The *Air V* air conditioners are constructed using all-copper coils, a powder coated base pan and high-strength polymer cover. Each air conditioner is rated for 15,000 BTU cooling and 5,600 BTU heat. The air conditioners utilize high capacity fans that deliver 362 cubic feet per minute airflow. Each air conditioner draws 14.5 amps (1,632 Watts) during the cooling cycle and 11.0 amps (1800 Watts) during the heat cycle. The air conditioners carry a full 2-year Carrier warranty.

Lighting: Each equipment shelter is equipped with two 48-inch twin bulb fluorescent lights. The light switch is mounted on the wall close to the personnel door and can be accessed from inside the shelter or while standing on the ground in front of the personnel door. The lights are placed on the ceiling over the rack sections.

3 ELECTRICAL SYSTEM

Utility Power: The *Satcom Scientific* trailerized earth station can be operated from any single-phase utility power source ranging from 195 to 240 VAC; 47 to 63 hertz. An optional UPS system can also be provided for selected technical loads. The trailer is connected to the utility power source using three (3) runs of #2 AWG entertainment grade cable. Two 50-foot utility power cables are provided with color-coded Cam-Lok connectors on both ends. The two 50-foot sections can be connected together to form a single 100-foot run. A set of 10-foot Pigtails are also provided that have matching E-1016 Cam-Lok connectors on one end, and bare wire on the other end. The ground connection on each cable set is deliberately reversed. The power cables can be stored in one of the optional 48-inch toolboxes, or inside the equipment shelter for travel. *(For further detail see drawing labeled Racetrack Electrical.)*

Main Power Disconnect: A 100-amp Main Circuit Breaker is provided in a NEMA-3 cabinet that bolts to the side of the diesel generator *(or to the ASCO Automatic Transfer Switch Cabinet if this option is selected)*. The matching color-coded Cam-Lok bulkhead connectors are mounted on the bottom side of the external Power Interface Panel that allows the operator to easily install the power cables. The Cam-Lok connectors form a weatherproof environment for the power cables. The main breaker should be in the *OFF* position during installation of the power cables.

Isolation Transformer: The output of the main breaker is then routed through metal conduit to the isolation transformer. The transformer is a custom-wound, *buck-boost*, 15 KVA isolation type that has seven (7) taps for operating the unit on any single-phase power source from 195 to 240 VAC supply. A seven-step manual tap switch is located inside the shelter that allows the operator to adjust the settings of this transformer to nominal range. The output of the isolation transformer is routed through metal conduit to the Utility Power side of the power selector switch *(utility-off-genset)* located on the interior Power Center Panel *(or to the primary input of the ASCO transfer switch if this option is present.)*

Diesel Generator: A Multiquip Model DCA-15SPX3 “*Whisper Watt*” diesel generator is mounted in a sound-attenuated cabinet behind the equipment and personnel shelter in front of the antenna. Sound level is 62 dB(A) at full load, 23 feet from the unit. The generator features a water-cooled, Kubota 4-cylinder engine that develops 24 hp at rated speed. The generator has an integral 16.3-gallon fuel tank that allows for approximately 12 hours of continuous operation between fueling. The generator provides 68 amps of power at 220 VAC. The generator is supplied with an electric block heater. *(The generator is also supplied with remote control circuitry to interface with the automatic transfer switch when present. The output of the generator is routed through metal conduit to the Emergency Input of the ASCO automatic transfer switch.)*



Automatic Transfer: As an option, an ASCO series 300 automatic transfer switch can be provided that will automatically switch the electrical system from the utility supply to the generator supply if the utility power should fail. The transfer switch features auto-start for the generator and a user-selectable time delay for switchover.

Power Center: A Power Monitoring and Control (M&C) Panel is provided in the interior section of the equipment shelter. A 100-Amp Main Circuit breaker and all subsystem circuit breakers are mounted on this panel. Metering of AC voltage, current, and frequency is also provided at the Power M&C Panel so that the operator can monitor inbound power.

Outlets: Two duplex outlets are provided inside the equipment shelter. One duplex outlet is on the wall in front of the equipment racks and another duplex outlet is on the wall at the rear of the racks. Both of the duplex outlets provide non-technical power. An additional GFI outlet is provided on the trailer deck between the antenna mount and the generator. This outlet is also fed from non-technical power, and is available to power the Hole Hawg drill when raising or lowering the antenna.



4 ANTENNA SYSTEM

Reflector: The Racetrack trailer is equipped with a Comtech 5.5-Meter Offsat antenna. The antenna is supplied with a three-port feed system (*Tx/Rx/Rx*). The reflector is a one-piece fiberglass antenna measuring 8 feet in width and 18 feet in length. The Offsat antenna conforms to all FCC rules concerning 2° satellite spacing.

Feed: The feed is motorized $\pm 12^\circ$ for peaking polarization. A 30° PLL LNB and transmit-reject filter is fitted to each receive port.

Antenna Mount: The antenna mount is a manual elevation-over-azimuth positioner. The elevation movement is accomplished by using a *Hole Hawk* hand-held drill motor with a socket that matches the elevation jack stud. Azimuth movement is accomplished by means of a hand wheel. (*Optional motorization of the Az and El planes and a jog-type controller can be provided as an option.*)

Waveguide & IFL: The waveguide from transmitters to the rear of the trailer consists of rigid WR-137. The waveguide from the feed to the reflector edge is rigid WR-137. Two pieces of 48-inch flex are provided: one or both can be used to provide sufficient length for reflector position. Two high quality RG-6 downlead cables are provided from the LNBs to the L-band Patch Panel. These cables and the polarization control cables are weather proof.

Antenna Specifications:

Electrical RF	Receive	Transmit
Operating Frequency	3.7 – 4.2 GHz	5.9 – 6.4 GHz
Gain @ Midband	42.0 dBi	45.9 dBi
VSWR		1.30:1
-3 dB Beamwidth	1.0°	0.65°
-15 dB Beamwidth	2.0°	1.30°
First Sidelobe Level (± 2 dB)	-24 dB	
Radiation Pattern	Meets or exceeds FCC requirement for 2° Satellite Spacing.	
Antenna Noise Temperature	32° K @ 10° Elevation	
Polarization	Linear	Linear
Power Handling Capability		2000 Watts
Cross Pol Isolation (On Axis)	35 dB	35 dB
Cross Pol Isolation (Off Axis 0.5 dB BW)	32 dB	32 dB
Cross Pol Isolation (Off Axis 1.0 dB BW)	30 dB	30 dB
Feed Port Isolation RX to RX	35 dB	
Feed Port Isolation TX to RX	60 dB	60 dB
Operational Wind Speed	45 mph deployed	
Survival Wind Speed	60 mph antenna deployed; 80 mph antenna stowed	
Temperature	Operational -20° F. to +125° F. Survival -40° F. to +140° F	

5 Theory of Operation

Interoperability The Satcom Scientific SD/HD Trailer is designed to be the most versatile and cost effective transportable satellite earth station available. In today's market, the service provider never knows what he may be asked to transmit, or what signals will be available from the production truck or studio facility. Sometimes the client will have his own encoders, and requires the uplink to modulate and uplink an ASI signal. Other times the uplink is also responsible for the encoding of the analog audio and video signals. Therefore, this unit is designed with an “*accept anything --return anything*” configuration to handle whatever is required in the field without having to rewire the transportable at every event. All cables and connectors are matched to the specific application for analog, SD, and HD signals. Extensive patching allows the service provider to configure the unit in any necessary fashion without modifying the rack wiring. Although this capability increases the initial cost of the transportable, it saves the service provider time and money in the long run, since all of the necessary hardware exists for any type of satellite uplink requirement.

Signal I/O Panel The trailer is equipped with a lighted and lockable signal I/O panel that allows for the interconnection of customer-supplied signals. The I/O panel is engraved to indicate the various inputs and outputs. The trailer will accept specific HD, SD and Analog video and audio signals. The I/O panel also provides a means for satellite return of HD, SD and analog signals back to the customer. The panel is designed to allow the customer to interface with any type of signal (Analog, SD, HD, ASI) input, and has provisions for any type of return (Analog, SD, HD, ASI) back to the customer. If the unit is to be used strictly as an RF terminal, there are two (2) IF inputs on the I/O panel that allow the operator to route an external 70 MHz signal directly to the upconverters. Likewise, an external ASI digital transport stream can be routed directly to the digital modulators. Audio and video tie lines are also provided on the I/O panel, as well as Telco connections.

Distribution Equipment All of the signals coming and going to the I/O panel appear on patch panels located in Rack #1 of the equipment shelter. In the case of the video signals, each input from the I/O panel is routed to a distribution amplifier. There are two (2) HD distribution amplifiers, two (2) SDI distribution amplifiers, and two (2) Analog distribution amplifiers. Two (2) outputs of the HD distribution amplifiers are routed through the video patch panel to the HD inputs of the encoders/DVB modulators. This signal passes through a set of HD/Analog monitors on the way to the encoder so that the inbound signal to each encoder can be monitored at all times. The two (2) SDI distribution amplifiers pass through the video patch panel and terminate to the SDI inputs of the encoders. These SDI distribution amplifiers also have an analog monitoring port which allows the SDI to be monitored from the analog monitor router. The two analog distribution amplifiers pass through the video patch panel and terminate to the analog inputs of the encoders. The outputs of the analog distribution amplifiers are also patched to the inputs of the monitor router. An additional analog distribution amplifier is supplied to route test signals to the encoding equipment. This DA is fully patchable and can also be used for a utility DA if needed.



Monitoring Equipment The monitor router allows the engineer to inspect any of the inbound or satellite return signals without interruption of the transmit or receive flow. The output of the monitor router is patched to the #1 analog input of the Leader 5700 Multi SDI Monitor. When the 5700 is selected to analog, the waveform, vector and picture information is displayed on the 5700 before being routed to the 17" flat screen LCD color monitor. This monitor accepts analog, SD and HD SDI signals and is auto detecting of the SD and HD signals. When the 5700 is selected to SDI the waveform, vector and picture information is displayed before being routed to the 17" engineering monitor. The 5700 also displays a status screen that checks the input signal for format, chroma and luma, video and audio ID, parity and check sum errors. The 5700 also decodes four stereo audio channels from the inbound HD or SDI signal and these audio outputs are routed to the audio patch panel. Additional inputs to the Leader 5700 are routed to the patch panel so that any other equipment can be patched to the 5700 for inspection.

Receiving Equipment The patch panels are designed to accept one analog receiver, two (2) SDI decoders and one (1) HD decoders. However, the patch panel has room for an additional HD decoder if the customer requires full receive redundancy. The receivers and SD decoders are cabled such that any of the satellite return signals can be inspected using the monitor router. The output of the HD decoder can be monitored from the HD/SDI input of the Leader 5700.

ASI Inputs and Outputs The ASI inputs of the satellite modulators and the ASI outputs of the encoders and decoders are all patched through the Canare video patch panels. These panels will accept analog and digital video signals with no distortion or roll off. Therefore the ASI output of the encoders can be routed to the ASI inputs of the decoders so that a loop back test can be accomplished prior to transmitting to the satellite.

Audio Signal Flow The audio flow matches the video flow of the system. Analog audio and digital audio can be routed from the I/O panel in a number of ways. Four (4) AES EBU audios are routed to the AES EBU audio patch panel from the BNC connectors on the I/O Panel. Four additional AES EBU audio connectors are provided as XLR connectors. Four (4) AES EBU audio baluns are fully patchable to accept coax and output to 3-wire, or accept 3-wire and output to BNC coax. All analog audio is routed to the monitor router which outputs to a pair of analog audio meters before being routed to the power amplifier.

IF Flow The IF patch panel allows the encoders/DVB modulators to be operated in a 1:1 redundant configuration. However, the encoders are patchable such that two different programs (one from each encoder) can be fed to an integral combiner and fed to either upconverter. The panel also allows for the injection of the 70 MHz signals from the I/O panel if desired.