The Measure of Excellence in Electrical Testing

AVO® ™

MULTI-AMP® BIDDLE™ MEGGER®

AVO BIDDLE INSTRUMENTS

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Instruction Manual AVTM 212480

For the

Major MEGGER® Insulation Testers BM14 and MJ20

Catalog Numbers 212480 and 212481

MULTI-AMP® BIDDLE™

AVO BIDDLE IN

SAFETY WARNING

- ***The circuit must be de-energized and isolated BEFORE connections are made for any test, (except a voltage measurement).***
- ***Do not touch the circuit during an insulation test.***
- ***After insulation tests, capacitive circuits MUST be discharged BEFORE disconnecting the test leads.***
- ***Test leads must be in good order; clean and having no broken or cracked insulation.***

Refer also to page 9 for further explanations and other precautions. The warnings and precautions must be read and understood before the instrument is used. They must be observed during use.

NOTE

This instrument is only to be used by a suitably trained and qualified person.

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GENERAL DESCRIPTION

The MJ20 and BM14 Major MEGGER® insulation testers are completely self contained instruments designed for insulation resistance testing, at high voltages, in the maintenance and servicing of rotating plant machinery, transformers, switchgear and industrial installations.

Both instruments have two insulation testing voltages, 2500 V and 5000 V, with insulation resistance measuring ranges of 0 to 5000 MΩ and infinity and 0 to 10000 MΩ and infinity, respectively. In addition the instruments have a 600 V a.c. range which, if selected after insulation resistance testing on an equipment having capacitance, discharges the circuit under test. A guard terminal, which can be used to minimize the effects of surface leakage resistance when carrying out insulation resistance testing, is also provided on the instruments.

The MJ20 uses a low voltage, hand cranked, brushless a.c. generator as a power supply. The generator is connected through a rectifier to a.d.c. to d.c. converter to provide the test voltages. The generator is designed to be easy to turn even under full load.

Power for the BM14 is derived from six 1,5V alkaline manganese cells mounted in a battery compartment in the base of the instrument. The cells are connected to a.d.c. to d.c. converter to provide the test voltages. A moving coil meter, with taut band suspension, white scales on a black scale plate and an orange "dayglow" pointer, indicates the insulation resistance being measured. There is a direct reading insulation resistance scale for each of the two test voltages.

Three 4 mm terminal sockets marked '+', '-' and 'G' are provided on the side of the case for connection of the test leads. After the test leads have been connected to the instrument terminals, the carrying handle folds down neatly over them. Should the handle accidentally become detached from the case it may be easily 'sprung' back into position. The case is robust, yet light-weight, and is made from a strong polycarbonate plastic. Mounted on top of the case is a three position, rotary, range selection switch.

In general the instruments comply with the safety requirements of the IEC 348 and BS 4743 specifications. However, the flash test is restricted to 11kV a.c. r.m.s.

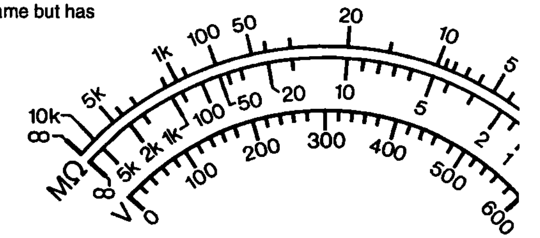
APPLICATIONS

These testers are intended for the direct measurement of insulation resistance of industrial wiring, cables, transformers, motors, generators and electrical machinery. Because they are self-powered they are suitable for use during installation and commissioning work as well as for service and maintenance applications.

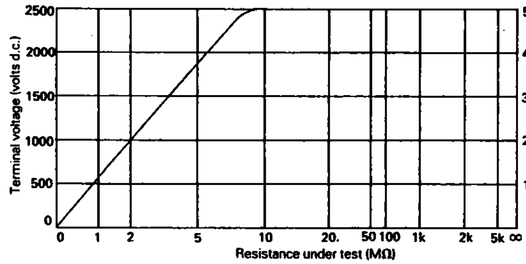
SPECIFICATION

INSULATION RANGE			
Insulation Resistance Ranges		0-5000MΩ and ∞	0-10 000 MΩ and ∞
Nominal Test Voltages d.c.		2500V	5000V
Terminal Voltage on Open Circuit		nominal voltage ±10%	
Terminal Current on Short Circuit		0.6mA	
Accuracy		±2% off s.d.	
Voltage Stability	MJ20	<±1% between 180 rev/min and 240 rev/min	
VOLTAGE RANGE			
Range		0-600 V a.c.	
Accuracy		±2,5% off s.d.	
GENERAL			
Overload Rating		600 V a.c. or d.c. on all ranges	
Power Supply	MJ20	low voltage, brushless a.c. generator	
	BM14	six 1,5 V cells IEC LR6 type (e.g. Duracell MN 1500)	
Temperature	operating	14°F to 122°F (-10°C to +50°C	
	storage	-4°F to 158°F (-20°C to +70°C)	
Flash Test		11kV a.c. r.m.s.	
Dimensions	MJ20	210 x 128 x 125 mm (including generator handle) (8¼ x 5 x 5 in approx.)	
	BM14	180 x 128 x 125 mm (7 x 5 x 5 in approx.)	
Weight		1 kg (2,2 lbs)	

Illustration of Typical Scale
MJ20 scale is shown, BM14 scale is the same but has a battery condition indication mark added.



Typical Terminal Voltage Characteristic — 2,5 kV



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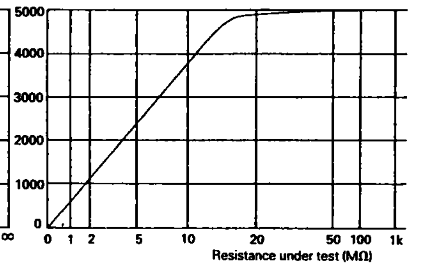

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IGE

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	MJ20	low voltage, brushless a.c. generator
	BM14	six 1,5 V cells IEC LR6 type (e.g. Duracell MN 1500)
	operating	14°F to 122°F (-10°C to +50°C
	storage	-4°F to 158°F (-20°C to +70°C)
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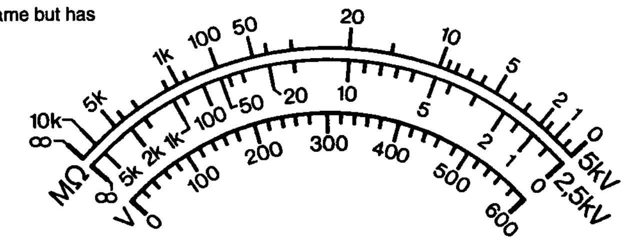

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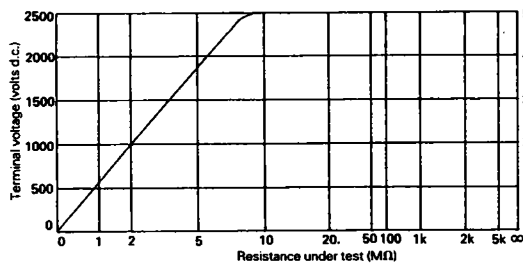
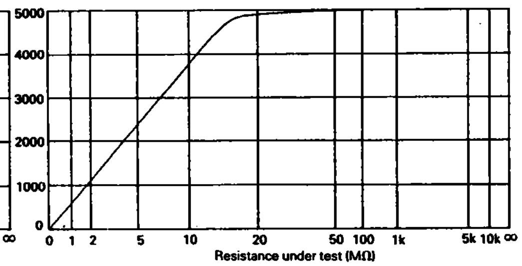


Typical Terminal Voltage Characteristic — 5 kV



ACCESSORIES

ORDERING INFORMATION

BM14 Analog Insulation Resistance Tester 212480CL
MJ20 Analog Insulation Resistance Tester 212481CL

INCLUDED ACCESSORIES

Test Lead Set, 6 ft. 210971
Carrying Case 217741
Instruction Manual AVTM212480
Test Record Card 210954

OPTIONAL ACCESSORIES

Test Lead Set, 12 ft. 210972

OPERATION

WARNINGS

1. The circuit under test must be de-energized and isolated before insulation tests are made. The instrument's voltmeter function may be used to verify that the circuit is 'dead'.
2. When capacitive circuits have been tested switch the instrument to the 'Discharge' position and allows a suitable time to elapse, before disconnecting the test leads, for the circuits to discharge. Monitor the discharge on the meter and remove the test leads, when this voltage has fallen to zero.
3. When connecting the instrument to the circuit care must be taken to ensure that there is no hazard to the user due to the voltage produced at the terminals. The voltage may be 2500 V or 5000 V as indicated by the selector switch.
4. The tester should not be used in explosive or inflammable environments, although there is unlikely to be a fire hazard from the instrument itself. However, arcing in faulty insulation, sparking caused when making or removing connections to equipment that has not been properly de-energized, or discharge of capacitance following tests, can lead to explosion or fire hazard.

CAUTION

1. Instruments used in dusty environments should be stripped and cleaned periodically.
2. The instrument circuit contains static sen devices. If the casing is opened for any r (this will automatically invalidate any wa covering the instrument), care must be e in handling the printed circuit board. The be done in accordance with BS 5783, DI 59-98 or EMER Telecommunications A4 Chapter 545, specifications for the hand static sensitive devices.

BATTERY CONDITION TEST (BM14 only)

Prior to carrying out any of the preliminary che testing with the instrument, perform the batter condition test. Press the battery condition test marked with the battery symbol, and check th meter indicates within the portion of the scale with the battery symbol. If the meter does not the correct battery voltage level the cells mus changed before proceeding with any checks or testing.

BATTERY REPLACEMENT (BM14 only)

The cells are housed in a battery compartmen base of the instrument. To change the cells, u screwdriver to remove the battery cover secu screws and lift off the battery compartment co Replace the cells ensuring that the polarity is marked on the base of the battery compartme Replace and secure the battery compartment

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BATTERY REPLACEMENT (BM14 only)

The cells are housed in a battery compartment in the base of the instrument. To change the cells, use a screwdriver to remove the battery cover securing screws and lift off the battery compartment cover. Replace the cells ensuring that the polarity is as marked on the base of the battery compartment. Replace and secure the battery compartment cover.

OPERATION

PRELIMINARY CHECKS

Without the test leads being connected to the instrument, but with the rotary selector switch set to the 5kV position, turn the generator handle, (MJ20 only) and ≥180 rev/min, or press the 'Test' button (BM14 only). The meter pointer should remain over the '∞' (infinity) position on the scale. This establishes that there is no leakage through the instrument itself.

Inspect the test leads to see that they have good unbroken insulation uncontaminated by grease, oil or dirt. Connect two of the test leads, to the '+' and '-' terminals on the side of the instrument case and ensure that their clips are not touching anything. Turn the generator handle, (MJ20 only) at approximately 180 rev/min, or press the 'Test' button (BM14 only) and observe the meter pointer, it should rest over the '∞' (infinity) position on the scale. If it does not the test leads may be faulty and should be inspected more closely for damage. Replace them if necessary.

Connect the test lead clips together and turn the generator handle, or press the 'Test' button (as appropriate), again. The meter should read zero. If it indicates infinity or a high resistance value the leads may be open circuit and should be inspected further. Replace them if necessary. (Shorting the leads together and obtaining zero readings also shows that instrument is working).

Note:—To avoid creating leakage paths when insulation testing, it is advisable not to allow the lead to twist together nor trail across metalwork etc., more than is really necessary.

INSULATION TESTING

After connecting the test leads to the instrument and carrying out the Preliminary Checks as detailed above, set the selector switch to the voltage required. With the circuit to be tested isolated, connect the test leads as follows;—

(a) For insulation tests to ground:—
Connect the '+' test lead to ground or frame of the equipment, and the '-' test lead to that part of the circuit to be tested.

(b) For insulation tests between wires:—
Connect a test lead to the core of each of the wires.

Turn the generator handle (MJ20 only) at ≥180 rev/min, or press the 'Test' button (BM14 only). The meter pointer will indicate the value of insulation resistance on the scale.

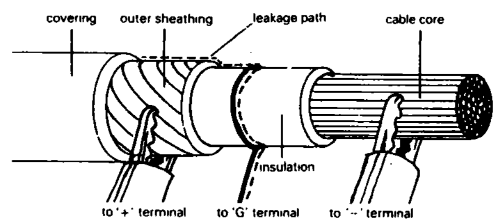
If a capacitive circuit is tested the pointer will initially deflect towards zero and then gradually rise to its final steady value as the capacitance is charged to the output voltage of the tester.

If several successive readings of '∞' are obtained, connect the two farther ends of the test leads together and turn the generator handle, or press the 'Test' button (as appropriate). A zero reading should result which double checks that the leads are not disconnected or broken and therefore the insulation resistance readings are correct.

After testing capacitive circuits the range selector switch should be set to the 'Discharge' position to discharge the circuit. The approximate discharge voltage will be indicated on the voltage scale. Wait a few moments for the voltage to fall to zero before disconnecting the test leads.

GUARD TERMINAL

The guard terminal 'G' is provided to minimize the effects of surface leakage currents on the resistance readings when carrying out insulation tests. During cable testing, for example, a leakage path may exist between the bared conductor and the external sheathing due to dirt or moisture contamination. Where this possibility exists, particularly when testing at higher voltages, a bare conductor may be bound tightly around the insulation and connected to the guard terminal as indicated in the diagram below. A test lead is provided for this purpose.



VOLTAGE RANGE

The instrument may be used directly as an voltmeter with a 0-600 V range, simply by selector switch to the 'V/Discharge' positio range may be used to check that a circuit i completely de-energized before an insulati made. It also acts as a discharge monitor selected following an insulation test on a c item, e.g. a cable. In this case it is importa realize that the actual voltage is not shown being d.c. in nature), but the meter does in when the voltage has decayed to zero and when it is safe to remove the test leads.

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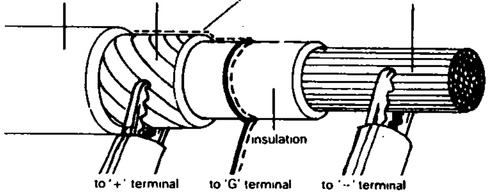

VOLTAGE RANGE

The instrument may be used directly as an a.c. voltmeter with a 0-600 V range, simply by setting the selector switch to the 'V/Discharge' position. This range may be used to check that a circuit is completely de-energized before an insulation test is made. It also acts as a discharge monitor when selected following an insulation test on a capacitive item, e.g. a cable. In this case it is important to realize that the actual voltage is not shown, (that being d.c. in nature), but the meter does indicate when the voltage has decayed to zero and therefore when it is safe to remove the test leads.

TESTING TECHNIQUES

DESIRABILITY OF INSULATION TESTING

The safety of electrical installations and apparatus depends on the condition of the insulation. It is essential that this is thoroughly checked when new equipment is installed, while being subjected to a voltage high enough to break through any mechanical flaws arising from manufacture or installation.

It is also desirable, in order to avoid interruptions or breakdowns, that tests on the condition of the installation and equipment are made from time to time to ensure that deterioration is not occurring because of the accumulation of dirt or moisture, or caused by mechanical factors of wear or breakage.

In every case the insulation resistance can be measured very simply by using the MEGGER® Tester.

In dealing with faults in electrical equipment, the location of a circuit discontinuity will often reveal the site of a breakdown in insulation which is often responsible for the final fault. By using a suitable instrument, circuit and earth continuity can be tested and any unsatisfactory joints or contacts can be measured, traced and corrected.

PREVENTIVE MAINTENANCE

It is good practice to make regular tests of the insulation resistance of all large machinery and thus detect any incipient faults. When the tests are entered in the logbook a considerable variation between test results will be noted.

It is therefore important to test under similar conditions each time and to note the current weather status.

Damp weather—or damp conditions of use or storage—can cause large reductions in insulation resistance. Drying out by heat or by running for a period, should give a more consistent and appropriate insulation resistance value.

A counter effect to that above occurs because the insulation resistance of the varnishes used in the construction of machine windings becomes lower when hot than when cold. Thus for constant comparisons the temperature of the machine under test should also be noted.

The best plan is regularly to make the time for testing a machine as soon as possible after it has been shut down. The insulation resistance is then likely to be at its lowest operational value. This then would become the figure which would show any continuing mechanical depreciation or potential insulation breakdown.

If the machine stands idle in humid conditions a worse picture might well apply but this would normally be assumed to be safe during the running up to temperature, provided that the resistance at working temperature remained unchanged.

TESTING MOTORS AND GENERATORS

1. Disconnect the equipment from the supply by opening the main switch and removing the main fuses.
2. Join together BOTH terminals on the motor side of the double pole main switch.
3. With a contactor operated starter where all the lines to the motor are disconnected at 'off' it is necessary to make tests to ground on both the incoming and outgoing terminals of the starter.
4. Connect the '+' test lead to ground using the frame of the motor.
5. Using the '-' test lead measure the resistance of each part of the circuit in the usual way. If the value is unsatisfactory then separate tests in starter, motor and cables must be carried out to locate the defect.
6. If the motor itself is suspect, disconnect cables and with one lead connected to t carry out the following tests:
7. Test with the armature and field windinc connected together.
8. Test with the brushes lifted from contact the commutator.
9. Test on the armature only, section by se
10. If all resistances are low the fault can us remedied by complete and careful clear machine. Equipment that has been in se period can accumulate metallic, or other conducting, dust especially when mixed from bearings etc. The leakage paths fr deposits are eliminated by thorough clea

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7. Test with the armature and field windings connected together.
8. Test with the brushes lifted from contact with the commutator.
9. Test on the armature only, section by section.
10. If all resistances are low the fault can usually be remedied by complete and careful cleaning of the machine. Equipment that has been in service for a period can accumulate metallic, or other conducting, dust especially when mixed with oil from bearings etc. The leakage paths from such deposits are eliminated by thorough cleaning.

SETTING-UP PROCEDURE

The basic setting-up procedure for the MJ20 and BM14 Major MEGGER® testers is detailed in the table below. It is, however, recommended that only a qualified instrument technician be employed to service the instruments.

Note:— (i) Opening the case will automatically invalidate any warranty covering the instrument.
(ii) Fit new battery cells to the BM14 before setting-up.

Caution:— The instrument contains static sensitive devices.

Step	Adjustment potentionmeter	Adjustment for	Conditions for adjustment
1	R5	5kV ±10% o/c terminal voltage	(a) switch to 5 kV range (b) 5 kV voltmeter (with >100 MΩ input impedance) across '+' and '-' terminals
2	R7	scale ∞ mark	(a) switch to 5 kV range (b) o/c terminals
3	R6	scale 0 mark	(a) switch to 5 kV range (b) s/c/ across '+' and '-' terminals
4	R4	scale 10 MΩ mark (5 kV range)	(a) switch to 5 kV range (b) 10MΩ resistor (5 kV rating) across '+' and '-' terminals

WARRANTY AND REPAIRS

WARRANTY

Products supplied by AVO Biddle Instruments are warranted against all defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to rep or repairing, at our option, defective equipment. Equipment returned to the factory for repair will shipped Prepaid and Insured. The warranty does not include batteries, lamps or tubes, where the original manufacturer's warranty shall apply. We make no other warranty. The warranty is void in vent of abuse (failure to follow recommended operating procedures) or failure by the customer to perform specified maintenance as indicated in this manual.

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REPAIRS

AVO Biddle Instruments maintains a complete instrument repair service, and recommends that it customers take advantage of this service in the event of equipment malfunction. Please indicate pertinent information including problem symptoms and attempted repairs. When returning equipn for repair, either in or out of warranty, it *must* be shipped prepaid and insured, and marked for the attention of the Repair Department.

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R6	scale 0 mark	(a) switch to 5 kV range (b) s/c/ across '+' and '-' terminals
R4	scale 10 MΩ mark (5 kV range)	(a) switch to 5 kV range (b) 10MΩ resistor (5 kV rating) across '+' and '-' terminals

WARRANTY AND REPAIRS

WARRANTY

Products supplied by AVO Biddle Instruments are warranted against all defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned to the factory for repair will shipped Prepaid and Insured. The warranty does not include batteries, lamps or tubes, where the original manufacturer's warranty shall apply. We make no other warranty. The warranty is void in the vent of abuse (failure to follow recommended operating procedures) or failure by the customer to perform specified maintenance as indicated in this manual.

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REPAIRS

AVO Biddle Instruments maintains a complete instrument repair service, and recommends that its customers take advantage of this service in the event of equipment malfunction. Please indicate all pertinent information including problem symptoms and attempted repairs. When returning equipment for repair, either in or out of warranty, it *must* be shipped prepaid and insured, and marked for the attention of the Repair Department.

COMPONENTS LIST

Components are common to both MJ20 and BM14 unless otherwise stated.

R1	Resistor	1kΩ±1%	¼W	
R2	Resistor	75kΩ±1%	¼W	
R3	Resistor	82,5kΩ±1%	¼W	
R4	Potentionmeter	200kΩ±20%		
R5	Potentionmeter	30kΩ±20%		
R6	Potentionmeter	2kΩ±20%		
R7	Potentionmeter	10kΩ±20%		
R8	Resistor	82,5kΩ±1%	¼W	
R9	Resistor	1,82kΩ±1%	¼W	
R10	Resistor	3,92kΩ±1%	¼W	
R11	Resistor	24,3kΩ±1%	¼W	
R12	Resistor	432kΩ±1%	¼W	
R13	Resistor	6,81kΩ±1%	¼W	
R14	Resistor	200kΩ±2%	2W	
R15	Resistor	100kΩ±2%	2W	
R17	Resistor	1kΩ±1%	¼W	
R19	Resistor	1MΩ±5%	½W	
R20	Resistor	1MΩ±5%	½W	
R21	Resistor	1MΩ±5%	½W	
R22	Resistor	1MΩ±5%	½W	
R23	Resistor	1,029MΩ±0,5%	1W	
R30	Resistor	30Ω±5%	2,5W	BM14
R31	Resistor	39,2KΩ±1%	¼W	BM14
RN	Resistor network			
C1	Capacitor	100µF	40V	MJ20
C2	Capacitor	1000µF	10V	
C3	Capacitor	100µF	10V	

C4	Capacitor	680pF	100V	
C5	Capacitor	4,7µF	40V	
C6	Capacitor	100µF	10V	
C7	Capacitor	1µF	63V	
C8	Capacitor	0,01µF	3kV	
C9	Capacitor	0,01µF	3kV	
C10	Capacitor	0,01µF	3kV	
C11	Capacitor	0,01µF	3kV	
C12	Capacitor	0,01pF	3kV	
C13	Capacitor	0,01µF	3kV	
C14	Capacitor	10µF	16V	tantalum
C15	Capacitor	0,22µF	63V	
C16	Capacitor	10µF	16V	tantalum
C18	Capacitor	680pF	100V	
C19	Capacitor	0,01µF	3kV	
C20	Capacitor	0,01µF	3kV	
C21	Capacitor	0,01µF	3kV	
C22	Capacitor	0,022µF	100V	
C23	Capacitor	12pF	3kV	
C24	Capacitor	12pF	3kV	
D1	Diode			1N4148
D2	Zener diode 1,2V			ICL8069
D4	Diode			BZX79C30
D5	Diode			SL500
D6	Diode			SL500
D7	Diode			SL500
D8	Diode			SL500
D9	Diode			1N4148
D10	Diode			1N4148

D11	Diode	1N4148	
D12	Diode	BZX79C15	
D13	Diode	1N4148	
D14	Diode	1N4148	
D15	Diode	1N4148	
D16	Bridge rectifier		MJ20
D17	Diode	1N4148	
D20	Diode	1N4148	BM14
IC1	Integrated circuit (voltage regulator)	7808	MJ20
IC2	Integrated circuit (op-amp)	CA3140	
TR1	Transistor	IRF531	
TFH1	Thick film hybrid		
T1	Transformer assy		
M1	Meter	262µA	

CIRCUIT DIAGRAM