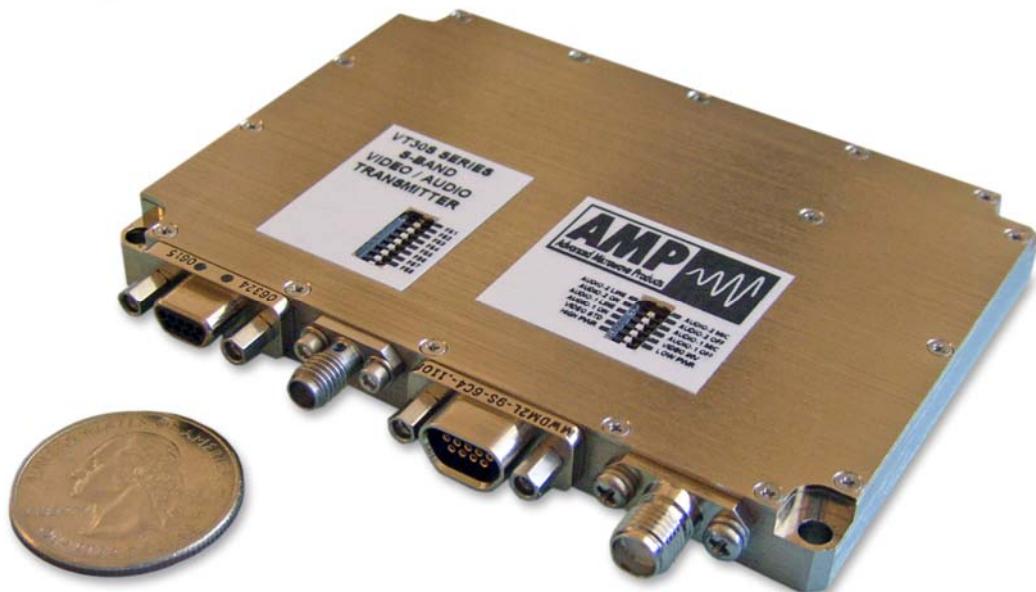


Operation Manual

VT30 Series UHF, L, S, C-Band Video / Audio Transmitters



Designed and Manufactured By



2465 Old Hwy 40W, Ste. A
Verdi, NV 89439

Distributed By



107 Woodbine Down Blvd, Units 7&8
Toronto, ON M9W 6Y1

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1.0 INTRODUCTION

Thank you for choosing this AMP Wireless Video Product. Every effort has been made to design and manufacture a quality product that will meet your surveillance needs for many years. Please visit our website (www.advmw.com/video) for information on other video products and for downloadable datasheets, operation manuals, model number builders, and frequency selection charts.

If you have any questions regarding this product or if you require technical assistance, please feel free to contact us at the telephone numbers below:

Dyplex Communications
(416) 675-2002

Advanced Microwave Products
(775) 345-9933

1.1 Purpose and Function

VT30 Series Video/Audio Transmitters are developed and manufactured by Advanced Microwave Products (AMP) and distributed by Dyplex Communications (Dyplex).

Transmitters are designed for color or monochrome video and audio surveillance. Transmitters are best operated with AMP's VR75 Series Video Receivers but are compatible with most other video receivers on the market.

1.2 Capabilities

AMP Transmitters are designed for harsh environments and feature robust packaging and connectors. Compact package sizes provide versatility in unit placement and system applications.

AMP Transmitters require no tuning or adjustments. All units operate directly with any standard video camera. Power requirements are +9 to +16 Vdc and can be derived from batteries, simple power supplies, or vehicle power.

Whip or "rubber duck" antennas are adequate for most transmitter applications. A variety of standard and high performance antennas are available through Dyplex.

AMP Transmitters and Receivers are standard equipped with video inversion, selectable via a slide switch, for a basic level of security.

VT30 Series Transmitters are available with many options allowing customization to specific applications. Most common options include frequency selection (full band selection), high RF output power (up to 2 Watts), dual power operation (any two power levels), PAL video, and dual audio subcarriers with up to 100 kHz bandwidth.

If our standard products and options do not satisfy your requirements, please contact us. Our experienced design team welcomes your custom specifications.

1.3 Specifications

RF Characteristics		
Frequency Range (Specify): (Other Ranges Available)	UHF 340.00 - 399.90 MHz L-Band 1710.00 – 1850.00 MHz S-Band 2450.00 - 2483.50 MHz C-Band 4400.00 – 4999.75 MHz	100 kHz Channels 250 kHz Channels 250 kHz Channels 250 kHz Channels
Frequency Selection (Specify):	Fixed or Channelized, Full Band, Slide Switch Selectable	
Frequency Stability:	±0.002% Over -20°C to +50°C	
Output Power (Specify):	250 mW, 500 mW, 1 W, 2 W, or Dual Power (Any 2 Levels, Slide Switch Selectable)	
Output Impedance:	50 Ω Nominal, VSWR 1.5:1 Maximum	
Output Protection:	UHF None – 20:1 VSWR Indefinitely L/S/C Internal Isolator - Open/Short Indefinitely	
Spurious Output:	-13 dBm Maximum	
Video Characteristics		
Modulation Type:	Analog FM	
Modulation Sense:	Standard (Positive) or Inverted (Negative), Slide Switch Selectable	
Frequency Response (Specify):	10 Hz to 3.5 MHz (Monochrome), 4.5 MHz (NTSC), or 5.5 MHz (PAL), ±1.5 dB	
Pre-Emphasis (Specify):	525-Line (NTSC), 625-Line (PAL), or None	
Modulation Sensitivity:	±4 MHz / 1 Vpk-pk @ Crossover Frequency	
Input Impedance:	75 Ω Nominal, Unbalanced, Shunted by 30 pF Maximum	
Distortion:	2% Maximum	
Incidental FM:	10 kHz Maximum	
Audio Characteristics		
Subcarriers (Specify):	One or Two	
Subcarrier Frequency (Specify):	4.83, 5.8, 6.0, 6.2, 6.5, 6.8, 7.2, 7.5, 8.3, 8.5, or 8.59 MHz, or Custom	
Subcarrier Separation (Two):	700 kHz Minimum	
Frequency Stability:	±0.5% Over -20°C to +50°C	
Subcarrier Insertion Level:	-26 dBc Nominal	
Subcarrier On/Off Control:	Slide Switch Selectable	
Modulation Type:	Analog FM, Positive Sense	
Frequency Response (Specify):	20 Hz to 10 kHz (Audio) or 100 kHz (Data), ±1.5 dB	
Pre-Emphasis (Specify):	75 μsec (NTSC) or 50 μsec (PAL)	
Modulation Sensitivity:	100 kHz pk-pk @ 1 kHz rate, Mic (-70 to -20 dBm) or Line (-10 dBV)	
Input Impedance:	4.7 kΩ Minimum, Unbalanced	
Input Level:	Line or Mic, Slide Switch Selectable	
Mic Supply Output (Specify):	1.5 Vdc, 3.3 Vdc, or 5.0 Vdc	

Power Requirements

Input Voltage:	+9 to +16 Vdc, Reverse Polarity Protected
Current Draw: (Maximum)	UHF/L/S-Band 200 mA, 350 mA, 600 mA, 800 mA (for 250 mW, 500 mW, 1 W, 2 W) C-Band 275 mA, 450 mA, 700 mA, 900 mA (for 250 mW, 500 mW, 1 W, 2 W)
On/Off Control:	Open = Off, Ground = On

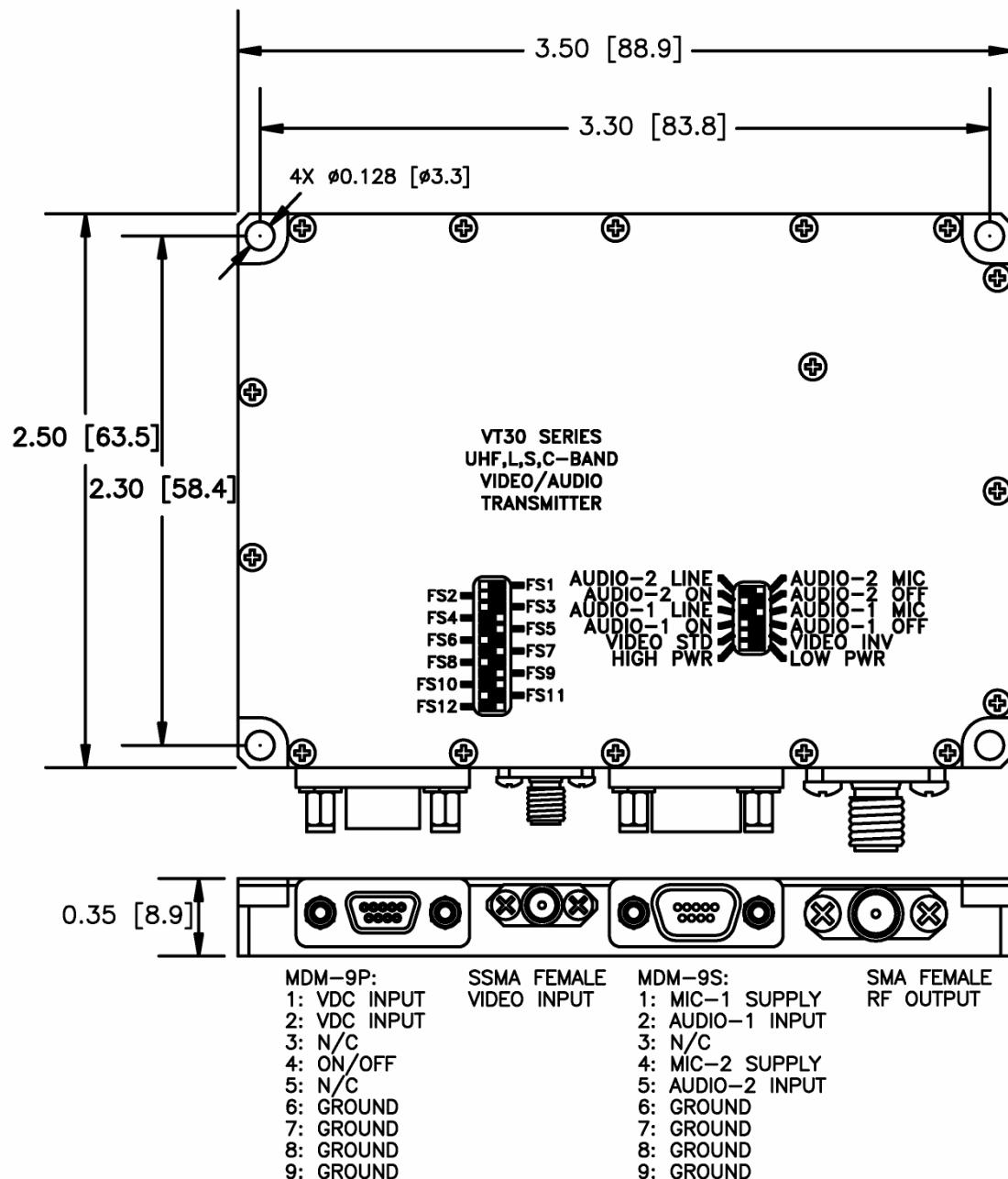
Mechanical

Material:	CNC Machined T6061-T6 Nickel Plated Aluminum	
Dimensions:	2.50" W x 3.50" L x 0.35" H	
Weight:	2.5 oz. Maximum	
Connectors:	RF Output:	SMA Female
	Video Input:	SSMA Female (Others Available)
	DC Supply, On/Off:	MDM-9P
	Audio/Mic Supply:	MDM-9S

Environmental

Temperature (Operating):	-20°C to +50°C
Humidity:	Up to 95% @ Any Temperature Forming Frost or Condensation

1.4 Mechanical Drawing and Connector Pin-Outs



1.5 List of Items Furnished

1-Transmitter

1-Type SSMA Plug (Male, SMB Optional) to BNC Jack (Female) Video Adapter Cable

1-Type BNC Plug (Male) to BNC Plug (Male) Video Cable

1-Type MDM-9S (Socket) DC Power Cable

1-Type MDM-9P (Pin) Audio Cable

1-Heatsink (if required / purchased)

1.6 List of Items Required

Antenna, Type SMA Plug (Male) Connector

Camera, Type BNC Jack (Female) Connector

Video connector adapter to BNC, if camera does not have BNC connector

Microphone(s)

1.7 Environmental Requirements

AMP Transmitters are designed for indoor or outdoor use. Precautions should be taken when exposing transmitters to the elements. Do not expose to 100% humidity.

Transmitters should be located in areas where the ambient temperature does not exceed the maximum operating temperature indicated in the specifications (Section 1.4).

Placement in confined locations with minimal air flow, in direct sunlight in areas of temperature extremes, or in proximity to other devices which generate heat, such as power supplies, heating systems, etc., should be avoided. Temperatures exceeding +75°C may cause permanent damage to the equipment.

When not used for extended periods of time external connections, including power cable, video cable, and antenna, should be removed and the units covered, boxed, or crated and stored in a clean, dry place. See Section 1.7 above for environmental requirements.

2.0 SAFETY PRECAUTIONS

Transmitters should be handled with caution like any electrical or electronic device. Do not handle the units or associated cabling with wet hands or materials.

Connections should be made only to previously-tested, active power sources (outlets or batteries) of the correct voltage, and each connector should be inserted only into its designated port. All connections should be checked to ensure they are firmly in place.

WARNING! RF RADIATION HAZARD

In order to keep the RF Exposure within the FCC 1.1310 limit, a safe personal distance from the antenna must be maintained according to the below tables. The first table is for transmitters operating 1500 MHz or higher where the Maximum Permissible Exposure (MPE) is 10 Watts/meter². The second table is for transmitters operating in the 340-400 MHz range where the MPE is 2.27 Watts/meter². See Appendix A for details on calculation of safe personal distances.

Operating Frequency 1500 MHz and Higher (MPE = 10 W/m ²)								
Antenna Gain (dBi)	Transmitter Power 0.25 Watts		Transmitter Power 0.5 Watts		Transmitter Power 1 Watt		Transmitter Power 2 Watts	
	EIRP (Watts)	Minimum Distance (Meters)	EIRP (Watts)	Minimum Distance (Meters)	EIRP (Watts)	Minimum Distance (Meters)	EIRP (Watts)	Minimum Distance (Meters)
0	0.25	>0.20	0.50	>0.20	1.00	>0.20	2.00	>0.20
2	0.40	>0.20	0.79	>0.20	1.58	>0.20	3.17	>0.20
5	0.79	>0.20	1.58	>0.20	3.16	>0.20	6.32	0.22
10	2.50	>0.20	5.00	>0.20	10.0	0.28	20.0	0.40
15	7.91	0.25	15.8	0.35	31.6	0.50	63.2	0.71
20	25.0	0.45	50.0	0.63	100.0	0.89	200.0	1.26
25	79.1	0.79	158.1	1.12	316.2	1.59	632.5	2.24
30	250.0	1.41	500.0	1.99	1000.0	2.82	2000.0	3.99

Operating Frequency 340 - 400 MHz (MPE = 2.27 W/m ²)								
Antenna Gain (dBi)	Transmitter Power 0.25 Watts		Transmitter Power 0.5 Watts		Transmitter Power 1 Watt		Transmitter Power 2 Watts	
	EIRP (Watts)	Minimum Distance (Meters)	EIRP (Watts)	Minimum Distance (Meters)	EIRP (Watts)	Minimum Distance (Meters)	EIRP (Watts)	Minimum Distance (Meters)
0	0.25	>0.20	0.50	>0.20	1.00	>0.20	2.00	0.26
2	0.40	>0.20	0.79	>0.20	1.58	0.24	3.17	0.33
5	0.79	>0.20	1.58	0.24	3.16	0.33	6.32	0.47
10	2.50	0.30	5.00	0.42	10.0	0.59	20.0	0.84
15	7.91	0.53	15.8	0.74	31.6	1.05	63.2	1.49
20	25.0	0.94	50.0	1.32	100.0	1.87	200.0	2.65
25	79.1	1.66	158.1	2.35	316.2	3.33	632.5	4.71
30	250.0	2.96	500.0	4.19	1000.0	5.92	2000.0	8.37

MAINTAIN A SAFE PERSONAL DISTANCE FROM THE ANTENNA WHILE TRANSMITTER IS OPERATIONAL.

FAILURE TO MAINTAIN A SAFE PERSONAL DISTANCE FROM THE ANTENNA MAY RESULT IN PERSONAL INJURY.

3.0 PREPARATION FOR USE

3.1 Unpacking

Carefully remove the transmitter from the shipping container and make sure all listed furnished items are included (Section 1.5). Inspect all items for damage. If any item is omitted from the shipment or appears damaged, contact Dyplex or AMP with detailed description of problem.

3.2 Pre-Test

Although each unit is thoroughly tested at the factory for both functional and environmental performance, a minimal amount of pre-testing should be done by the operator before placing the transmitter into service. The transmitter, an appropriate AMP receiver, transmit and receive antennas, a video camera, a video monitor, a microphone, a speaker or headphones, and DC power supplies are the only components required to perform a functional test of the transmitter.

The transmit and receive antennas should be situated at a distance of greater than 25 feet apart to prevent serious damage to or destruction of the receiver's front end. Set up the receiver and make all necessary adjustments in accordance with that unit's Operation Manual. Connect the receiver video output to the video monitor and the receiver audio output to the speaker or headphones.

If using remote control, connect remote control to the On/Off Control line (white wire in DC Power Cable). If not using remote control, connect the On/Off Control line to power or chassis ground.

Verify DC power supplies are between +9 and +16 Vdc. With the DC Power Cable (MDM-9S connector) DISCONNECTED from the transmitter, connect DC power supply to DC Power Cable (red = positive DC input, black = negative DC input (ground)). Do not connect DC Power Cable to transmitter until all other connections are complete.

Connect the transmit antenna to transmitter RF output connector (SMA). Connect the Video Adapter Cable to the transmitter video input connector (SSMA, SMB optional). Connect the Video Cable between the Video Adapter Cable and video camera. Connect the microphone to the Audio Cable (MDM-9P connector) and Audio Cable to the transmitter (mates to MDM-9S connector on transmitter). Refer to Section 4.1 for Audio Cable wiring.

Configure switches as instructed in Section 4.2. Connect DC Power Cable to transmitter (mates to MDM-9P connector on transmitter). If not using remote control, video should be observed on the monitor and audio heard through the speaker / headphones once the transmitter locks on frequency (requires several seconds). If using remote control, the On/Off Control line must be enabled (grounded or <0.8 Vdc) before video and audio will be present.

If no video or audio is present, refer to Section 5.2 for troubleshooting instructions.

4.0 INSTALLATION AND OPERATING INSTRUCTIONS

4.1 Use and Function of Connectors

AMP Transmitters are simple to install, requiring only connection to the antenna, camera, microphone, and DC power supply using the appropriate cables and jacks. The use and function of the transmitter connectors are as follows:

POWER CONNECTOR (MDM-9P) <i>Mate: Supplied MDM-9S Power Cable</i>	Red Wire – Positive DC Input (+9 to +16 Vdc) Black Wire – Negative DC Input (Ground) White Wire – On/Off Control (Ground or <0.8 Vdc for On, Open for Off)
AUDIO CONNECTOR (MDM-9S) <i>Mate: Supplied MDM-9P Audio Cable</i>	Red Wire – Mic 1 Supply Output Yellow Wire – Audio 1 Input (Mic or Line) Orange Wire – Mic 2 Supply Output Violet Wire – Audio 2 Input (Mic or Line) Black Wire(s) – Ground (1 per subcarrier)
VIDEO CONNECTOR (SSMA) <i>SMB Connector Optional</i> <i>Mate: Supplied Video Adapter Cable</i>	Standard 75 Ohm Video Input <i>Accepts Standard 1 Vpk-pk Video Signal</i>
RF OUTPUT CONNECTOR (SMA) <i>Mate: Appropriately Selected SMA Antenna</i>	Standard 50 Ohm RF Output <i>Outputs Nominal RF Power Level to Antenna</i>

4.2 Use and Function of Switches

4.2.1 Frequency Selection Switches:

Frequency selectability is an option on all VT30 Series Transmitters providing RF frequency control with slide switches accessible through the chassis lid. S-Band units utilize 8 slide switches; UHF, L-Band, and C-Band units utilize 12 slide switches. Each switch is uniquely identified (FS1 through FS8, or FS1 through FS12) on the unit label.

To program the desired RF frequency, position the individual switches as shown in the applicable Frequency Selection Chart, included with product shipment and available as a download on the applicable Video Product Page of our website (www.advmw.com/video).

4.2.2 Dual Power Switch:

VT30 Series Transmitters may be ordered with nominal RF output power of 250 mW, 500 mW, 1 Watt, or 2 Watts and may be optionally configured for dual power operation utilizing any two power levels. RF output power level is controlled with a slide switch accessible through the chassis lid. Switch is inactive if this option is not purchased.

To select the higher RF output power level, position the slide switch to HIGH PWR as indicated on the unit label. To select the lower RF output power level, position the slide switch to LOW PWR as indicated on the unit label.

L, S, and C-band VT30 Series Transmitters operating at 2 Watts incorporate an automatic power “fold back” circuit to protect the unit in case of high VSWR loads (such as RF short, RF open, broken antenna, wrong antenna, etc.). In the event of a high VSWR load causing greater than 1 Watt power reflection, the RF output power is automatically reduced to below 1 Watt to avoid excessive heat and potential damage to the unit. The “fold back” circuit attempts to restore the RF output power to its normal level every 1 millisecond, checking each time whether the high VSWR load has been repaired.

4.2.3 Video Inversion Switch:

All AMP Transmitters and Receivers are standard equipped with video inversion, selectable with a slide switch accessible through the chassis lid. When selected, the phase of the video signal is inverted (shifted 180°) in the transmitter and re-inverted in the receiver, providing a basic level of security. If an inverted video signal is detected by a receiver not configured for inversion, the resulting picture is scrambled.

To select standard video (no inversion), position the slide switch to VIDEO STD as indicated on the unit label. To select inverted video (phase inversion), position the slide switch to VIDEO INV as indicated on the unit label.

The video inversion switch position on AMP's Receivers must match that of the transmitter or the picture will appear scrambled. If using AMP's Transmitters with other receivers or vice-versa, position the Video Inversion slide switch to VIDEO STD.

4.2.4 Audio On/Off Switch(es):

VT30 Series Transmitters are standard equipped with one audio subcarrier. A second audio subcarrier is optional. Each subcarrier is individually enabled / disabled with a slide switch accessible through the chassis lid. When enabled, the audio signal applied to the audio input is transmitted. When disabled, the subcarrier signal is not produced, and no audio is transmitted.

To enable audio transmission, position the corresponding slide switch to AUDIO ON as indicated on the unit label. To disable audio transmission, position the corresponding slide switch to AUDIO OFF as indicated on the unit label.

When two subcarriers are specified, Audio On/Off switches are designated as AUDIO-1 ON / AUDIO-1 OFF and AUDIO-2 ON / AUDIO-2 OFF on the unit label.

4.2.5 Line / Mic Audio Level Switch(es):

VT30 Series Transmitters accept either Line or Microphone Level audio inputs. Audio level for each subcarrier is individually controlled with a slide switch accessible through the chassis lid. When set to Line, the audio input circuitry adjusts to accept standard Line Level (-10 dBV) audio. When set to Mic, the audio input circuitry adjusts to accept typical Microphone Levels (-70 thru -20 dBm) with automatic level control (ALC).

To adjust the audio input to Microphone Level for either subcarrier, position the corresponding slide switch to MIC as indicated on the unit label. To adjust the audio input to Line Level for either subcarrier, position the corresponding slide switch to LINE as indicated on the unit label.

When two subcarriers are specified, Audio Level switches are designated as AUDIO-1 LINE / AUDIO-1 MIC and AUDIO-2 LINE / AUDIO-2 MIC on the unit label.

When 100 kHz subcarrier frequency response is specified on either or both subcarriers, the Audio Level switch for the corresponding subcarrier(s) is inactive and the 100 kHz data is transmitted at a constant FM deviation sensitivity (no ALC).

4.3 Use of Heat Sink

VT30 Series Transmitters operating at or over 500 mW RF output power must utilize AMP Heat Sink VH2505 (0.5" high) or be securely fastened to an adequate heat sinking object or surface. VT30 transmitters should be fastened to AMP heat sinks using provided 4-40x5/16" pan head or socket head screws with #4 lock washers. Use of thermal grease, such as Wakefield Engineering 120 Series Thermal Compound, to improve thermal conduction between transmitter baseplate and heat sinking surface will reduce unit temperature and increase product reliability.

Caution: Failure to provide adequate heat sinking **VOIDS PRODUCT WARRANTY.**

4.4 Initial Adjustments and Settings

There are no initial adjustments or settings necessary to use AMP Transmitters other than proper configuration of the slide switches as outlined above in Section 4.2. To assure optimum performance, the user should be familiar with the camera, monitor, microphone, and speaker/headphones used with this video/audio system.

4.5 Shut Down

If the transmitter is to be shut down only briefly, simply remove DC voltage from the DC Power Cable or disconnect DC Power Cable from transmitter. If the unit is to be shut down for an extended period, all external cabling including the antenna should be removed and the unit should be stored in a container and placed in a clean, dry environment.

5.0 MAINTENANCE INSTRUCTIONS

5.1 Cleaning

AMP Transmitters should be periodically wiped off with a clean, damp cloth. For more thorough cleaning, dampen a clean cloth with glass cleaner and wipe off unit. Ensure units are completely disconnected from their power sources before cleaning.

5.2 Troubleshooting

To avoid poor performance, ensure all transmitter and mating connectors are tightly fastened, clean, and have no pins bent or damaged.

Verify configuration of all slide switches (refer to Section 4.2).

If poor or no operation is observed, ensure the external DC voltage supply is between +9 and +16 Vdc with correct polarity. All AMP Transmitters have over-voltage and reverse polarity protection circuits. If the input voltage is over +16 Vdc, remove the DC Power Cable from the transmitter, reduce the DC voltage to between +9 and +16 Vdc, and reconnect the DC Power Cable. If the input voltage is negative polarity, remove the DC Power Cable from the transmitter, reverse the connections between the DC voltage supply and DC Power Cable, and reconnect the DC Power Cable.

If all connections are adequate, switches are correctly configured, and DC voltage is correctly applied, check the video camera, video cable, and antenna for damage. A monitor may be connected directly to the camera to verify proper camera operation. If receiving video but no audio, check connections between microphone and Audio Cable. Also check microphone and Audio Cable for damage.

If these efforts fail, **do not attempt to repair the unit.** Please contact Dyplex or AMP with a detailed description of the problem. Depending on the nature of the problem, Dyplex or AMP may provide further troubleshooting assistance or advise the entire system be returned for repair and retest.

Caution: Removal of the cover constitutes breaking the seal and VOIDS PRODUCT WARRANTY.

5.3 Preparation for Reshipment

If the transmitter and/or any other purchased item(s) are to be shipped to another location or returned for repair or realignment, use the original packaging or a sturdy box with sufficient protective material to avoid damage from movement or exposure during transit. Remove all external connections (cables, antenna, etc.) prior to shipping.

5.4 Returning an Item

Please contact Dyplex customer service at (416) 675-2002 for a Return Authorization Number before returning an item. The Dyplex ship-to address is listed below. When returning an item, always include a contact name and phone number and a detailed description of the problem with your shipment.

Dyplex Communications
107 Woodbine Downs Blvd, Units 7 & 8
Etobicoke, Ontario,
Canada M9W 6Y1

WARRANTY STATEMENT

Advanced Microwave Products (AMP) warrants these products to be free from defects in material and workmanship for a period of one year from date of original shipment. AMP shall, at its option, either repair or replace products which prove to be defective.

No products may be returned to AMP without the permission of AMP. BUYER, after obtaining a return authorization from AMP, shall return the equipment to AMP accompanied by a report stating as completely as possible the reason for return, the defects, and the conditions under which they occurred. BUYER shall pay all shipping charges, duties, and fees for the return of products to AMP. All warranty services will be carried out at AMP's facility. AMP will pay for the return of products to the BUYER.

All articles are to be properly and carefully inspected by BUYER upon receipt. Shipping container damage may indicate equipment damage. All shipping damage must be promptly reported to the carrier. AMP is not liable for shipping damage.

Limitation of Warranty: The above warranty does not apply to defects of, or resulting from the following:

- 1) End items included as part of a system, but not designed by, AMP are subject only to warranty as may be obtained from the original manufacturers. Such items include, but are not limited to, batteries, cameras, monitors, cabling, etc.,
- 2) Operation outside of the environmental specifications of the product,
- 3) Unauthorized modifications, misuse, or mishandling,
- 4) Improper or inadequate maintenance by BUYER,
- 5) Improper or inadequate heat sinking by BUYER
- 6) Improper installation or improper testing,
- 7) Malfunction of connected hardware.

THIS WARRANTY IS EXCLUSIVE AND NO OTHER WARRANTY, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED. AMP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OR MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

The remedies set forth above are the purchaser's sole and exclusive remedies. In no circumstances shall AMP assume liability for loss, damage, or consequential expense (including loss of profits) whether based on contract, tort, or any other legal theory, arising directly or indirectly from the use of its equipment separately or in combination with other equipment.

APPENDIX A

Calculation of Safe Personal Distance From Antenna

The Maximum Permissible Exposure (MPE) limit according to FCC 1.1310 is as follows:

Frequency	Limit
30-1500 MHz	$F/150 \text{ W/m}^2$ (where F is frequency in MHz)
1500 MHz – 100 GHz	10 W/m^2

For VT50 Upper L-band, S-band, and C-band transmitters (all greater than 1500 MHz), the MPE is 10 W/m^2 .

For VT50 Lower L-band transmitters, the operating frequency range is 1300-1600 MHz resulting in a MPE of 8.67 W/m^2 (the lowest MPE in the 1300-1600 MHz range occurs at 1300 MHz and is $1300/150 \text{ W/m}^2$).

For VT50 UHF transmitters, the operating frequency range is 340-400 MHz resulting in a MPE of 2.27 W/m^2 (the lowest MPE in the 340-400 MHz range occurs at 340 MHz and is $340/150 \text{ W/m}^2$).

Using the formula for the Power Density $S = \text{EIRP} / 4\pi D^2$, the distance D, where the Maximum Permissible Exposure (MPE) satisfies the FCC 1.1310 limit ($S=\text{MPE}$) for General Population/Uncontrolled Exposure, can be calculated as:

$$D \geq \sqrt{(\text{EIRP} / 4\pi S)} \quad (\text{meters})$$

where S is the MPE and EIRP is the Effective Isotropic Radiated Power, calculated as:

$$\text{EIRP} = 10^{(G/10)} P \quad (\text{Watts})$$

where G is the logarithmic antenna gain in dBi and P is the transmitter power in Watts. The resulting safe personal distance calculation is:

$$D \geq \sqrt{(10^{(G/10)} P / 4\pi S)} \quad (\text{meters}).$$