EMCEE

MODEL EM1
SOLID STATE
FREQUENCY AGILE MODULATOR

BROADCAST PRODUCTS

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12/94

IMPORTANT

Transient Overvoltage Protection

Transient overvoltage of micro- and nano-seconds durations are a continuous threat to all solid-state circuitry. The resulting costs of both equipment repairs and system downtime make preventative protection the best insurance against these sudden surges. Types of protection range from isolation transformers and uninterruptible power supplies to the more cost effective AC power line protectors. As transient culprits are most often lightning induction and switching surges, AC power line protectors are the most practical solution. An effective AC power line protector is one capable of dissipating impulse energy at a low enough voltage to ensure the safety of the electronic components it is protecting. The protection unit should be across the AC line at all times even during periods of total blackout. It should also reset immediately and automatically to be 100% ready for repeated transients.

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SECTION I

THE EM1 MODULATOR

1.1 Introduction:

The EMCEE EM1 is a solid-state high performance modulator that can be used in many applications where baseband video and audio need to be converted to AM television signals. This unit can provide a modulated RF signal on any channel from 2 to 61 (YY), as well as 5A, and A minus 1 to A minus 5, with an output level of at least 6.25dBm. The desired channel is easily chosen using the front panel selector, which is equipped with a positive lock to prevent inadvertent channel changes. Where channels are subject to FCC mandated frequency control, offsets of ±12.5kHz or ±25kHz can be selected from the rear panel.

The EM1 has dual IF loops with output levels in excess of -13.5dBm that are accessed from the rear panel. The IF output can be used directly by a transmitter (e.g., the TTS10HS) or can be looped back into the modulator to provide an RF output. Either way the modulator is set up, the IF loops provide a connection that is compatible with any IF scrambling system.

The EM1 modulator is a self-contained unit and requires only 1.75 inches of height clearance in a standard 19 inch rack.

1.2 Specifications:

Video Input

Type	Composite NTSC video, sync negative
Level	0.5 to 2.5 V p-p, front panel adjustable (0.5V p-p minimum for 87.5% modulation)
Impedance	75 ohms, unbalanced (Type F Connector)
Frequency Response	±0.5dB, 30Hz to 4.0MHz +0/-1.5dB, 4.0MHz to 4.2MHz
Differential Phase	2° maximum
Differential Gain	2% maximum
Visual Signal-to-Noise	>60dB @ 87.5% modulation
AM Hum and Noise	60dB minimum below 87.5% modulation
Group Delay	Meets FCC requirements (-170, ±60ns max.)
Field Time Distortion	2% maximum, 60Hz, 50% square wave

Line Time Distortion	2% maximum
White Clip Level	95%, ±2% modulation

Audio Input

Type	Baseband Monaural
Level	10 to +10dBm
Impedance	600 ohms, unbalanced (RCA Phono Jack)
Frequency Response	±1dB, 40Hz to 15kHz with 75μsec pre-emphasis
Harmonic Distortion	1% maximum (1kHz with 25kHz deviation)
Hum and Noise	50dB minimum at 25kHz deviation
Over Deviation Threshold	25kHz

4.5MHz Input

Input	4.5MHz modulated FM signal, monaural or BTSC stereo
Impedance	75 ohms, unbalanced (Type F Connector)
Level	13.5 to 1.25dBm

IF Input/Output

Impedance	75 ohms, unbalanced (Type F Connector)
Operating Level	>-13.5dBm with normal setup (all IF input/output ports)
Frequency Accuracy	±1.0kHz of 45.75MHz visual or 41.25MHz aural IF

RF Output

Frequency Range	54-450MHz, 66 Channels (Channel 2 to Channel 61 [YY]) (Channel 5A, A Minus 1 to A Minus 5)
FCC Offset	0, ±12.5kHz and ±25kHz, selectable
Frequency Stability	Within ±5kHz of selected frequency
Impedance	75 ohms, unbalanced (Type F Connector)

Level	>6.25dBm
Level Range	>10dB, front panel adjustable
Level Stability	±1dB
Return Loss	16dB
Aural Control Range	-10 to -20dB (front panel adjustable)
Spurious Outputs	60dB below visual carrier, 50-450MHz at 6.25dBm output
Sideband Response	-20dB at channel edge; -40dB at adjacent channel visual and aural carrier frequency
RF Test	-20dB, type F connector

Mechanical

Power Requirements	115Vac ± 8% Vac @ 50-60Hz, 27W
Ambient Temperature	-30°C to +50°C
Mechanical Dimensions	19"W x 1.75"H x 12.75"D
Weight	10.5 lb.

1.3 Installation:

The connectors and terminals mentioned in the following instructions are located on the rear of the equipment.

1. After unpacking the modulator, a thorough inspection should be conducted to reveal any damage which may have occurred during shipment. If damage is found, immediately notify the shipping agency and advise EMCEE Broadcast Products (Customer Service) or its field representative. Also check to see that any connectors, cables or miscellaneous equipment, which may have been ordered separately, are included.

2. Place the modulator in a clean, weatherproof environment with an air gap around the unit to provide adequate ventilation. It is important to maintain the ambient operating temperature within the -30°C and +50°C limits.

3. Place the modulator in its permanent location near a receptacle that supplies 115Vac at 50-60Hz. The ac source should have a minimum power capacity of 30W.

4. Set all circuit breakers and switches, including the incoming ac mains breakers, to the off position. Place an appropriate ac power line protector (surge suppressor) across the ac supply line.

5. Connect the input video signal to the F connector labeled VIDEO IN. The video signal level should be 1.0V p-p.

6. Connect the audio input signal to the 600 ohm RCA phono jack labeled AUDIO IN. This signal should be at a level of 0dBm. When using this input, make sure the last switch in the frequency offset group of switches is in the INT (down) position.

7. If using an external 4.5MHz input, connect it to the AURAL 4.5MHz IN F connector. The level of this signal should be -8dBm. To use this input, the last switch in the frequency offset group must be set to the EXT (up) position.

   If the modulator is packaged in a cabinet with a transmitter, go to step #10. Otherwise, continue with step #8.

8. If the transmitter is going to use a direct IF input, then connect the VISUAL IF OUT and AURAL IF OUT of the modulator to the visual and aural IF IN of the transmitter. Refer to the transmitter manual for correct interconnections.

9. For RF operation, the short coaxial jumpers supplied with the modulator must be connected as follows: Connect the VISUAL IF OUT to the VISUAL IF IN, and connect the AURAL IF OUT to the AURAL IF IN. Once the jumpers are installed, the output channel must be selected using the procedure below. (If unsure of the channel, refer to Table 1-1.)

   a. The output channel is chosen with the CHANNEL selector located on the right of the front panel. The tabs above and below the CHANNEL display must be opened to operate the selector. This is done by gently lifting them away from the front panel.

      The tabs below the display increase the digit directly above by one for each time they are pressed. The tabs above the display decrease their respective digit by one. Each display digit ranges from 0 to 9, allowing any combination from 00 to 99 to be selected.

   b. Set the first digit to the desired value. For channels lower than 10, this will be zero. Set the second digit to the correct value. The display indicates the channel currently selected.

   c. Once the selection is completed, fold the tabs back down. This locks the CHANNEL selector and prevents an unintentional change.

   d. To verify channel frequency and selection, refer to Table 1-1, EM1 OUTPUT CHANNEL/FREQUENCY.

      The modulator is now installed and ready for use. Proceed to section 1.4.

10. Verify that all cabling is correctly connected.

11. If the modulator is providing an RF output, check the channel indicator for correct output channel. If the channel is incorrect, see above step 9.

1.4 Operation:

Once the EM1 is installed in the rack with cabling and channel selection completed, make the following signal level adjustments.

1.4a RF Output Level:

1. Visual Carrier - Disconnect the video source from the Video In connector on the rear of the EM1. Connect a suitable level meter (Field Strength Meter or Spectrum Analyzer) to the RF TEST connector on the EM1 front panel. (Remember the signal at this point is 20dB less than the actual output.) Tune the meter to the visual carrier frequency.

2. Set the RF output to the desired level by adjusting the RF LEVEL VISUAL CARRIER control on the front panel. This control simultaneously adjusts both the visual and aural carriers. The aural carrier is factory set at 15dB below the visual carrier. If this ratio is incorrect or a different ratio is required, proceed to step 3.

3. Aural Carrier - Adjust the RF LEVEL AURAL CARRIER control on the front panel to set the aural carrier 16dB below the visual carrier, or to the desired ratio.

1.4b Video Modulation:

1. Connect a known video source to the Video In connector on the rear of the EM1. A standard signal of 1.0V p-p, such as stairstep or color bars is preferred. The unit is factory adjusted for this input and should not require adjustment.

2. Check the WHITE CLIP indicator on the front panel. If it is lit, reduce the video level by adjusting the VIDEO MOD control on the front panel until the indicator is extinguished. When operating with a video signal which is not static, such as the video from a camera or VCR, an occasional flash of the WHITE CLIP indicator is acceptable.

   (An alternative method of checking the video level is to observe it on a TV set, tuned to the operating channel. If the picture appears to be too low, increase the video level by adjusting the VIDEO MOD control on the front panel. The WHITE CLIP indicator should not be lit after the adjustment.)

1.4c Audio Deviation:

1. Connect a known audio source to the Audio In connector on the rear of the EM1. A standard signal at 0dBm, such as a 1kHz tone from an audio generator is preferred. The unit is factory adjusted for this input and should not require adjustment.

2. Check the OVER DEV indicator on the front panel. The indicator should not be lit. If it is, reduce the audio level by adjusting the AUDIO DEV control on the front panel until the indicator is extinguished.

In operation, the OVER DEV indicator should flash only very briefly during the loudest portions of speech or music. If the indicator flashes frequently, additional reduction in audio level must be made.

(An alternative method of checking the audio level is to listen to the sound from a TV set, tuned to the operating channel. If the sound level appears to be low compared to other TV channels, increase the audio level by adjusting the AUDIO DEV control on the front panel. The OVER DEV indicator should not be lit after the adjustment.)

1.4d 4.5MHz Modulated FM Carrier:

1. There are no modulator adjustments for operation with a 4.5MHz modulated carrier.

2. When operating with a 4.5MHz modulated carrier, the modulation depth is controlled by the unit originating the carrier. The AUDIO DEV control and OVER DEV indicator do not function in this mode of operation.

3. If sound modulation bars appear in the picture, this is an indication the level of the 4.5MHz carrier is too high and should be reduced. This is accomplished by reducing the level at the originating equipment. If this equipment is not accessible, the signal can be attenuated by using a fixed attenuator at the input of the EM1.

1.4e Theory of Operation:

All modulator functions are consolidated on three printed circuit boards in the EM1. The IF section generates the visual and aural IF carriers and modulates them with processed video and audio or 4.5MHz modulated aural carrier signals. The Converter section converts the IF signals to the final RF frequency, and the RF Amplifier section amplifies the signal to the final output level.

Within the IF section, the video signal is amplified and clamped. It enters the white clip circuit which provides signal limiting and indication of overmodulation. The signal then modulates a stable 45.75MHz IF frequency. After modulation, the signal is amplified and passes through a SAW filter. The audio signal is first pre-emphasized and then frequency modulates a 4.5MHz oscillator. A buffer amplifier with a preset comparator provides indication of over deviation of the audio. When the unit is operated with an external 4.5MHz subcarrier, the audio processing and modulation sections are bypassed and the external signal is substituted. The 4.5MHz modulated subcarrier and the 45.75MHz visual carrier create the 41.25MHz modulated aural IF carrier.

The IF carriers separately loop through the rear panel of the unit and are then combined into a composite IF which is sent to the Converter section. The PLL Converter section is controlled through the front panel channel selector and the rear panel frequency offset switches. The composite IF is then converted to the selected RF output frequency.

The output of the Converter section is passed to an RF amplifier which provides the necessary gain for the final output signal.

1.4f Indicators and Controls:

This list gives the title and a brief description of the controls, indicators and connections located on the front and rear panels.

Front Panel

POWER:	This indicator illuminates yellow when the modulator is receiving ac power.
WHITE CLIP:	This red LED will light if the video modulation level exceeds 95%.
VIDEO MOD:	The control labeled VIDEO MOD adjusts the amount of modulation of the visual carrier.
OVER DEV:	When this indicator is illuminated red, it means that the aural carrier is overmodulated. This corresponds to an audio deviation in excess of 25kHz.
AUDIO DEV:	The AUDIO DEV control adjusts the audio modulation to achieve the correct deviation.
RF LEVEL - AURAL CARRIER:	This control changes the amplitude of the aural carrier with respect to the visual RF carrier.
RF LEVEL - VISUAL CARRIER:	This adjustment alters the level of both the visual and aural carriers simultaneously.
CHANNEL:	The CHANNEL selector/indicator controls the selection of the output RF channel and also provides a readout of the currently selected channel.
RF TEST:	The F type connector labeled RF TEST provides a sample of the output RF channel that is 20dB below the actual output.

Rear Panel

RF OUTPUT:	The composite, modulated RF signal is accessed at this 75 ohm F connector.
AURAL IF - IN:	This port is driven by the IF signal returned from the AURAL IF - OUT.
AURAL IF - OUT:	The IF signal from this port can be used to drive a transmitter, or can be looped back into the AURAL IF - IN port. With either configuration the IF signal can be passed through any IF scrambler.

VISUAL IF - IN:	The VISUAL IF signal is returned to this port from the VISUAL IF - OUT.
VISUAL IF - OUT:	Like the AURAL IF - OUT, this output can be used as the input to a transmitter or be looped into the VISUAL IF - IN. This signal can also be scrambled.
FREQUENCY OFFSET:	The FREQUENCY OFFSET switch group allows for a choice between five different offset options: No offset, +12.5kHz, -12.5kHz, +25kHz, and -25kHz. The last switch in this group selects either an Audio Input (INT.) or a 4.5MHz AURAL CARRIER (EXT.).
AUDIO IN:	A 600 ohm RCA jack is provided to accept the monaural baseband audio signal. For this input the last switch of the FREQUENCY OFFSET group must be set to INT.
AURAL 4.5MHz IN:	This option is provided to allow for the input of an externally modulated MONO or BTSC audio subcarrier. To use this option, connect the 4.5MHz externally modulated signal to the F connector and set the last switch in the FREQUENCY OFFSET group to EXT.
VIDEO INPUT:	This 75 ohm F connector accepts the baseband video signal that is to be modulated.
FUSE 250V 1A:	This fuse provides protection against overloads to the circuitry of the modulator.
117AC:	This ac line cord supplies the ac power to the modulator. The three-pronged plug is intended to be used with a properly grounded outlet.

1.5 Warranty and Parts Ordering:

Warranty - EMCEE warrants its equipment to be free from defects in material and workmanship for a period of one year after delivery to the customer. Equipment or components returned as defective (prepaid) will be, at our option, repaired or replaced at no charge as long as the equipment or component part in question has not been improperly used or damaged by external causes (e.g., water or lightning). Semiconductors are excepted from this warranty and shall be warranted for a period of not more than ninety (90) days from date of shipment. Equipment or component parts sold or used by EMCEE, but manufactured by others, shall carry the same warranty as extended to EMCEE by the original manufacturer.

Equipment Returns - If the customer desires to return a unit, drawer, or module to EMCEE for repair, follow the procedure described below:

1. Contact EMCEE Customer Service Department by phone or fax for a Return Authorization Number.

2. Provide Customer Service with the following information:

   Equipment model and serial numbers.
   Date of purchase.
   Unit input and output frequencies.
   Part number (PN) and Schematic Diagram designator if a module is being sent.
   Detailed information concerning the nature of the malfunction.

The customer shall designate the mode of shipping desired (e.g., Air Freight, UPS, Fed Ex, etc.). EMCEE will not be responsible for damage to the material while in transit. Therefore, it is of utmost importance that the customer insure the returned item is properly packed.

Parts Ordering - If the customer desires to purchase parts or modules, utilize the following procedure:

1. Contact EMCEE Customer Service by phone or fax indicating the customer's purchase order number. If the purchase order number is provided by phone, written confirmation of the order is required.

2. Also provide:

   The equipment model and serial number.
   The unit input and output frequencies.
   The quantity, description, vendor, number, and designation of the parts needed as found in the Parts Lists subsection of this manual.
   If a module is required, give the part number (PN) and Schematic Diagram designator (e.g., 30368014).
   Designate the mode of shipping desired (e.g., Air Freight, UPS, Fed Ex, etc.).
   Shipping and billing addresses.

For EMERGENCY technical assistance, EMCEE offers a toll free, 24-hour, 7-day-a-week customer service hot line: 1-800-233-6193.

EM1 OUTPUT CHANNEL/FREQUENCY

TV CH	CHANNEL DISPLAY	VISUAL FREQUENCY (MHz)	AURAL FREQUENCY (MHz)	TV CH	CHANNEL DISPLAY	VISUAL FREQUENCY (MHz)	AURAL FREQUENCY (MHz)
2	02	55.250	59.750	7	07	175.250	179.750
3	03	61.250	65.750	8	08	181.250	185.750
4	04	67.250	71.750	9	09	187.250	191.750
5A	01	73.250	77.750	10	10	193.250	197.750
5	05	77.250	81.750	11	11	199.250	203.750
6	06	83.250	87.750	12	12	205.250	209.750
				13	13	211.250	215.750
A-5	95	91.250	95.750				
A-4	96	97.250	101.750	J	23	217.250	221.750
A-3	97	103.250	107.750	K	24	223.250	227.750
A-2	98 **	109.250	113.750	L	25 *	229.250	233.750
A-1	99 **	115.250	119.750	M	26 *	235.250	239.750
				N	27 *	241.250	245.750
A	14 *	121.250	125.750	O	28 *	247.250	251.750
B	15 *	127.250	131.750	P	29 *	253.250	257.750
C	16 *	133.250	137.750	Q	30 *	259.250	263.750
D	17	139.250	143.750	R	31 *	265.250	269.750
E	18	145.250	149.750	S	32 *	271.250	275.750
F	19	151.250	155.750	T	33 *	277.250	281.750
G	20	157.250	161.750	U	34 *	283.250	287.750
H	21	163.250	167.750	V	35 *	289.250	293.750
I	22	169.250	173.750	W	36 *	295.250	299.750

* FCC mandated ±12.5kHz offset required, where applicable.
** FCC mandated ±25.0kHz offset required, where applicable.

TABLE 1–1

EM1 OUTPUT CHANNEL/FREQUENCY

TV CH	CHANNEL DISPLAY	VISUAL FREQUENCY (MHz)	AURAL FREQUENCY (MHz)	TV CH	CHANNEL DISPLAY	VISUAL FREQUENCY (MHz)	AURAL FREQUENCY (MHz)
AA	37 *	301.250	305.750	WW	59	433.250	437.750
BB	38 *	307.250	311.750	XX	60	439.250	443.750
CC	39 *	313.250	317.750	YY	61	445.250	449.750
DD	40 *	319.250	323.750				
EE	41 *	325.250	329.750	---	00/62-94	451.250	455.750
FF	42 **	331.250	335.750				
GG	43 *	337.250	341.750				
HH	44 *	343.250	347.750				
II	45 *	349.250	353.750				
JJ	46 *	355.250	359.750				
KK	47 *	361.250	365.750				
LL	48 *	367.250	371.750				
MM	49 *	373.250	377.750				
NN	50 *	379.250	383.750				
OO	51 *	385.250	389.750				
PP	52 *	391.250	395.750				
QQ	53 *	397.250	401.750				
RR	54	403.250	407.750				
SS	55	409.250	413.750				
TT	56	415.250	419.750				
UU	57	421.250	425.750				
VV	58	427.250	431.750				

* FCC mandated ±12.5kHz offset required, where applicable.
** FCC mandated ±25.0kHz offset required, where applicable.

TABLE 1–1

SECTION II

MAINTENANCE AND TROUBLESHOOTING

2.1 Maintenance:

The EM1 requires very little maintenance. Once it is set up and adjusted correctly, it should require no further attention aside from an occasional visual inspection of the cables. The cables should be checked to be sure that all connections are tightly secured, there are no cuts or tears in the cable covering, and there is no tension in the cables that could cause them to break or damage the connectors on the modulator. The EM1 and its cables should also be periodically cleaned and dusted.

2.2 EM1 Troubleshooting Chart:

PROBLEM	CAUSE	SOLUTION
Power Indicator does not light.	AC power cord is not plugged in.	Plug power cord into a properly grounded, 117Vac outlet.
	Fuse is blown or improperly inserted.	Check fuse and make sure it is properly inserted. If fuse is blown, replace with a 250V 1A fuse (an SOC MQ4 or other compatible fuse).
	Circuit breaker of ac supply is tripped.	Identify and correct problem before resetting the circuit breaker.
No RF output	Cable not connected or improperly connected.	Check cable connection to RF output port. Make sure that the center conductor of the coaxial cable is properly inserted into the F connector.
Poor Video contrast	Modulation depth not set correctly.	Adjust the VIDEO MOD for best contrast. (See Section 1.4b.)
Poor Audio quality	Deviation level is incorrect.	Adjust the AUDIO DEV control for correct deviation level. (See Section 1.4c.) [If using a 4.5MHz AURAL Input, Audio deviation adjustments must be made at the remote modulator.]
Adjacent Channel has beat	Aural carrier level is too high.	Using the RF LEVEL - AURAL CARRIER control, adjust the level of the carrier until the beat interference disappears.

If the above chart has not identified the problem, or an internal fault is suspected, contact an EMCEE service representative.

TABLE 2–1