MANUFACTURERS AWA SUPERVISED SERVICE

TRANSISTOR INVERTER
TYPE VB-32QA

Issued by Amalgamated Wireless (Australasia) Limited

GENERAL DESCRIPTION:

The Transistor Inverter Type VB-32QA converts the 32 volts d.c. of home lighting plants, battery groups, etc., to 240 volts a.c. for the operation of television receivers.

The unit is mounted in a rugged case with an attractive vinyl coated sheet steel cover. A suitable handle is fitted to the front panel for ease of carrying. Plastic feet are fitted to the base of the case to avoid marking furniture.

A standard 3-pin socket is used as the output socket so that the television receiver may be plugged into the Inverter and the receiver operated without any modifications.

ELECTRICAL SPECIFICATIONS:

INPUT: 28-36 Volts D.C.
Nominal Current 8.5 Amps.
OUTPUT: Nominal 240V RMS. 180W Max.
Frequency 60 to 65 cps modified square wave.
TRANSISTORS: 4—Type 2N277; 1—Type 2N284A
DIODE: 1—Type 1N1763

MECHANICAL SPECIFICATIONS:

	Height	Width	Length
Case Dimensions	5"	7"	13"
Carton Dimensions	6"	8"	14"
Weight	22½ lbs. nett.		

TECHNICAL DESCRIPTION:

The heart of the inverter is a transistor switching unit consisting of a switching transformer TR2, and four transistors connected in a bridge configuration. A feedback winding from the transformer is connected from base to emitter of each transistor.

When 32V d.c. is applied to the input of the unit, one pair of transistors (eg., VT2 and VT5) starts to conduct causing a current to flow in the primary of the switching transformer. Voltages are induced in the feedback windings in such a way that the conducting pair of transistors are biased to conduct harder while the other pair are biased off. This state continues until the conducting pair "bottom", i.e., the voltage across the pair drops to approximately ½ volt. The magnetising current of the transformer then increases till the core saturates and the drive to the conducting pair is reduced. This is the commencement of a "snowballing" process where the drive to the conducting pair is reduced while the drive to the "OFF" pair is increasing until the conducting pair are cut off and the other pair of transistors conduct. This switching process continues automatically while the input voltage is applied.

The frequency of switching is determined mainly by the inductance of the half-primary windings and the input voltage.

Resistors R9, R10, R14 and R15 (0.5 ohms) are to swamp variations in input impedance of the transistors. Resistors R12 and R13 are to limit the peak collector current of the transistors at the instant of switching.

OUTPUT CIRCUIT

The primary of the output transformer TR1 is connected across the primary of the switching transformer TR2 and resistors R12 and R13. When transistors VT2 and VT5 are conducting, the full supply voltage appears across the primary of the output transformer. During the next half cycle, when VT3 and VT4 are conducting, the supply voltage again appears across the primary but in the opposite polarity. That is, there is an a.c. square wave voltage of 64 volts p-p across the primary. This voltage is stepped up by the transformer and fed to the output socket through a choke L1, which is so designed that the waveform appearing at the output socket has a peak to r.m.s. ratio similar to that of a sine wave.

The H.T. voltage of a television receiver is proportional to the peak value of the supply wave form while the valve heater power is proportional to the r.m.s. value of the supply waveform. Thus for correct operation of a television receiver designed to operate from a sine wave source, it must be driven from a source having the same peak to r.m.s. ratio as a sine wave.

HIGH INPUT VOLTAGE PROTECTION

A voltage sensitive relay control circuit and an associated relay are used to protect the inverter against high input voltage and reverse input polarity.

This circuit employs a transistor VT1 whose base voltage is held constant by a zener diode MR1 and bleed circuit R2 and R3 at—10 volts. By adjusting the relay control RV1 in the bleed circuit (R5, RV1 and R6) the emitter to base voltage of transistor VT1 may be varied and the transistor made to conduct at any desired input voltage.

The relay coil and diode MR2 are in the collector circuit of the transistor. If the input polarity is reversed, the diode will not conduct making the relay and hence the Inverter inoperative. When the relay and its control are correctly adjusted the Inverter will only operate when the input voltage is between 28 and 36 volts and of the correct polarity. The relay circuit is also stabilised over a wide temperature range by the inclusion of the thermistor network.

INSTALLATION

GENERAL:

Many types of 3-pin double adaptors when used on 32 volt outlets will reverse the polarity. It is recommended that where the use of adaptors is essential, the Pick-a-back type combination 3-pin plug/adaptor be used.

The distance between the 32 volt plant and the Inverter should be as short as possible. For distances of up to 30 feet, the wiring should have conductors no lighter than 16/.012", 40/.0076" or 1/.051" (16 B & S). For distances up to 50 feet, the minimum recommended conductor size is 40/.010" or 1/.064" (14 B & S).

If the distance from the 32 volt plant to the Inverter is greater than 50 feet, it is recommended that the Inverter be located near the plant and a normal 240 volt line run from the Inverter output to the television receiver.

If the Inverter is to be driven directly from a motor generator, then a 32 volt battery bank or an electrolytic capacitor of minimum value 150u.f. should be connected permanently across the output terminals of the generator. This is to ensure that the sudden surge of current needed to start the Inverter may be supplied by the 32 volt supply system.

Fit a suitable plug to the input lead of the Inverter, RED to POSITIVE, BLACK to NEGATIVE.

Plug the television receiver power plug into the 3-pin socket on the Inverter.

Plug the Inverter input leads into the 32 volt supply and switch on.

Switch the television receiver on and operate in the normal way.

If a motor generator is used it is important to start this first before switching the Inverter on.

The Inverter is essentially an impulse starting device and if for some reason it ceases to operate, the input must be switched off and then on again to restart the Inverter.

Do not leave the Inverter switched on for long periods when the television receiver is not on. A current of 1.5 amps is drawn from the 32 volt supply under these conditions and will drain the charge from the batteries unnecessarily.

VENTILATION

The Inverter operates at a relatively high temperature and hence it is important to locate it in a position where ventilation through its case and around the finned section at the rear of the case is not impaired.

Place the Inverter horizontally on its four plastic feet on a relatively firm surface—not on a carpet which may cover the ventilation holes in the bottom of the case.

Do not place magazines, newspapers, etc., on top of the case and do not stand the Inverter on its finned section when in operation.

These simple precautions should be strictly followed especially in a hot climate.

The Inverter is designed to operate in ambient temperatures up to 120° F. provided that the natural circulation of air through and around its case is not impaired.

INPUT VOLTAGE VARIATION

The voltage supplied by a nominal 32 volt d.c. system can vary considerably depending on the load, and if the batteries are being charged the voltage can rise to a figure well in excess of the nominal.

To prevent overloading of the television receiver, a protective relay is built into the Inverter which switches the Inverter off when the d.c. voltage rises above 36 volts.

A HIGH INPUT VOLTAGE warning indicator on the front panel of the Inverter lights up when this condition exists.

The necessary steps must then be taken to reduce the input voltage to 32 volts, e.g., by switching the charger off or tapping down on the battery bank.

If the input voltage drops to 28-30 volts, the picture size on the television receiver may be reduced.

Consequently, it is recommended that the input voltage be kept as close as possible to 32 volts d.c. for trouble-free operation of the Inverter and television receiver.

If the supply voltage is in excess of 36 volts, end cell correction could be used to lower the voltage so that the Inverter will operate. This correction takes the form of tapping the Inverter line down on the battery bank so that the end cell or cells, as required, are out of circuit. With an Inverter remotely located from the battery, this will entail the running of a further line from the battery to the Inverter. Where the Inverter is located at the battery a simple manual change-over switch could be used.

SERVICING

Before applying 32 volts d.c. to the input, depress the relay armature by hand and measure the resistance across the input lead. This should read a minimum of 3 to 5 ohms.

RELAY CONTROL CIRCUIT

To check the operation of the relay and its control circuit plug a TV receiver into the output socket of the inverter and set the input voltage to the inverter at 34 volts d.c. Switch the inverter on and check that the relay is closed and the Inverter operates. Switch the input to 36 volts and the relay should open. Reduce the input to 26 volts and check that the relay is closed.

If the above conditions cannot be achieved make small adjustments of the control RV1 (50 ohms) till the relay operates in the 34 to 36 volt range. Check that relay still operates at 26 volts.

If it is not possible to adjust the control RV1 to obtain correct operation the relay should be readjusted as below.

RELAY ADJUSTMENT

Remove the relay from the inverter and, if necessary, polish the contacts with very fine emery paper and wipe free from dust.

Check the gap between the contacts (.020" to .025") and the gap between the armature and core with the armature depressed by hand (.010" to .014").

Using a continuously variable d.c. supply and a 50 mA ammeter in series with the relay coil, adjust the spring tension so that the relay closes at coil currents between 14 and 17 mA and opens between 11 and 14 mA.

Before final adjustment, make sure that the relay spring is not twisted or skewed and is securely glued at each end.

The relay should operate positively. If not, the 8 BA screw holding the armature may be too tight or the spring may be twisted or skewed.

GENERAL:

When servicing the Inverter, electrolytic capacitors C1 and C2 should be inspected and, if possible, checked. These should be replaced if there is any doubt as to their condition.

If individual transistors appear to be overheating, tighten the mounting nut. Make sure that the transistor does not twist and allow the base or emitter tags to short to the heat sink.

TRANSISTOR SERVICE NOTES

GENERAL:

Whilst transistors, when used within the manufacturer's ratings, should give considerably longer life and service than vacuum tubes, the following precautions should be observed when servicing receivers to prevent damage to transistors.

Transistors can be damaged when checking circuit continuity by the d.c. voltage present in an ohmeter. To avoid damaging a transistor and obtaining a misleading resistance reading, the transistors should therefore be disconnected from the circuit. However, an ohmeter, if used carefully, may be utilised to test a **power** transistor as described below.

The use of screwdrivers as a means of checking voltages is very likely to cause permanent damage to transistors.

Transistors are extremely sensitive to heat, temperatures in excess of 90° C. can cause permanent damage. Great care should therefore be exercised when soldering transistor leads, keeping the soldering iron as far away from the transistor body as practicable and applying heat for as short a time as possible.

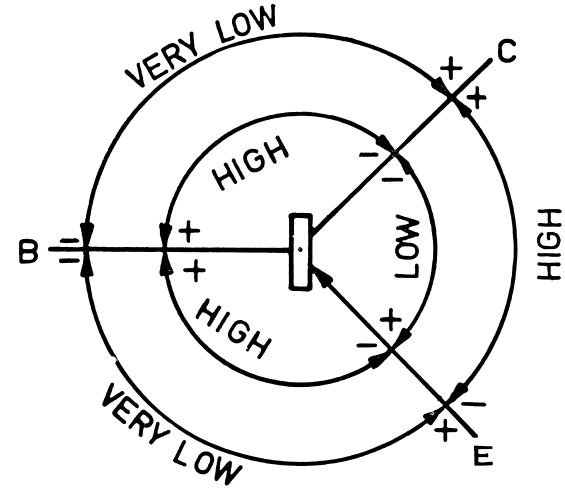
Voltmeters used for test purposes must be at least 20,000 ohms per volt. The use of low impedance meters will only give misleading results as serious shunting effects will occur.

POWER TRANSISTOR TEST

Power transistors can be readily checked for short or open circuit by carefully applying an ohmeter check to determine the forward and reverse resistance of each junction as a diode.

An ohmeter, either multimeter or vacuum tube type, having a small battery voltage of say 1.5 volts applied on the X1 range must be used. Check this with a voltmeter before using, as a higher voltage will cause damage. Also check the polarity of the meter leads in the ohmeter position. Often this is the reverse of the polarity when used as a voltmeter or ammeter.

Fig. 1 shows the correct order of resistance between the junctions of the 2N277 power transistor with the + and — signs indicating the correct polarity of the applied ohmeter leads. The base and emitter leads should be disconnected from a mounted transistor.



RESISTANCE DIAGRAM
FIG. 1

TRANSISTOR MOUNTING

Power transistors are thermally connected to, but electrically insulated from, the heat sink.

If a transistor is removed from the heat sink or replaced for any reason it is essential that the following method of mounting be carefully adopted.

On no account must the old mica insulator be used again.

To mount the transistor, first liberally smear the relevant surfaces of the heat sink and the transistor, and both sides of the mica insulator with silicone grease. (M54 silicone compound is available in handy 8 oz. tubes.)

Fit the insulating bush over the stud of the transistor. Place the mica insulation in position on the finned side of the heat sink followed by the transistor. Fit the following components to the stud of the transistor in order: mica washer, plain washer, I.T.L. tag, nut.

WARNING

Excessive tightening of the nut can distort the transistor base with the danger of rupture to the mica insulator.

Finally check with an ohmeter the insulation between the collector (mounting flange) and the heat sink (should be greater than 1 megohm).

For this check, leads to the base and emitter tags of the transistor should be removed.

MEASUREMENTS

Output voltage should preferably be measured with a moving iron meter which measures true r.m.s. voltages. However, if such a meter is not available, a meter reading average voltage or a c.r.o. measuring peak voltage may be used and conversions made using the following table.

OUTPUT VOLTAGE FROM INVERTER

Rectifier Type (Moving Iron Meter)	Peak to Peak Volts (C.R.O. or A.W.A. Voltohymst)	R.M.S. Volts Moving Coil Meter (AVO)
190	480	196
200	505	206
210	530	216
220	555	226
230	580	236
240	605	246
250	630	256
260	655	266

HEATER VOLTAGE IN TV RECEIVER

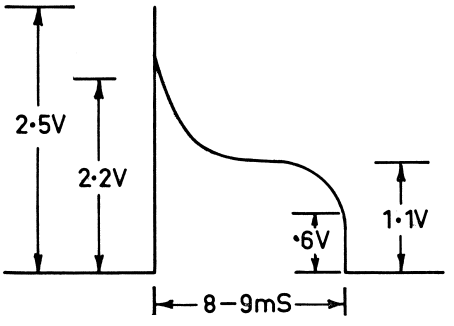
5.86	14.5	6.0
6.06	15.0	6.2
6.26	15.5	6.4
6.46	16.0	6.6

D.C. RESISTANCE OF WINDINGS

Winding	D.C. Resistance in OHMS
Switching Transformer TR1	
Primary	0.6
Feedback sections	0.1
Output Transformer TR2	
Primary	0.2
Secondary	9.2
Choke L1	3.7
Relay Coil	900

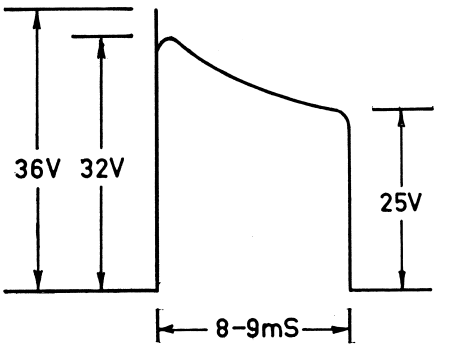
WAVEFORMS

1



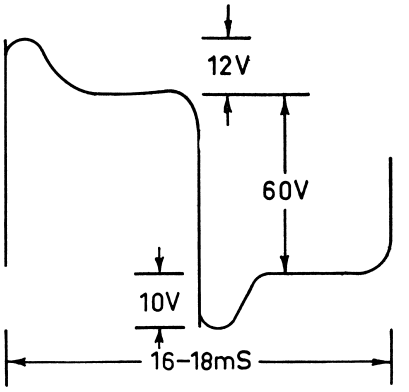
BASE CURRENT
VOLTAGE ACROSS EACH 0.5Ω RESISTOR

2



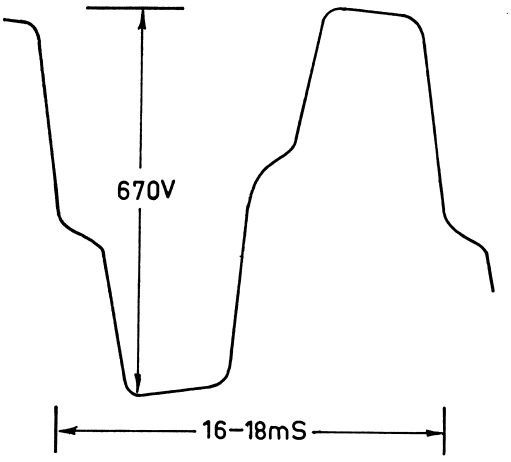
COLLECTOR TO EMITTER VOLTAGE
FOR EACH TRANSISTOR

3

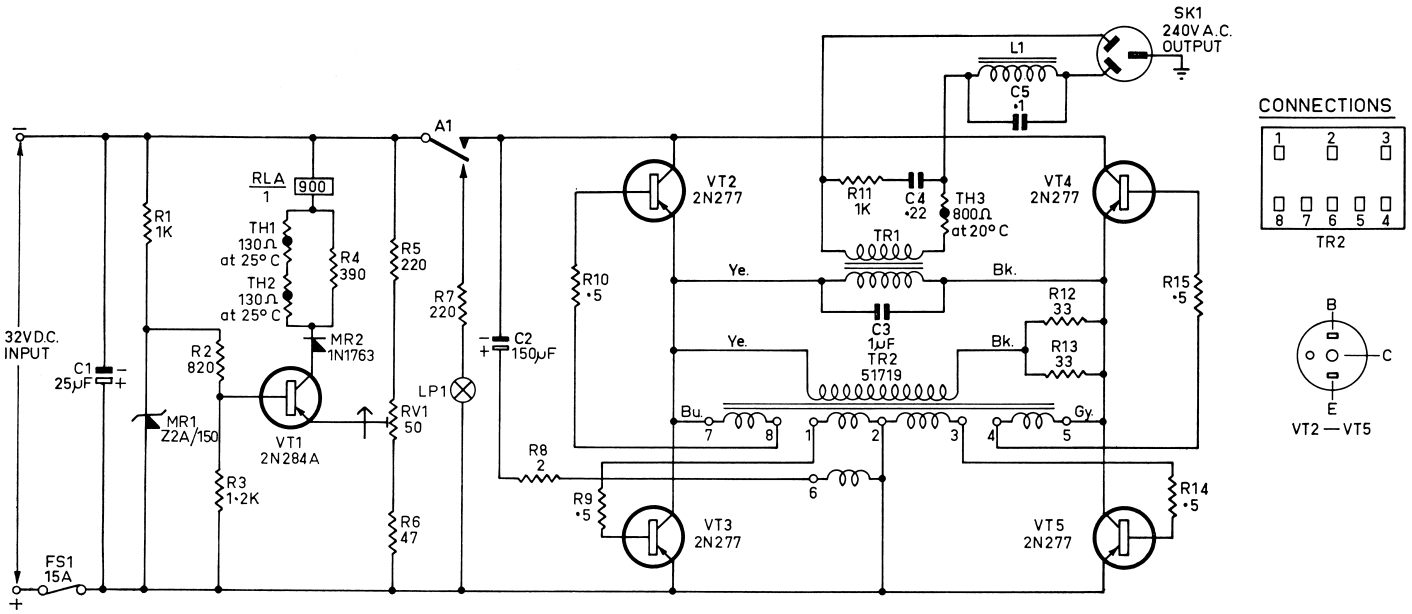


VOLTAGE ACROSS PRIMARY OF
OUTPUT TRANSFORMER

4



OUTPUT WAVEFORM



Note: C1 and C2 are now 50uf 300vw electrolytic capacitors 229590.

CIRCUIT CODE

CODE No.	DESCRIPTION	PART No.
	RESISTORS	
R1	1K ohms ± 10% 1 watt	608031
R2	820 ohms ± 10% 1 watt	607670
R3	1.2K ohms ± 10% 1 watt	608319
R4	390 ohms ± 10% ½ watt	606254
R5	220 ohms ± 10% 5 watts	605263
R6	47 ohms ± 10% 5 watts	603111
R7	220 ohms ± 10% 5 watts	605263
R8	2.2 ohms ± 10% 5 watts	600428
R9	0.5 ohms ± 10% 4 watts	600230
R10	0.5 ohms ± 10% 4 watts	600230
R11	1K ohms ± 10% 10 watts	608045
R12	33 ohms ± 10% 10 watts	602768
R13	33 ohms ± 10% 10 watts	602768
R14	0.5 ohms ± 10% 4 watts	600230
R15	0.5 ohms ± 10% 4 watts	600230
RV1	50 ohms Linear W.W. 2 watt	620985
	CAPACITORS	
C1	25uf 65vw Electrolytic	229425
C2	150uf 50vw Electrolytic	229741
C3	1uf ± 20% 200vw Hunts W48	227731
C4	0.22uf ± 10% 1000vw paper	227340
C4	0.22uf ± 10% 1,000vw paper	227340
C5	0.1uf ± 20% 600vw paper	227011
	TRANSISTORS and DIODES	
VT1	AWV 2N284A	
VT2	AWV 2N277	
VT3	AWV 2N277	
VT4	AWV 2N277	
VT5	AWV 2N277	
MR1	Zener Diode Z2A/150	
MR2	AWV 1N1763	

CODE No.	DESCRIPTION	PART No.
	MISCELLANEOUS	
TR1	Output Transformer	51505A
TR2	Oscillator Transformer	51719
L1	Choke	51555
RLA	Relay Assembly	62280
FS1	15 Amp. Fuse Cartridge	370014
PL1	12 volt 2.2 watt Pilot Lamp	428147
SK1	Output Socket	793031

Note: In some early Chassis R1 was a 1.5K ohm ± 10% 1 watt resistor 608710.

R5 was a 150 ohms ± 10% 5 watt resistor 604688.

R6 was a 100 ohms ± 5% 5 watt resistor 604018.

R2, R3, R4, TH1 and TH2 were missing.

Base of VT1 was connected to junction of MR1 and R1.

MECHANICAL REPLACEMENTS

Bezel, High Input Voltage	41530
Clamp Body, Power Cable	41397
Clamp Lock, Power Cable	41398
Foot, Rubber	42953
Handle, Turner Type H537 x 4⅝"	396028
Holder Assembly, Lamp	4195
Holder, Fuse	400002