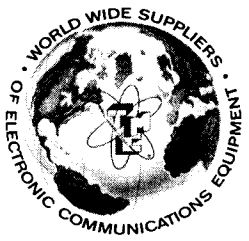

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Product Analysis

for

Antenna Matching Unit

Model AMU-6K

THE TECHNICAL MATERIEL CORPORATION

COMMUNICATIONS ENGINEERS

Functional Description

The AMU-6K antenna matching unit is ideally suited to matching the unbalanced RF outputs of any type transmitter - whether designed by TMC or not - to any type antenna system requiring a balanced coupling. Insertion loss through the matching unit is typically less than 2dB and the frequency response curve over the operating range is exceptionally flat.

The AMU-6K is a broadband antenna matching unit capable of low-loss matching between 50-ohm unbalanced impedances and a range of balanced impedances. Standard balanced ratings are 50-ohm, 300-ohm and 600-ohm, inclusive, with other ratings available to suit specific antenna characteristics. The RF power rating of the AMU-6K is 6,000 watts (6kW) continuous and 6kW peak-envelope-power (PEP).

The unit is designed to operate in conjunction with any high frequency transmitter operating in the range of 1.6 to 30MHz. Broadband coverage over such a wide frequency range is possible at some sacrifice to passband linearity, resulting in additional insertion loss. To minimize these effects, the AMU-6K is normally sectioned into optimized networks, each designed for a much narrower bandwidth to effectively improve linearity by lowering passband variations. The inherent nature of these networks enables suppression of harmonics outside the passband. The matching network range is listed in the following chart:

Matching Network Passband by Section

1	Low	1.6MHz	High	2.0MHz
2		2		3
3		3		5
4		5		8
5		8		12
6		12		16
7		16		30

The passband can be increased or decreased depending in insertion loss and SWR requirements. In addition, each section can be optimized for specific frequencies of operation by selection of optimal values for inductance and capacitance.

A sensor circuit is provided on one leg of each balanced output for detection of RF current through the AMU-6K. This compensated sensor network feeds a DC voltage back through the control line to the control unit where it is available for metering or other indication of RF path continuity. A separate path is used to calibrate the DC voltage so that line losses between the AMU-6K and control unit can be estimated and used to accurately compensate the return voltage.

Physical Description

The AMU-6K can be configured for either interior or exterior operation. As shown in the accompanying photograph (Figure 1) of a parallel, two-section unit, the AMU-6K can be mounted in a standard equipment rack for interior operation. The exterior units are similar in layout but are housed in a re-inforced fiberglass case with heavy-duty mounting hardware. Switching of networks is slightly different between interior and exterior units due to variations in environmental conditions and the critical requirement for "hands-off" operation in exterior units.

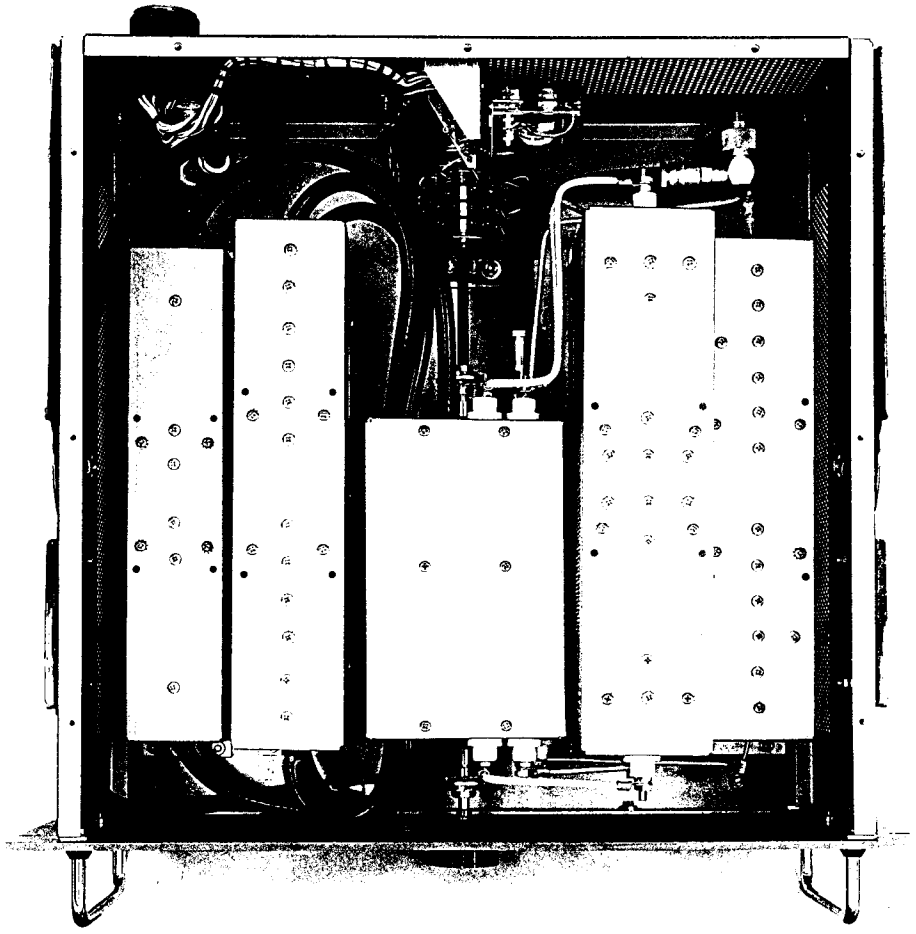


Figure 1 *Single-Input, Dual-Channel Antenna Matching Unit (Interior)*

Each network in the AMU-6K consists of two sections: a closely-coupled balanced-to-unbalanced transformer (BALUN) and an inductive-capacitive (LC) ladder network. Each section is normally housed in a separate, electrostatically shielded case. The photograph shows a dual-network configuration with each two-section network located on either side of the (switching) digital control housing. This configuration can be expanded for four, six or eight networks - the size is limited only by available space and weight restrictions. Note the difference in size between the two LC ladder networks located on either side of (and adjacent to) the control housing. The right-hand unit is optimized for a lower frequency range which accounts for its slightly larger size. The outer housings contain the BALUNs which do not vary significantly in size as frequencies change.

Figure 2 is a photograph of the interior of a typical LC ladder network. This particular network was designed with two purposes: to match the input RF to the output RF and to provide at least 35dB of suppression of harmonic content in the output. Normally, this number of "rungs" in the ladder network is not required since matching can be accomplished by properly selecting inductive series-L and capacitive parallel-C components. Note how each ladder rung is isolated from its neighbor to reduce the undesireable effects of mutual inductance and capacitance. The networks basically consist of a series of constant K sections between M-derived end sections. The two M-derived end sections determine the ratio of cut-off frequency to frequency of high attenuation. The constant K section(s) determines the frequency passband and input/output impedance of the matching network.

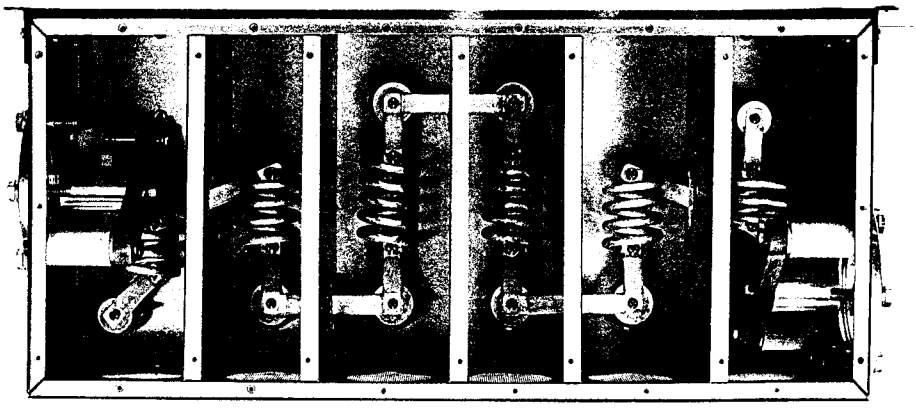


Figure 2 LC-Type Ladder Network Configuration

The interior model AMU-6K is normally housed in a standard 19-inch rack-mounted chassis with removable top and bottom covers. RF switching of active networks is by rotary, electromagnetic action due to the high current/voltage requirements of the RF path. Switching is controlled by a digital circuit that receives signal pulses via hardwire from a separate BCD-coded network. The interface connector can be a standard RS232 "D-type" or a circular "MS-type" depending on the requirements of the system. Control coding can also be changed from the standard BCD. Normally, both balanced and unbalanced RF connections are made at the real panel with 1-5/8 inch EIA flange assemblies used for the unbalanced line and twin Mycroy bowls in 12-inch centers used for the balanced line. (Note: The AMU-6K shown is the photograph is not configured for a balanced RF line.)

The exterior model AMU-6K is housed in a specially constructed fiberglass case. The case is re-inforced to allow for suspension from guy wires or support lines and is weatherproofed for protection of the internal components from punishing outdoor conditions. Special adaptor mounts are available in installations that allow for cross-arm bracing on poles or bulkheads. Internally, the layout of the matching networks and BALUNs is similar to the interior unit except that high-energy relay actuators are used in place of the rotary switches for selection of the RF path through the unit. In both cases, the only moving part in the unit is the relay armature which derives its operating voltage via the DC connector providing control information. Experience with this method of switching RF indicates that MTBF is typically in excess of 120,000 operations at the extremes of temperature and humidity.

Technical Specifications

The operating parameters of the AMU-6K are listed as follows:

Frequency Range 1.6 - 30MHz

Power Rating 6kW PEP and Average

Insertion Loss Less than 0.5dB (99% efficiency) when properly terminated into 50 ohms. BALUN is typically less than 0.1dB.

Insertion VSWR Better than 1.2-to-1

Load VSWR Maximum 3-to-1 for extended periods without degradation of performance. Gradual degradation above 3-to-1.

Impedance Match 50-ohm unbalanced (U) to 600-ohm balanced (B)
Optional 50U/50B and 50U/300B. Note that 50U/50U is also available enabling the matching network to be used for harmonic suppression.

RF Fitting - Unbalanced 1-5/8 inch EIA flange

RF Fitting - Balanced Twin Mycroy bowls on 12-inch centers

Mounting Crossbar, pole or thru-line (guys). Lifting eye bolts are fastened to each unit at the vertical balance point (COG).

Safety Feature Spark gap for protection against static discharge or lightning.

Dimensions and Weight (Approximate based on configuration)

AMU-6K	16H x 8W x 22D inches, 20 lbs.
AMU-2X6K	16H x 16W x 22D inches, 37 lbs.

Operating Temperature -40°C to +75°C, 100% RH (exterior)

Models and Accessories

The following lists standard models available in the AMU-6K series. Note that the number of channels can be increased or decreased depending on installation requirements. Each channel consists of two sections: a closely-coupled BALUN transformer and an LC ladder-type network. The LC network can be provided with standardized passbands or can be optimized for a specific passband and center frequency. See OPTIONS for the standard passbands available in the series.

AMU-6K	**Single-Channel 6kW Antenna Matching Unit**
AMU-6K-#	**Multi-Channel 6kW Antenna Matching Unit**
AMU-2X6K-#	**Dual Multi-Channel 6kW Antenna Matching Unit**
	(#) represents the number of channels installed.

OPTIONS:

/50U	Each output is 50-ohm unbalanced (harmonic suppression)
/50B	Each output is 50-ohm balanced
/300B	Each output is 300-ohm balanced
/C	Take-off coil installed in one leg of each balanced output
/SA	Unbalanced input EIA adaptor assembly
/QDL	Unbalanced QDL input connector assembly
/LC	Unbalanced LC input connector assembly
/N(#)	Standard channel number in accordance with the following:

#=1	1.6-2MHz	#=2	2-3MHz	#=3	3 -5MHz
4	5-8MHz	5	8-12MHz	6	12-16MHz
7	16-30MHz				

/S(f)	Special operating frequency (f) of each channel

EXAMPLE: AMU-6K-2/C/LC/N2/S4.144

This represents a two-channel matching unit with LC-type input connectors and a sensor circuit in one leg of the balanced output line. One channel is standard (#2) and the second channel is special, optimized for a center frequency of 4.144MHz.

The interior model of the AMU-6K contains one operating control that can be used under manual override conditions: a front-panel mounted rotary switch that selects the correct network (RF path) on command. A series of LED indicators display the path selected in terms of the passband limits imposed by the selected network. The exterior AMU-6K model does not have any operating controls or indicators. Position information is fed back to the control panel via the digital control line used to actuate the relay solenoids. In both models, the RF take-off circuit used to sample the output provides positive indication that the correct network was selected.

Digital signaling is provided from a control panel to the AMU-6K control circuit and the appropriate network selected to correspond to the transmitter operating frequency. This positioning information is sent to the control circuit via the data line and connector on the unit. The selection can be slaved to the transmitter band selector so that all switching is made automatically. A terminal strip on the control panel is provided as interface to the transmitter. A simple return voltage (supplied by the control panel) is needed from the transmitter to properly select the appropriate matching network. Switching is typically accomplished in under one second from initiation of the command sequence. Should the switching action mistakenly select an improper AMU-6K network setting, the associated transmitter will detect an overload condition (normally VSWR>3) and the entire system will be placed in a standby condition (biased off). This is standard practice when the AMU-6K is used with TMC transmitters.

The digital control circuitry can accomodate two separate sets of position control signals to handle two RF inputs simultaneously. On occasion, each input is fed from a single transmitter via an RF splitter. The control circuits are then tied together so that only one position signal is required to operate two RF paths in tandem. This feature is particularly important in phased array antenna configurations where the AMU-6K must be as closely matched as possible. It is important to recognize that in a split-input system, there is an inherent 6dB loss through the splitter while the AMU-6K contributes less than 0.5dB loss through to the balanced antenna feed line.

Figure 3 depicts a typical dual-input, eight-channel antenna matching unit in schematic format. Two RF signals from associated transmitters operating at 6kW PEP or average power levels in the 1.6-30MHz range are applied to each of two unbalanced input connectors. The RF from each input is routed to one of four networks, each consisting of an input BALUN transformer and an LC ladder-type network. The network is selected on the basis of the transmitter operating frequency. Position signaling is provided from the transmitter via a local control panel to the unit's digital control circuit which activates the appropriate solenoid relays. When no DC voltage is present at the control circuit, all relays are in the relaxed (open) position effectively removing all networks from the RF path. The transmitter must be biased off before switching RF paths. Control circuits are not operational until RF power is removed in order to protect components in the RF path, including but not limited to the relay contacts.

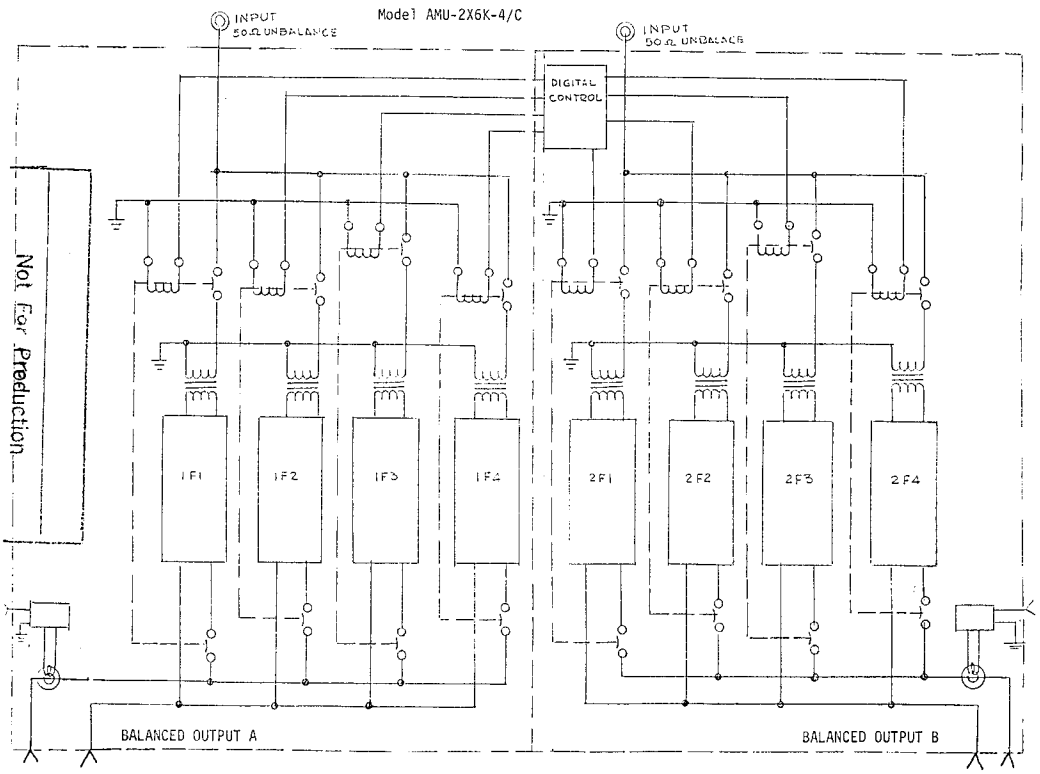


Figure 3 Dual-Input, Eight-Channel Matching Unit (Schematic)

With the appropriate relay energized, a set of normally-open contacts is closed and the RF path is established through the LC network. Note that all relays are inserted in the non-grounded legs of the unbalanced input lines and in one leg of the balanced output lines. The grounded input legs of the BALUNs are all common and one leg of each balanced output from the LC networks are common but not grounded. The input and output relay contacts for each BALUN-NETWORK chain are physically mounted together and act in tandem. This assures that both input and output paths are selected concurrently. Alternatively, this also assures that the BALUN-NETWORK chains not selected are electrically isolated from the selected RF output path. With this design, it is not necessary to terminate the unused networks since they are both electrically and mechanically isolated from the active network paths.

One leg of the balanced output is used to detect RF current to the antenna system. The take-off circuit consists of a simple current transformer with rectifying diode circuitry to provide an average DC voltage return to the digital control connector. Optionally, an RF take-off can be installed in place of or along with the current sensor circuit. This RF take-off is calibrated so that a 10-volt RMS reading corresponds to full output into the balanced line. The RF take-off signal is a true reproduction of the actual output RF signal but attenuated for monitoring purposes. To prevent distortion of this signal and possible false triggering of the switching control circuits, the sample RF must be fed back to the control unit via a separate 50-ohm RF coaxial line. It cannot be placed on a spare pin of the digital interface connector.

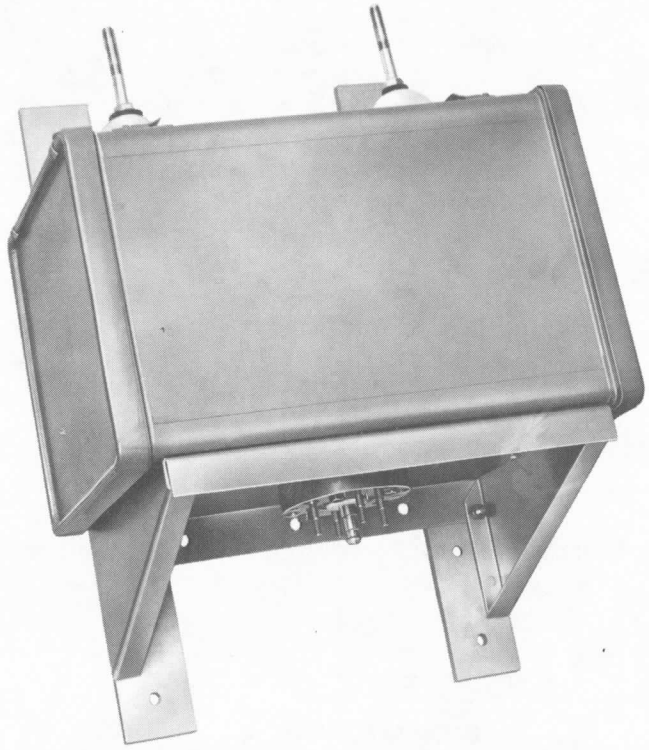
Conclusion

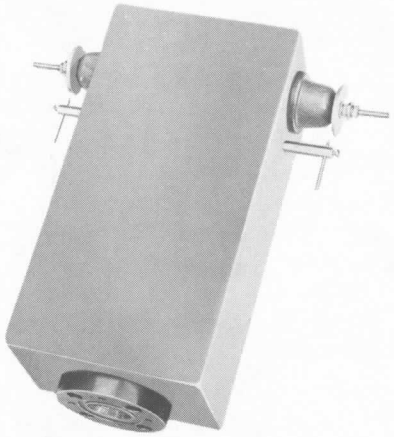
The AMU-6K is one in a series of antenna matching units that operate up to 300kW PEP/average. They are extremely reliable units that operate equally well in humid-or-dry, hot-or-cold and high-or-low altitude conditions. Thousands of units are in active service today throughout the world, providing the necessary matching and harmonic attenuation for RF signals from high-power transmitters. One design criteria incident to all models is the minimal use of moving parts. This results in a unit that requires virtually no maintenance during a nominally 20-year service life. In fact, the only units returned to the factory for repair since the early 1960's have been those hit by lightning. This record of performance is characteristic of TMC equipment and is one reason why TMC has been such a consistent and successful supplier of RF communication products to the world market for over 45 years.

Antenna Matching Unit

Model AMU-6K and AMU-20K

Product Bulletin 110352





Model AMU-6K

Model AMU-20K

The AMU Series of broadband antenna matching units provide low-loss matching between 50-ohm unbalanced impedances and a range of balanced impedances. All AMU-6K and AMU-20K models - both single and dual input are rated at 6KW and 20KW PEP/average, respectively. Higher-rated units are available to 300KW PEP.

The AMU consists of two sections: a closely-coupled BALUN and an LC ladder network. The BALUN provides highly efficient coupling of RF energy from balanced-to-unbalanced impedances in the HF frequency range of 2 to 30MHz while the network provides additional balanced matching into the antenna system. The AMU couplers are ideally suited to matching the unbalanced RF outputs of any make transmitter - whether designed by TMC or not - to any type antenna requiring a balanced coupling. Insertion loss through the AMU is typically less than 2dB and the frequency response curve over the operating range is exceptionally flat.

The AMU-2X models provide for twin RF input ports (nominally 50 ohms each) and up to four output networks per port. When multiple output networks are installed, each tailored to the operating characteristics of the antenna, a high-energy relay is used for switching. Digital control over an RS232 interface is provided for selection of the proper operating channel and to indicate sucessful switchover. Switching is completed in less than one second. Optional take-off coils are provided at each of the balanced output legs for real time measurement of RF currents into the antenna system.

The photographs above depict two single-input versions of the AMU series. Note the twin balanced output terminals and the single unbalanced input connector. The AMU-2X dual-input series features two unbalanced inputs and two sets of balanced outputs. The couplers, matching networks and relay (if required) are mounted internally with the optional control and take-off networks. The broadband coupling transformers and networks are sealed in steel containers which are anchored to weatherproof, reinforced fiberglass cases for protecting internal circuits from punishing outdoor conditions. All AMU units are passive and do not require power supplies or any tuning adjustments. Only the relay in the AMU-2X series requires DC power which can be supplied via the control or the coaxial supply lines.

OPERATING PARAMETERS

Frequency Range 2-30MHz

Power Rating

AMU-6K 6kW PEP/Average
AMU-20K 20kW PEP/Average

Insertion Loss Less than 2dB (99% efficiency)

Impedance Match 50-ohm unbalanced to 600-ohm balanced is standard. Optional: 50/50 and 50/300.

RF Fittings - Unbalanced

AMU-6K 1-5/8" EIA flange
AMU-20K 3-1/8" EIA flange
Optional: See table of options

RF Fittings - Balanced Bowls

AMU-6K Twin Mycroy/12-inch centers
AMU-20K Twin Porcelain/12-inch centers

Mounting Crossbar, pole or thru-line

Safety Feature Spark gap for protection against static discharge or lightning.

Dimensions and Weight

AMU-6K	16H x 8W x 22D in/20 lbs
AMU-2X6K-4	16H x 16W x 22D in/35 lbs typ
AMU-20K	21H x 20W x 30D in/80 lbs
AMU-2X20K	21H x 35W x 30D in/114 lbs

Operating Temperature -40°C to +75°C

ORDERING INFORMATION AND ACCESSORIES

Note: Units listed are 50-ohm unbal/600-ohm bal.

AMU-6K	Antenna Matching Unit, 6kW
AMU-6K-4	Single-Input/4-channel AMU-6K
AMU-2X6K-4	Dual-Input AMU-6K-4
AMU-20K	Antenna Matching Unit, 20kW
AMU-20K-4	Single-Input/4-channel AMU-20K
AMU-2X20K-4	Dual-Input AMU-20K-4

Input/Output Options:

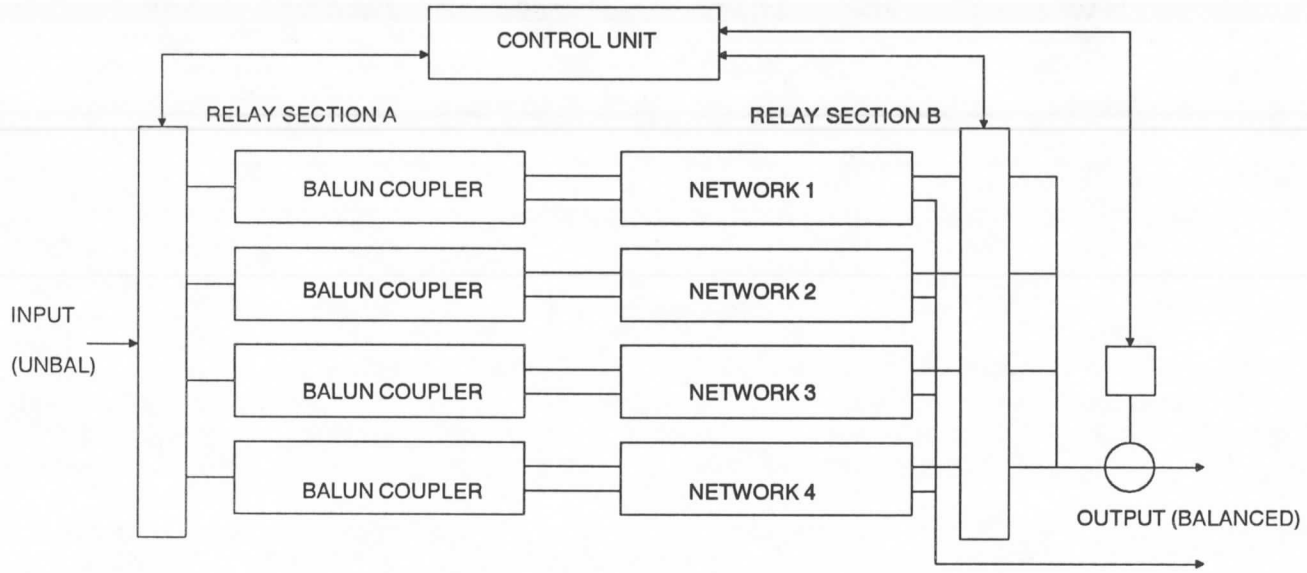
/50	Each output is 50-ohm balanced
/300	Each output is 300-ohm balanced
/C	Take-off coil (One each balanced leg)

Input Connector Assembly Options:

/ES85	ES-85/U*	AX274-2
/QDL	QDL-type*	AX273-1
/LC	LC-type*	AX287-1
/SA	EIA Adapter**	AX278

*AMU-6K models only
**AMU-20K models only

Specifications are subject to change without notice - Please verify with TMC Customer Service



Single-Input/Four-Channel Antenna Matching Unit

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