AVRs and why they are needed.

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I could write endlessly about the Trust's Outside Broadcast van, MCR21, but it might be more interesting to talk about some of the equipment used and why it was needed...

One of the problems for outside broadcasts in the 1960s was finding a suitable stable mains electricity supply. An OB unit of the period needed some 60 Amps of current and this could vary as equipment and loads like heating or air-conditioning was switched on/ off . This coupled with longish supply cables could lead to low and changing voltage at the point of use. I^2R losses in the cable run and possibly mobile generator instabilities.

In a larger OB there might be two or even three OB vans, a links van, maybe a VT van, production office, catering, lighting, lots of scope for voltage fluctuations.

These days, with switch mode power supplies it is not seen to be a problem, but back in the '60s switch mode power supplies were in the future.

Now it is quite true that a regulated PSU could be built to deal with these input variations, but there is a penalty in this.

Consider the voltage at the input to the regulator device in the simplified diagram. The minimum voltage at this point must be the output voltage plus the voltage drop in the regulator device plus an allowance for the ripple voltage from the rectifier-capacitor. In a linear regulator the difference between the input and output voltages must be lost in the regulator “pass” device be it valve or solid state. This voltage difference multiplied by the current appears as heat. V x A = watts (heat). In practice this margin would be big enough to allow for some small changes in supply voltage. You might call this excess of input voltage to the regulator the “headroom”.

Now if you design for a bigger “headroom” to accommodate a lower (or higher) mains input voltage this equates to more heat dissipated and overall increased power consumption. Providing even more work for the air-conditioning unit. After a while this becomes unreasonable needing bigger transformers and heat sinks.

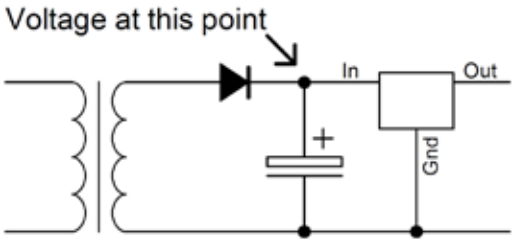
Many camera manufacturers specified the input voltage range that could be accommodated by the PSU, in at least one type this was as low as ±5%.

A solution, is to pre-regulate the mains supply with an Automatic Voltage Regulator, the AVR. This is a simple device, just a motor driven Variac, a Buck-Boost transformer* and a servo amplifier to drive the motor in the appropriate direction. They came in different current ratings. The ones in MCR21 are rated at 30 Amps for an input voltage range of 190 – 260 volts AC model TS3. It has a potentiometer to set the output voltage, in this case 240, and all the transformer input taps on the connected equipment transformers can be set accordingly.

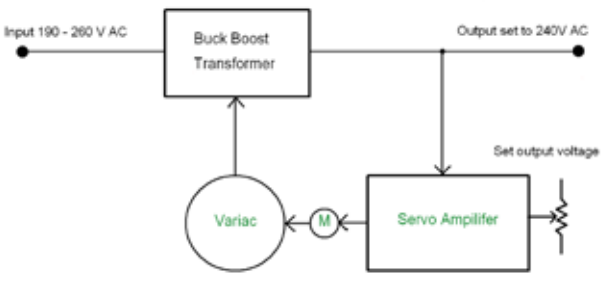
* The secondary of the Buck-Boost transformer is in series with the mains supply and it can add or subtract a correcting voltage. One connection of the primary of the Buck-Boost transformer connected



Restored Automatic Voltage Regulator (AVR)



Simplified PSU Diagram



AVR Block diagram



Before disassembly starts, note the heavy input output cables at the top



Final re-assembly, awaing in-out cables at the top

to the slider of the variac and the other connection to a 50% tap on the variac, such that the feed to the Buck-Boost transformer primary can be 0V when the input voltage is correct. Or a correction voltage that is ± in phase to give the Buck or Boost required.

The restoration

These are very heavy units and the Claude Lyons AVRs installed in MCR21 weigh 55Kg. each and there are three of them in the rear side locker.

The restoration caused a number of problems, weight was one of them, even when stripped down just the transformer was a significant lift! They were in a sad and corroded condition some 60 years outside had not done them any favours. We fully disassembled them and the cases and small parts were sent of to a local firm, Aurora Coatings, for sandblasting and repainting. This was not a cheap job but the work and finish was most satisfactory. We then started cleaning and refitting the insides. The varnished and well insulated Buck-Boost transformer gave no trouble and they were the first items to be refitted. Heavy but easy to refit.

The Variacs gave the most trouble, light corrosion on the aluminium castings but the insulating tube that carries the rotating brush plate had completely seized up solid, due no doubt by moisture absorption. When these had been freed up and the brushes adjusted and reset the variac still worked well. An interesting point about the brushes on variacs they are very thin, you don't want the brush to be in contact with more than on turn of the toroidal winding, lest it shorts out a turn.

The reversible 8V DC motor drives the variac via a worm and pinion reduction gear and a cruciform rubber coupling. There are two end of travel microswitches mounted on the top of the variac.

The last item to be refitted were the servo amplifiers. For an electronic item these looked a bit grim, all the usual suspects; corrosion, dodgy electrolytics and three worrying OC28 germanium power transistors. Each servo had two electrolytic capacitors which were changed on sight, apart from the usual problems the connection leads had corroded through and they virtually fell off the PCB. Amazingly the three transistors and all the rectifiers proved to be working just fine, Two of the three servos worked OK on test and the third just needed a VA1034 thermistor which had fallen apart.

The servo is powered by it's own mains transformer fed from the buck boost transformer output. The rectified output of one of the secondaries, via the set volts control, is compared in a bridge circuit to a reference zener diode and the output of this bridge goes to the first of the three OC28 amplifier transistors. The full handbook for the AVRs are on the MCR21 website: http://mcr21.org.uk/wp-content/uploads/2020/09/Claude-Lyons-AVR-type-TS-3.pdf

Broadcast Television Technology Trust
www.BTTT.org.uk

I would like to thank our MCR21 volunteer team and in particular Iain, both Steves, David & Paul for their sterling work in this restoration.



The Servo Amp after cleaning but showing the two dodgy electrolytics



The AVR production line