6. DIGITALNI MULTIMETRI i OSCILOSKOPI za merenja na vozilima

- Digitalni multimetri
- Digitalni osciloskopi
- Ispitivači kola

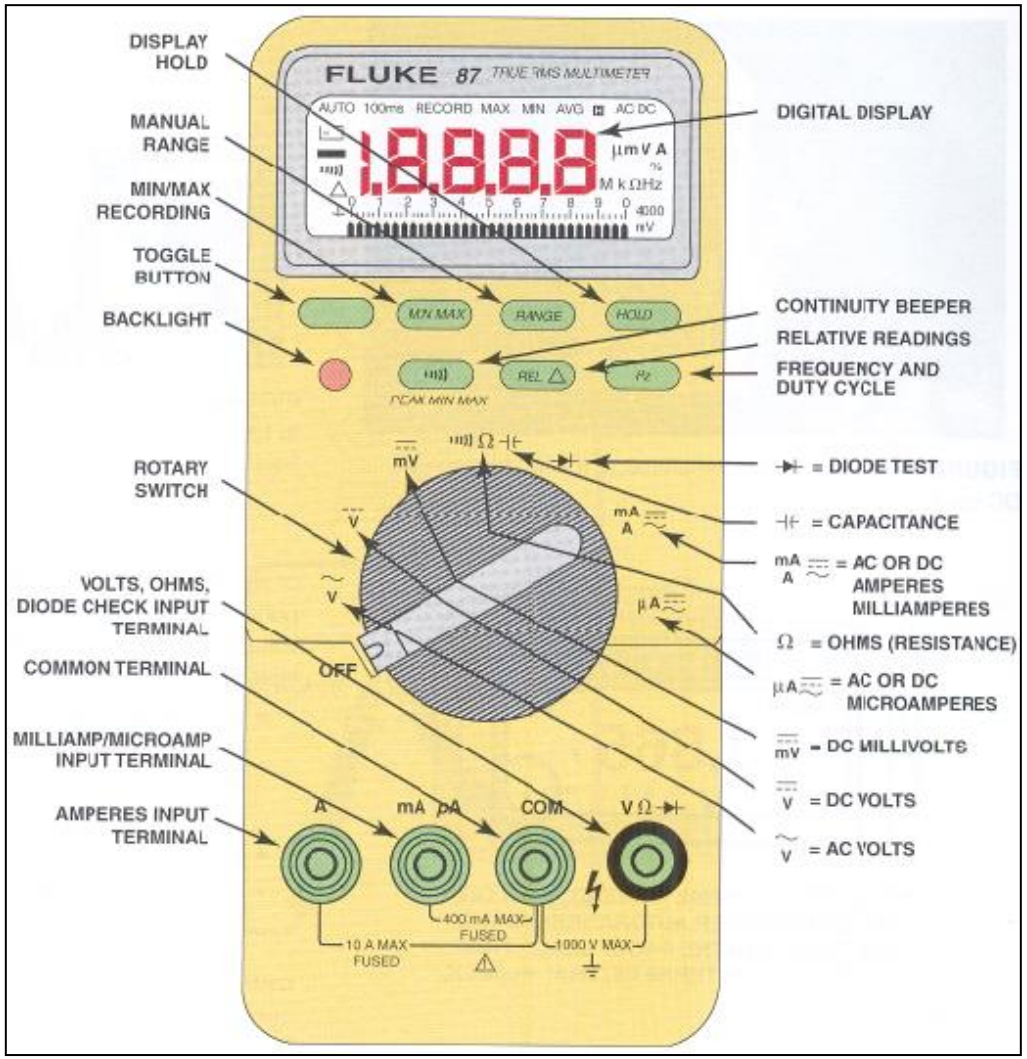
DIGITALNI MULTIMETRI

- **Jedan od najvažnijih elemenata elektronske dijagnostičke procedure je utvrđivanje vrednosti parametara motornog vozila i njihovo poređenje sa podacima u radioničkim bazama podataka.**
- Za to se koriste merni instrumenti;
  - namenski i
  - univerzalni.

- Univerzalni merni instrument ili **multimetar** je višenamenski elektronski uređaj čija funkcija se određuje (zadaje) pomoću preklopnika.
- Predviđen je za merenje većeg broja mernih veličina:
  - napon (jednosmerni i naizmenični)
  - struja (jednosmerna i naizmenična)
  - električna otpornost
  - kapacitivnost, učestanost i temperatura
- Digitalni multimetar (DMM) i digitalni volt-om-miliampermetar (DVOM) su pojmovi koji se obično koriste za elektronske multimetre visoke impedanse (unutrašnji otpor).
- Većina danas ima najmanje 10 MΩ unutraćnji otpor.

Fluke 87V

DIGITALNI MULTIMETRI



SYMBOL	MEANING
AC	Alternating current or voltage
DC	Direct current or voltage
V	Volts
mV	Millivolts (1/1,000 volts)
A	Ampere (amps), current
mA	Milliampere (1/1,000 amps)
%	Percent (for duty cycle readings only)
Ω	Ohms, resistance
kΩ	Kilohm (1,000 ohms), resistance
MΩ	Megohm (1,000,000 ohms), resistance
Hz	Hertz (cycles per second), frequency
kHz	Kilohertz (1,000 cycles/sec.), frequency
Ms	Milliseconds (1/1,000 sec.) for pulse width measurements

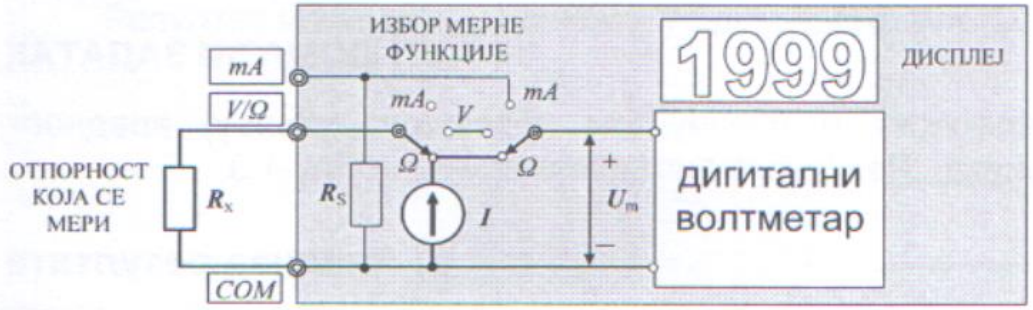
Uobičajene skraćenice za jedinice veličina koje mnogi multimetri mogu da mere.

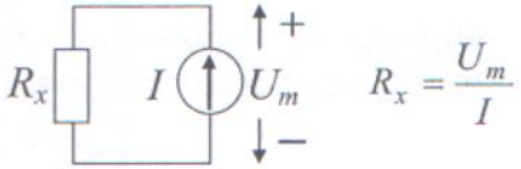
Tipični digitalni multimetar. **Crni** merni provodnik se uvek nalazi u **COM** priključku, a **crveni** treba da bude u priključku VΩ, osim kada se meri struja u A ili mA µA.

DIGITALNI MULTIMETRI

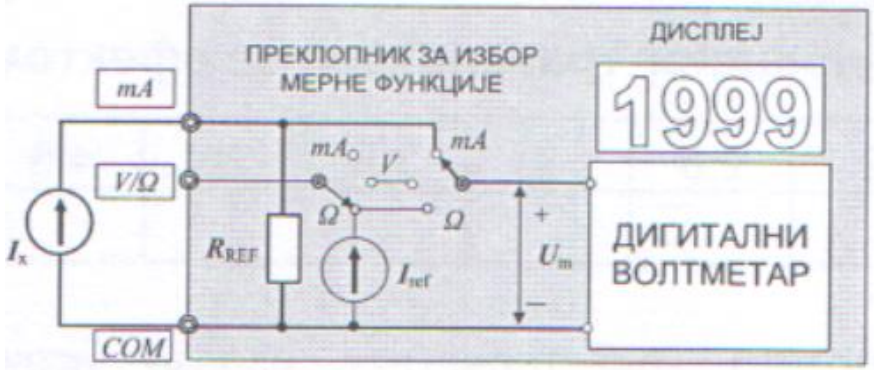
Principska šema merenja multimetrom

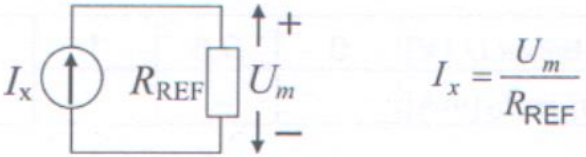
Merenje električne otpornosti





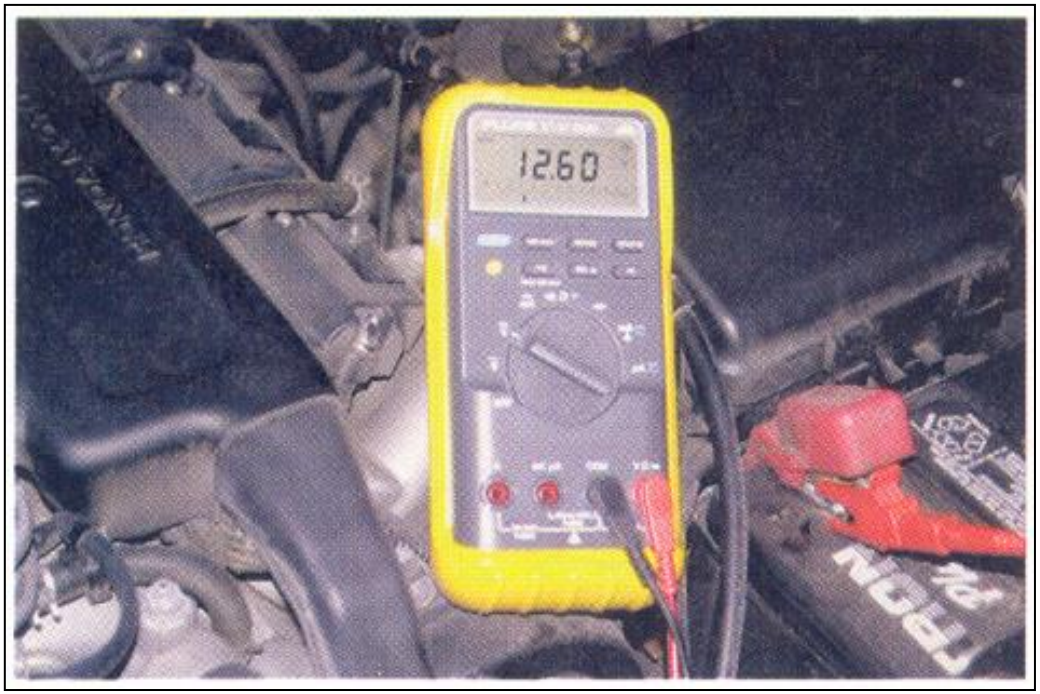
Merenje električne struje





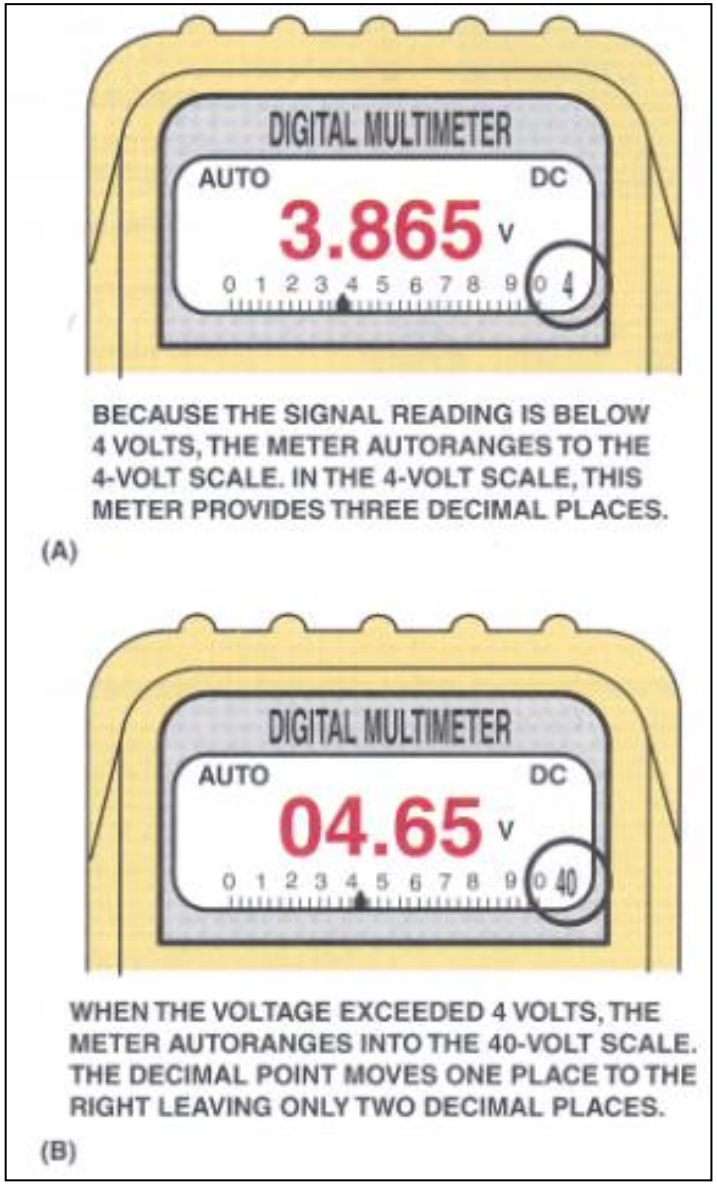
DIGITALNI MULTIMETRI

Merenje napona



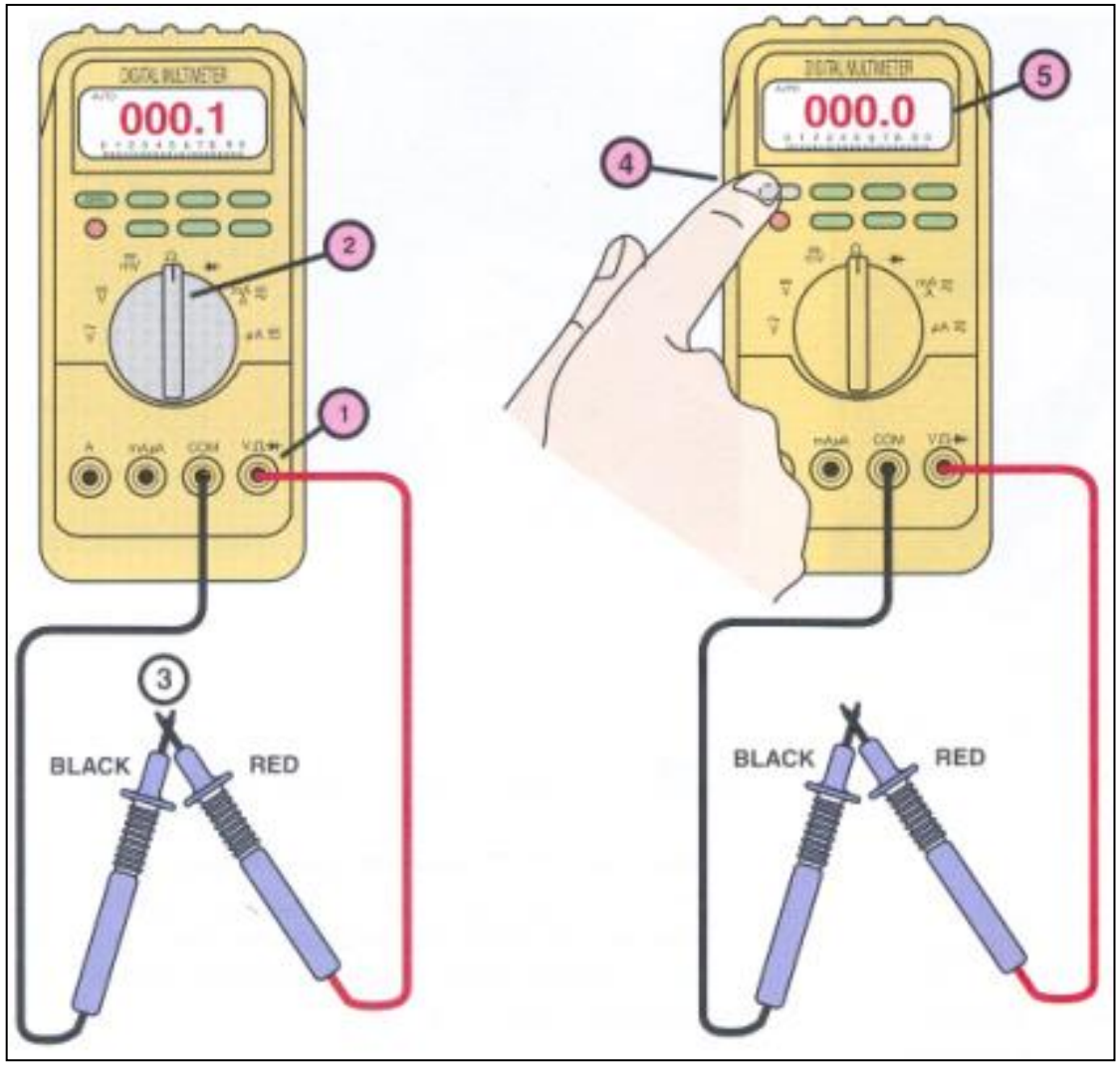
Tipični digitalni multimetar (DMM) podešen da meri DC napon.

Tipičan automatski digitalni multimetar automatski bira odgovarajuću skalu za očitanje napona koji se meri. Odabrana skala se obično prikazuje na displeju instrumenta.



DIGITALNI MULTIMETRI

Merenje otpornosti



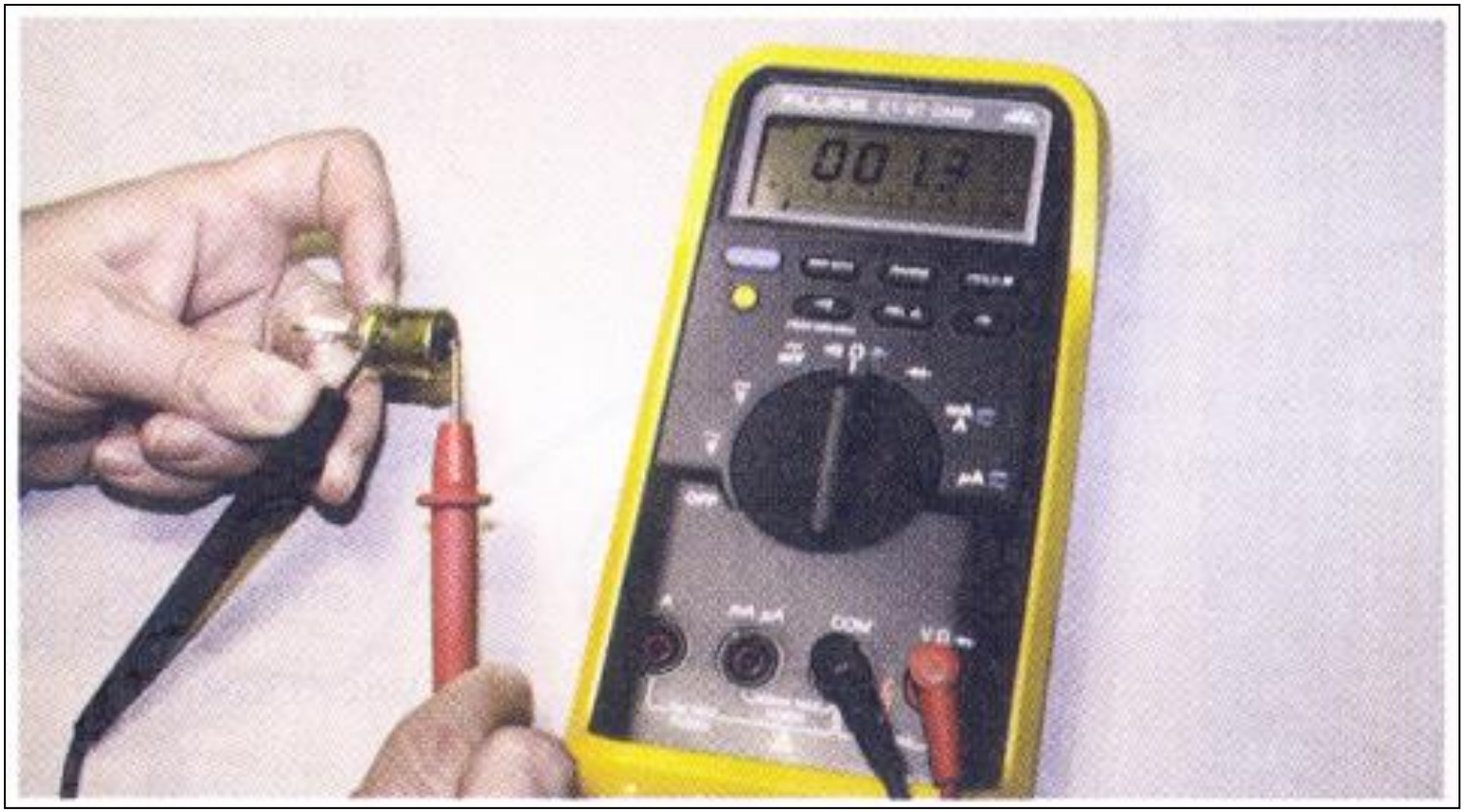
Mnogi DMM mogu da kompenzuju otpor ispitnih provodnika da bi na displeju pokazali nulu.

1) Priključe se provodnici u terminale VΩ i COM
2) Izabere se Ω skala
3) Dodirnu se ispitni-provodnici
4) Pritisne se dugme "nula" ili "relative"
5) Na displeju će se pokazivati nula Ω otpornosti.

UPOZORENJE: Kolo mora biti električno otvoreno bez protoka struje prilikom korišćenja ommetra. Ako struja teče kada je priključen ommetar, očitavanje će biti netačno i instument se može uništiti.

DIGITALNI MULTIMETRI

Merenje otpornosti

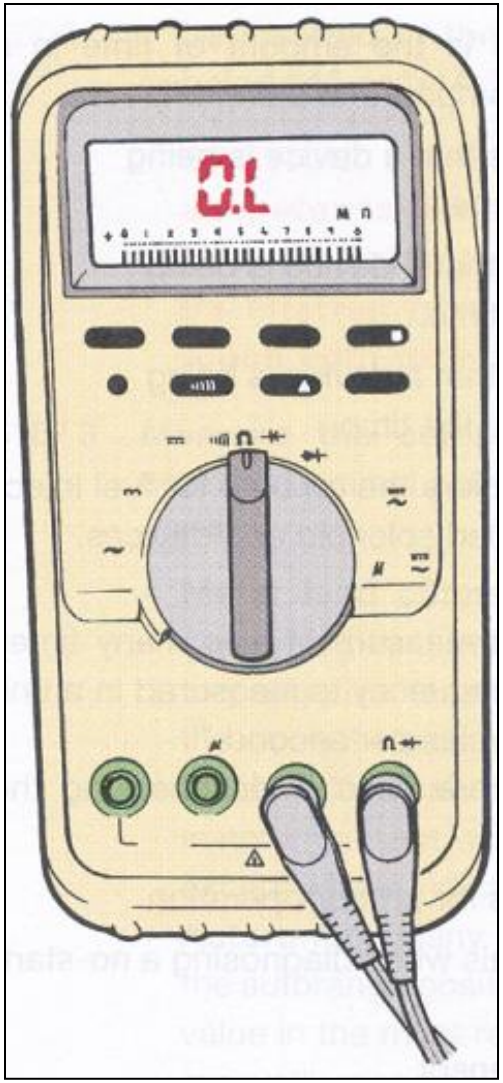


Korišćenje digitalnog multimetar postavljenog da meri otpornost za proveru ispravnosi sijalice. Instrument prikazuje otpornost vlakna.

DIGITALNI MULTIMETRI

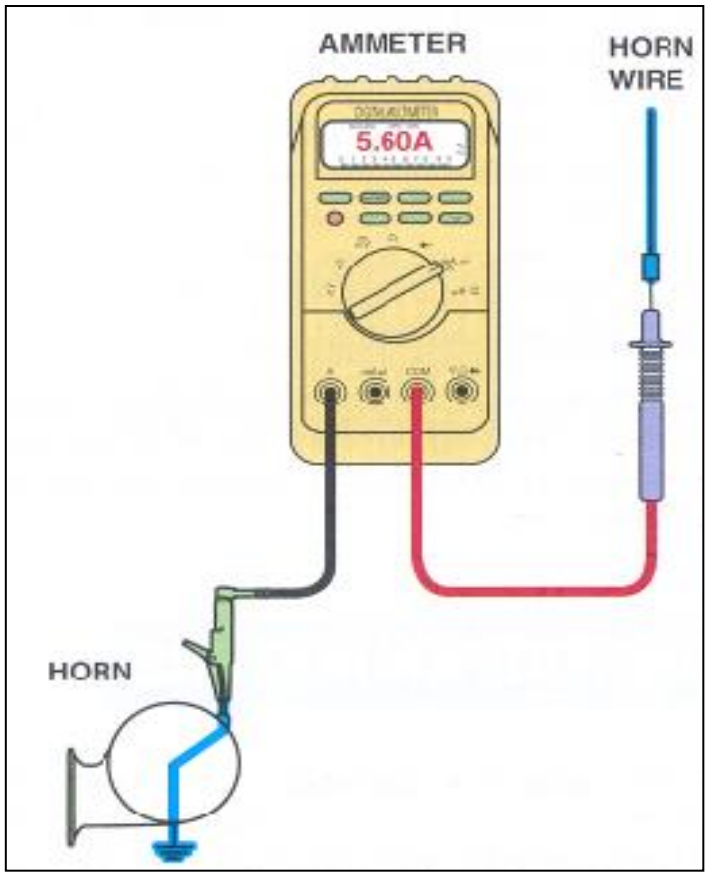
Prekoračenje mernog opsega (*OL*)

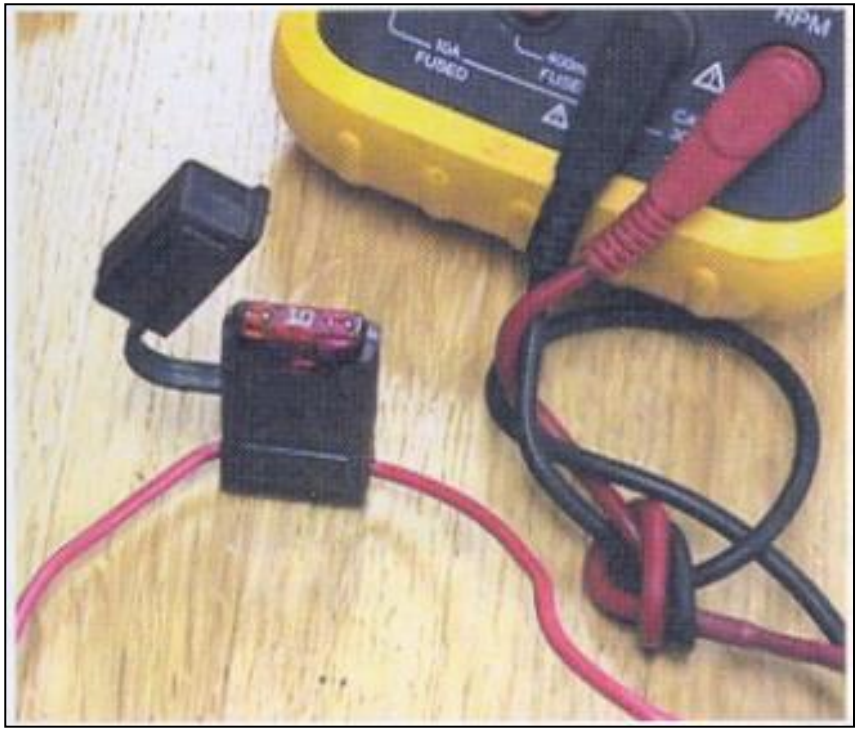
- Prikazivanje prekoračenja mernog opsega na digitalnom multimetru često zbunjuje početnike.
- Na pitanje šta instrument očitava kada se na displej prikazuje (*OL*), odgovor je često "*NIŠTA*".
- To nije tačno, nego jednostavno znači da je očitavanje preko maksimuma koji se može prikazati za izabrani merni opseg.
- Na primer, multimetar će prikazati *OL* ako se meri napon od 12 V, a instrument je podešen tako da može da očita napon najviše do 4 V.
- Kada se meri otpornost, preklopnik se nalazi u položaju (Ω), i na displeju je prikazano *OL*, izmerena otpornost je beskonačna, to znači da je kolo otvoreno ili u prekidu.



DIGITALNI MULTIMETRI

Merenje struje





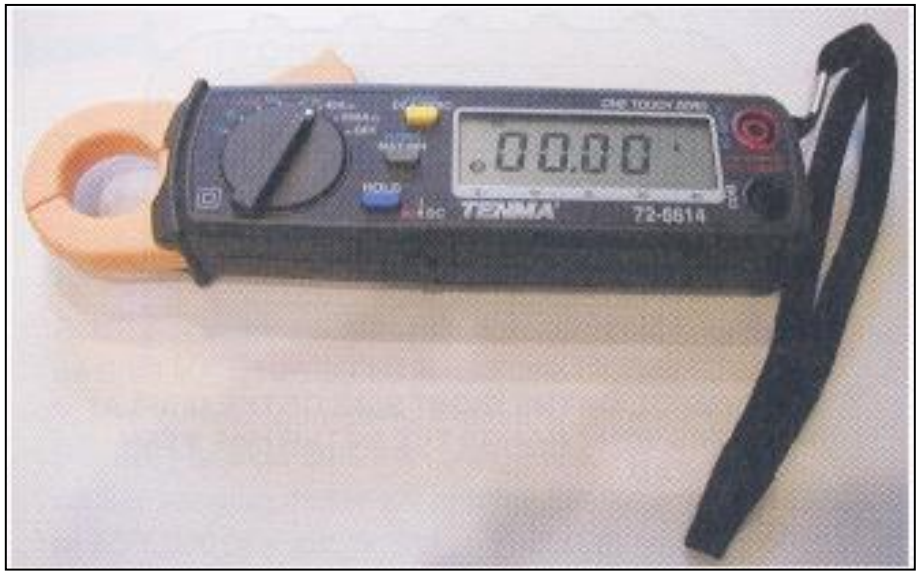
Merenje jačine struje koja je potrebna sireni zahteva da se ampermetar priključi u el. kolo serijski (redno).

Osiguranje ispitnih provodnika i instrumenta

Često se ispitni kablovi posle merenja struje, a pre merenja napona ili otpora ne vrate na poziciju VΩ, već ostanu na poziciji A ili mA μA, te dolazi do oštećenja kablova ili instrumenta. Da bi se izbegao ovaj problem, jednostavno se ubaci osigurača od 10A u jedan od ispitnih provodnika.

DIGITALNI MULTIMETRI

Induktivni ampermetri



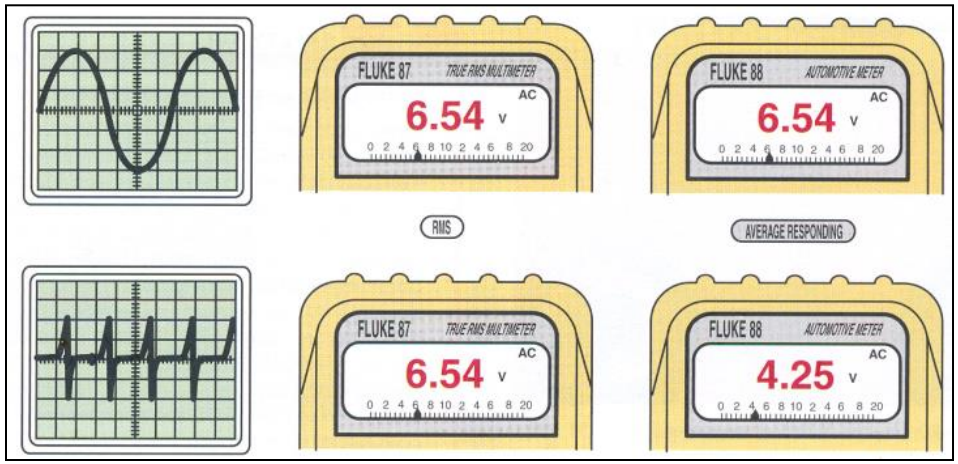
Induktivni ampermetri ne vrše fizički kontakt s el. kolom. Oni pomoću klešta mere jačinu magnetskog polja oko provodnika kroz koji protiče struja koristeći senzor sa Holovim efektom.

Digitalni multimetri sa AC / DC strujnim kleštima

DIGITALNI MULTIMETRI

Merenje različitih talasnih oblika

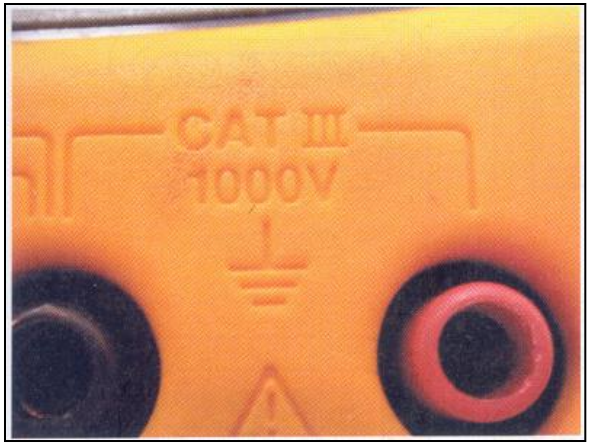
- Talasni oblici naizmenične struje mogu biti:
  - sinusoidni (prostoperiodični) ili
  - nensinusoidni
- Pri merenju naizmeničnih veličina (napona i struje) rezultat merenja se prikazuje kao efektivna vrednost.



- Postoje dve metode za merenje efektivne vrednosti periodičnih veličina:
  - prava efektivna vrednost (RMS - *root-mean-square*) i
  - srednja vrednost modula signala.
- Kod merenja sinusoidalnih talasnih oblika pokazivanje instrumenata po obe metode će biti isto, dok kod nesinusoidalnih talasnih oblika samo instrumenti sa pravom RMS metodom su tačni.

DIGITALNI MULTIMETRI

Upotreba multimetra na hibridnim i elektro vozilima



- Mnoga hibridna i elektro vozila koriste sistemski napon veći od 650 V DC.
- Međunarodna elektrotehnička komisija (IEC) ima nekoliko kategorija naponskih standarda za instrumente i ispitne provodnike.
- Ove kategorije su ocene za zaštitu od prenapona i imaju oznake CAT I, CAT II, CAT III i CAT IV.
- Što je veća kategorija, to je veća zaštita naponskih šiljaka uzrokovanih visoko-energetskim kolom.
- Zbog toga, radi najbolje lične zaštite, kada se meri napon na hibridnom vozilu koristiti samo instrumente i ispitne provodnike koji su katgorisani sa CAT III ili CAT IV.

OSNOVI DIJAGNOSTIKE VOZILA

Meter Functions – Voltage (V)

- Select the **Volts "V"** range with the rotary switch.
- The meter will automatically select the best voltage (V) range.
- Select DCV or ACV with the **MODE** button.

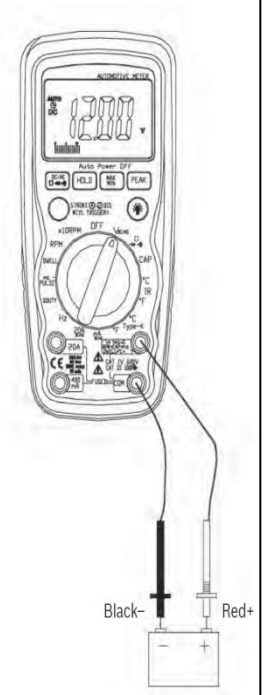
Insert:

- Black lead in **COM** terminal.
- Red lead in **V-Ω-RPM** terminal

Touch the Black probe to ground or to the negative (-) circuit

Touch the Red probe to the circuit coming from the power source

IMPORTANT: Voltage must be measured in parallel (Red probe measuring circuit from power source).



⚠ WARNING

When measuring voltage, be sure the Red test lead is in the terminal marked "V". If the test lead is in an Amp (A) or Milliamp (mA) terminal, the meter can be damaged and risk of personal injury.

Meter Functions – Resistance (Ω)

IMPORTANT: If you are testing an application that has capacitors in the circuit, be sure to turn the power OFF on the test circuit and discharge all capacitors. Accurate measurement is not possible if external or residual voltage is present.

- Select the **Resistance "Ω"** range with the rotary switch.
- Select the **Resistance "Ω"** function with the Mode button. Please note, the unit defaults to resistance.

Insert:

- Black lead in **COM** terminal.
- Red lead in **V-Ω-RPM** terminal.

Touch the test lead probes across the resistor to be tested.

Meter Functions – Diode Check (→|)

IMPORTANT: Turn the power OFF to the test circuit

- Select the **Diode Check "→|"** function with the rotary switch and mode button.

Insert:

- Black lead in **COM** terminal.
- Red lead in **V-Ω-RPM** terminal.

Touch the Black test probe to the negative (-) side of the diode.

Touch the Red test probe to the positive (+) side of the diode. Reverse the probes: Black to the positive (+) side and Red to the negative (-) side.

NOTE: A "good" diode will read low in one `direction and high in the other direction when the probes are reversed (or vice versa).

A defective diode will have the same reading in both directions or read between 1.0 to 3.0 V. in both directions.

Diode	- to +	Reverse Probes + to -
Good	.4 to .9V	OL
	OL	.4 to .9V
Bad	OL	1.0 to 3.0V
	1.0 to 3.0V	OL
	.4 to .9V	.4 to .9V
	OL	OL
	.000V	.000V

Meter Functions – Capacitance (CAP)

IMPORTANT: Turn the power OFF to the test circuit

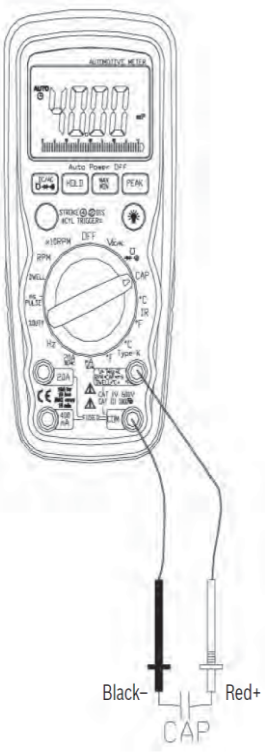
- Select the Capacitance "**CAP**" function with the rotary switch and mode button

Insert:

- Black lead in **COM** terminal.
- Red lead in **V-Ω-RPM** terminal

CAUTION: When checking in-circuit capacitance, be sure that the circuit has all power removed and all capacitors are fully discharged.

Touch the test lead probes across the capacitance circuit to be tested. Read the measured value from the LCD display.



NOTE:

1. The bar graph is disabled in capacitance measurement mode. However, since the measurement time of 4mF and 40mF modes is quite long (3.75s and 7.5s respectively, to be precise), the bar graph is instead used to display the time required to accomplish the measurement.
2. In order to obtain an accurate reading, a capacitor must be discharged before measurement begins. The meter has a built-in discharge mode to automatically discharges the capacitor. In discharge mode, the LCD displays "DIS.C"
3. Discharging through the chip is quite slow. We recommend the user to discharge the capacitor with some other apparatus.

Meter Functions – Audible Continuity (•))

IMPORTANT: Turn the power OFF on the test circuit

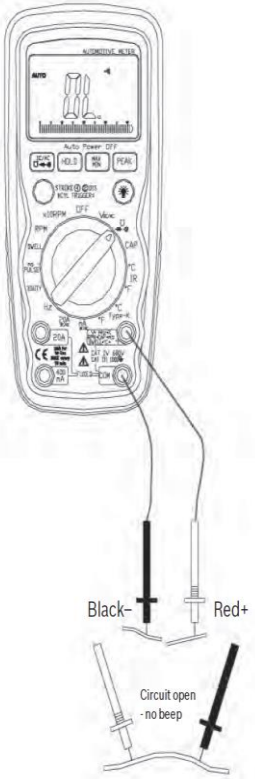
- Select the **Audible Continuity** "•))" function with the rotary switch and mode button.

Insert:

- Black lead in **COM** terminal.
- Red lead in **V-Ω-RPM** terminal.

Connect one test probe to each end of the circuit to be tested.

- Circuit complete, the meter will beep continuously.
- Circuit open, there is no beep and the display shows to OL (over limit).

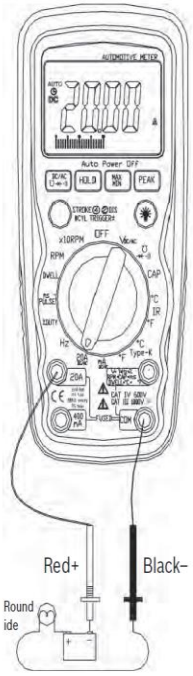


Meter Functions – AC or DC Current (A)

IMPORTANT: All current measured flows through the meter.

It is important that you do not:

1. **Measure current greater than 600 Volts AC or DC, with respect to ground.**
2. **Do Not Exceed 30 seconds when measuring continuous current between 1A-20A. Allow five minutes for cool down before continuing.**



- Select the "**20A**" or "**mA**" range with the rotary switch.
- Press the **Mode** button to select **AC** or **DC**.

Insert:

- Black lead in **COM** terminal.
- Red lead in the **20A** or **mA** terminal (select 20A if you are unsure of the current draw).

IMPORTANT: Turn OFF all power to the circuit or disconnect the circuit from the power source.

Connect:

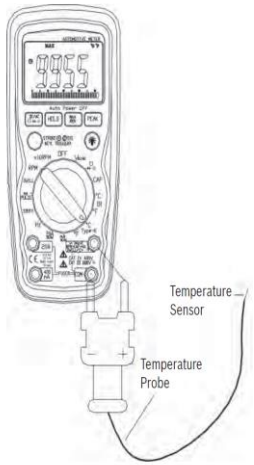
- The Red probe to the side of the circuit closest to the power source.
- The Black probe to the side of the circuit to ground.
- Turn the power ON and test.

NOTE: Current must always be measured with the meter test probes connected in series, as described

Meter Functions – Temperature (°C/°F)

IMPORTANT: To avoid heat damage to the meter, keep it away from sources of very high temperature. The life of the Temperature Probe is also reduced when subjected to very high temperatures. Probe operating range is –58° to 482°F.

- Select the **Temperature "°C or °F"** function with the rotary switch.
- Insert the temperature probe connector into the K-type thermocouple adapter. Insert the adapter into the front of the meter as shown.



- Touch the end of the temperature sensor to the area or surface of the object to be measured.

Meter Functions – Frequency(Hz)

- Select the **"Hz" Frequency** function with the rotary switch.

Insert:

- Black lead in **COM** terminal.
- Red lead in **V-Ω-RPM** terminal.

Connect the Black test probe to ground.

Connect the Red test probe to the "signal out" wire of the sensor to be tested.

Meter Functions – Dwell (∠°)

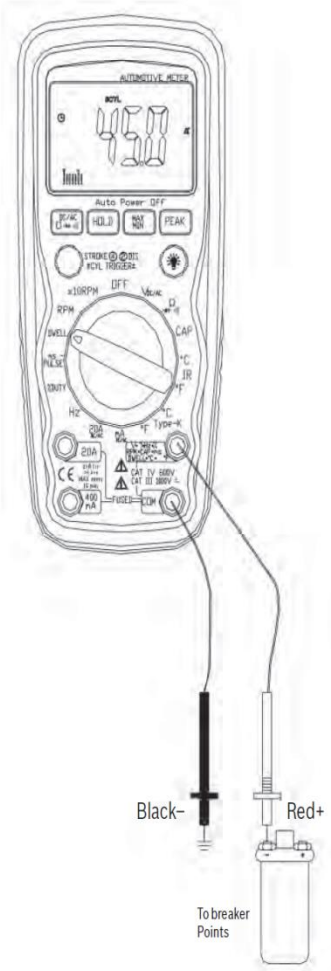
- Select the **"DWELL"** function with the rotary switch.

Insert:

- Black lead in **COM** terminal.
- Red lead in **V-Ω-RPM** terminal.

Connect the Black test probe to ground.

Connect the Red test probe to the wire that connects to the breaker points (see illustration).



Meter Functions – Duty Cycle (%)

- Select the **"%DUTY"** Cycle function with the rotary switch.

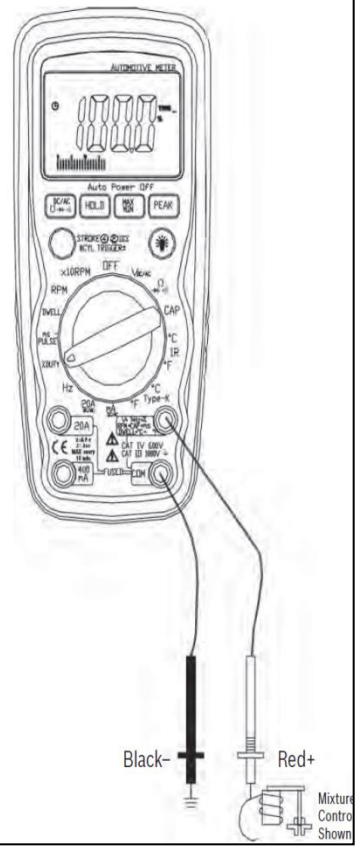
Insert:

- Black lead in **COM** terminal.
- Red lead in **V-Ω-RPM** terminal.

Connect the Black test probe to ground.

Connect the Red test probe to the signal wire circuit.

The illustration for a mixture control solenoid is shown with the metering rod in the closed position. The meter will display the percentage of time the plunger is in the closed position. (low duty cycle) during one duty cycle.



Meter Functions – ms-PULSE (Pulse Width) & ms-PERIOD (Period)

Pulse Width is the length of time an actuator is energized. For example, fuel injectors are activated by an electronic pulse from the Engine Control Module (ECM).

This pulse generates a magnetic field that pulls the injectors nozzle valve open.

The pulse ends and the injector nozzle is closed.

This open to close time is the Pulse Width and is measured in milliseconds(ms).

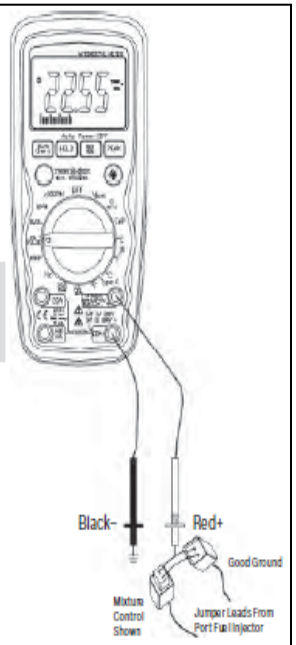
The most common automotive application for measuring pulse width is on fuel injectors.

You can also measure the pulse width of the fuel mixture control solenoid and the idle air control motor.

Measuring Pulse Width on Port Fuel injectors is described on the following page.

- Select the "**mS-Pulse**" function with the rotary switch .
- Press the **±TRIG** button for 2 seconds until the negative (-) trigger slope is displayed on the upper left side of the display.

NOTE: The applied time for most fuel injectors is displayed on the negative (-) slope.



Insert:

- Black lead in **COM** jack.
- Red lead in **V-Ω-RPM** jack.

Connect:
Jumper wires between the fuel injector and the harness connector.

Black test probe to a good ground at the fuel injector or the negative (-) vehicle battery post.

Red test probe to the fuel injector solenoid driver input on the jumper cable.

Start the engine. A pulse width in milliseconds should be read.

NOTE: Initially, the unit will read "OL", then readings will descend and stabilize to the actual pulse width. If "OL" remains, re-check your connections.

Meter Functions – RPM/×10RPM

- Select the **RPM** range with the rotary switch.

OR

- Select the**×10RPM** range with the rotary switch (1,000 to 12,000 RPM). Multiply the displayed reading by ten to get actual RPM.

Press **STROKE** 4 2/ **DIS** button to select through **RPM** 4 for 4-stroke, **RPM** 2 for 2-stroke and **DIS** ignitions.

Insert the inductive pickup connecting terminals into the meter.

- Black lead in **COM** terminal.
- Red lead in **V-Ω-RPM** terminal.

Connect the inductive pickup to a spark plug wire. If no reading is received, unhook the clamp, turn it over and connect again.

NOTE:

- Position the inductive pick-up as far away from the distributor and the exhaust manifold as possible.
- Position the inductive pick-up to within six inches of the spark plug or move it to another plug wire if no reading or an erratic reading is received.

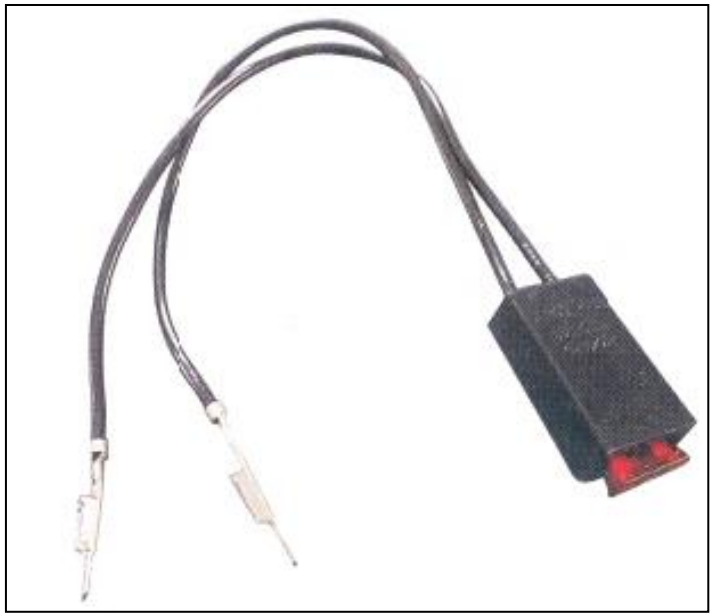
RPM 4: For RPM of 4-stroke engines which have 1 ignition on every 4 engine strokes

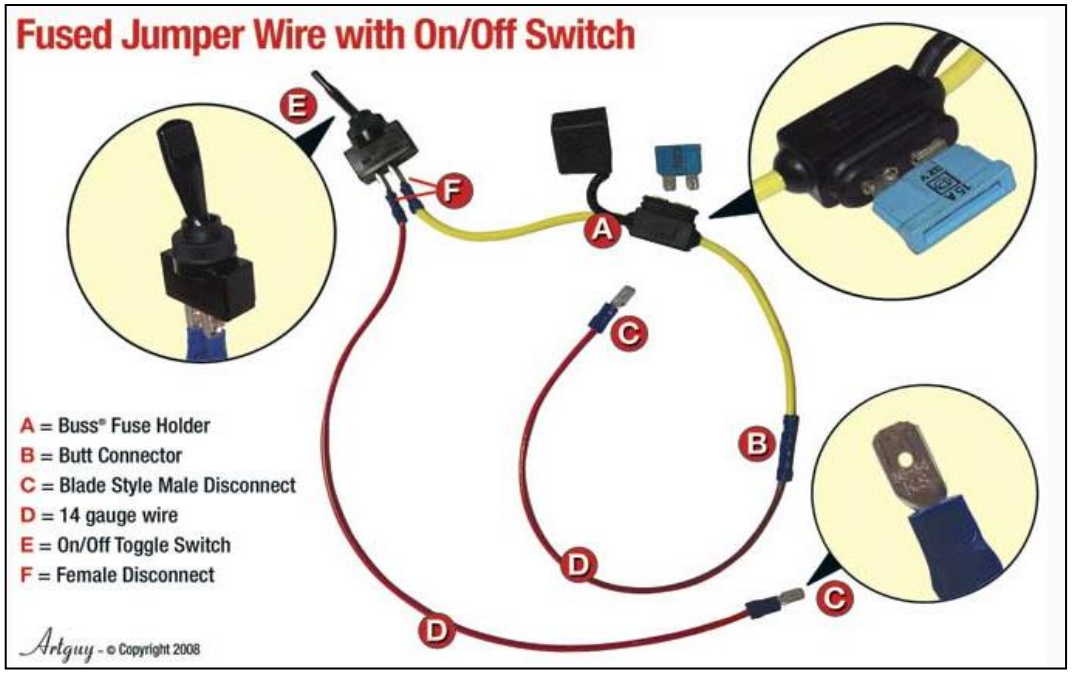
RPM 2: For RPM of DIS (Distributorless Ignition System) & 2-stroke engines which Have 1 ignition on every 2 engine strokes

NOTE: The rpm pick-up has an adjustable sensitivity switch that can also be used to correct an unstable reading.

ISPITIVAČI KOLA

Osigurani kratkospojnici



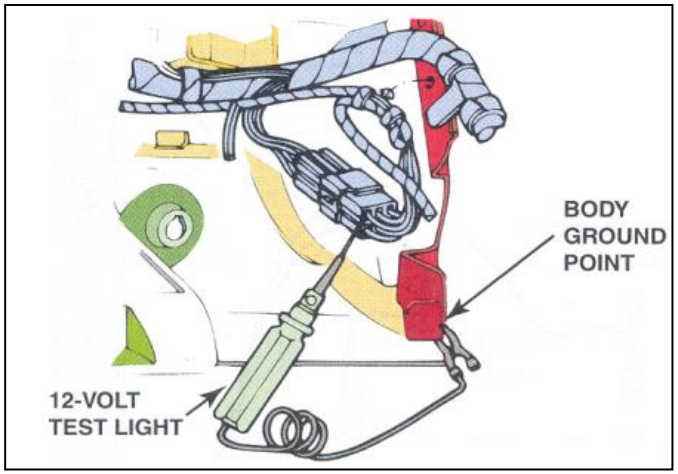


Priručni osigurani kratkospojnik, opremljen osiguračem od 10 A (crveni). Ovi osigurani kratkospojnici za testiranje kola koriste terminale na konektoru ili krokodilke.

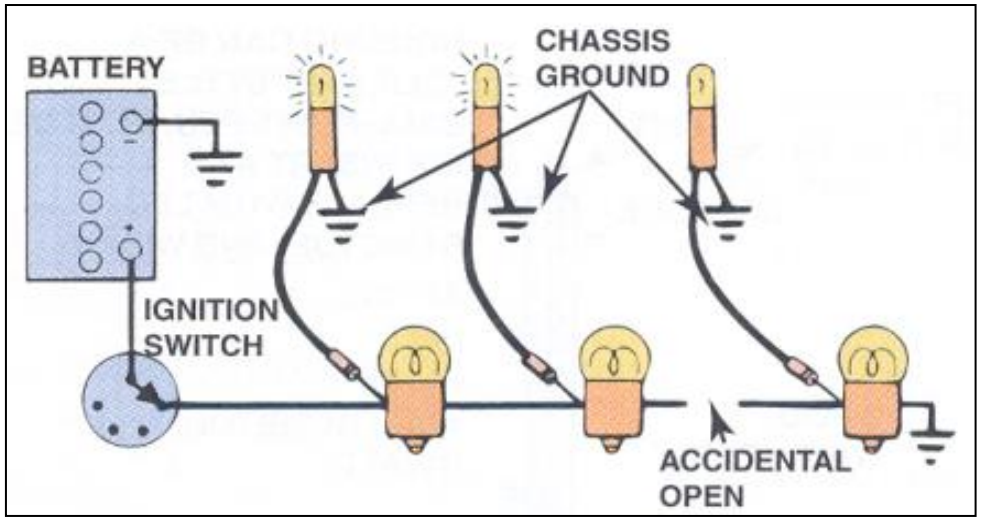
UPOZORENJE: Nikada nemojte koristiti osigurani kratkospojnik da biste zaobišli bilo koji otpornik ili potrošač u kolu. Povećani strujni tok može oštetiti provodnik i upaliti osigurač na kratkospojniku.

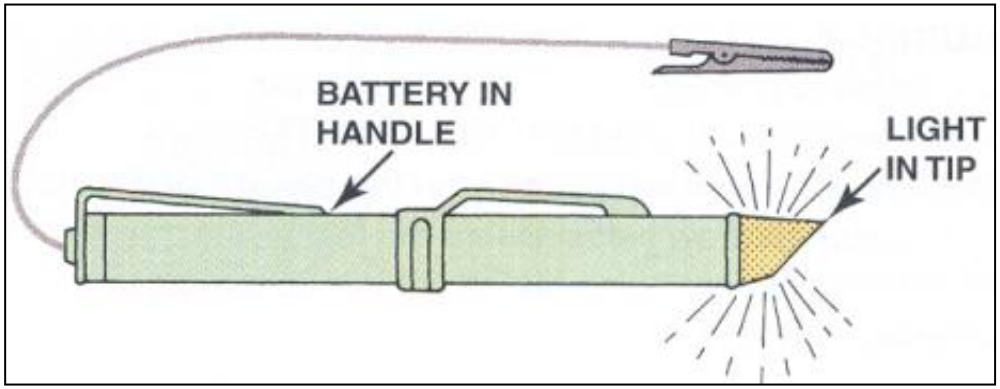
ISPITIVAČI KOLA

Ispitne lampe



Ispitna lampa bez napajanja



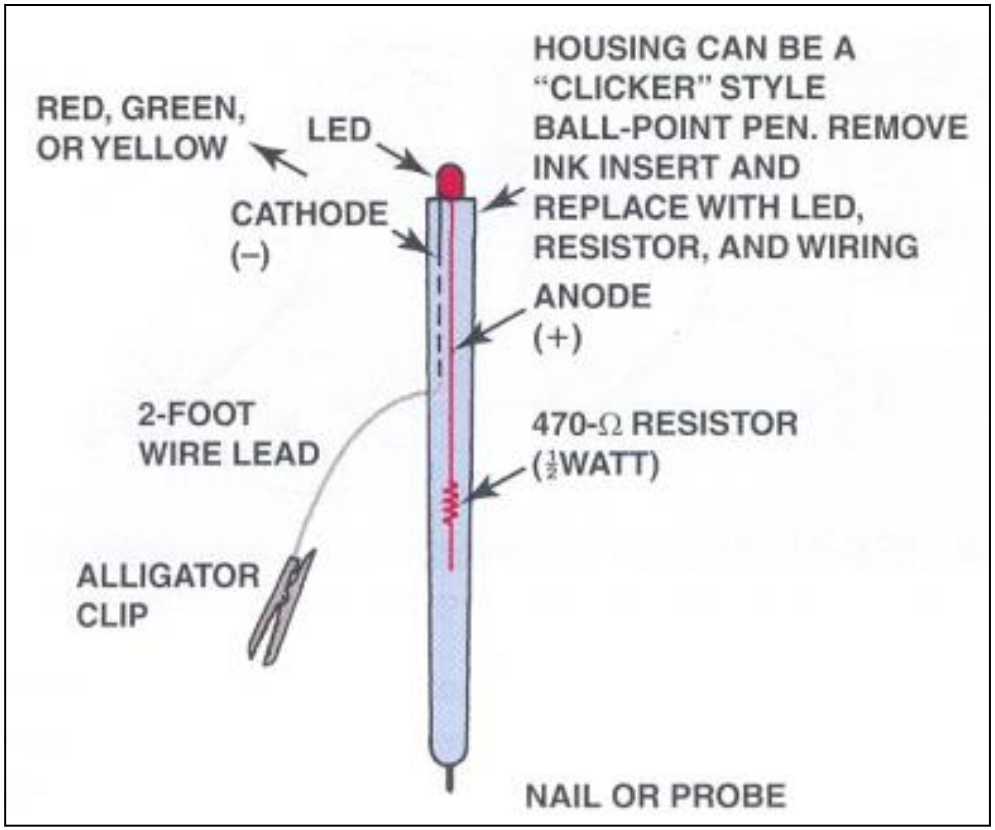


Ispitna lampa sa napajanjem

UPOZORENJE: Upotreba ispitne lampice sa samo-napajanjem ne preporučuje se na računarskim kolima, jer sadrži bateriju i prisutni napon može oštetiti delikatne elektronske komponente ili kola.

ISPITIVAČI KOLA

Ispitne lampe



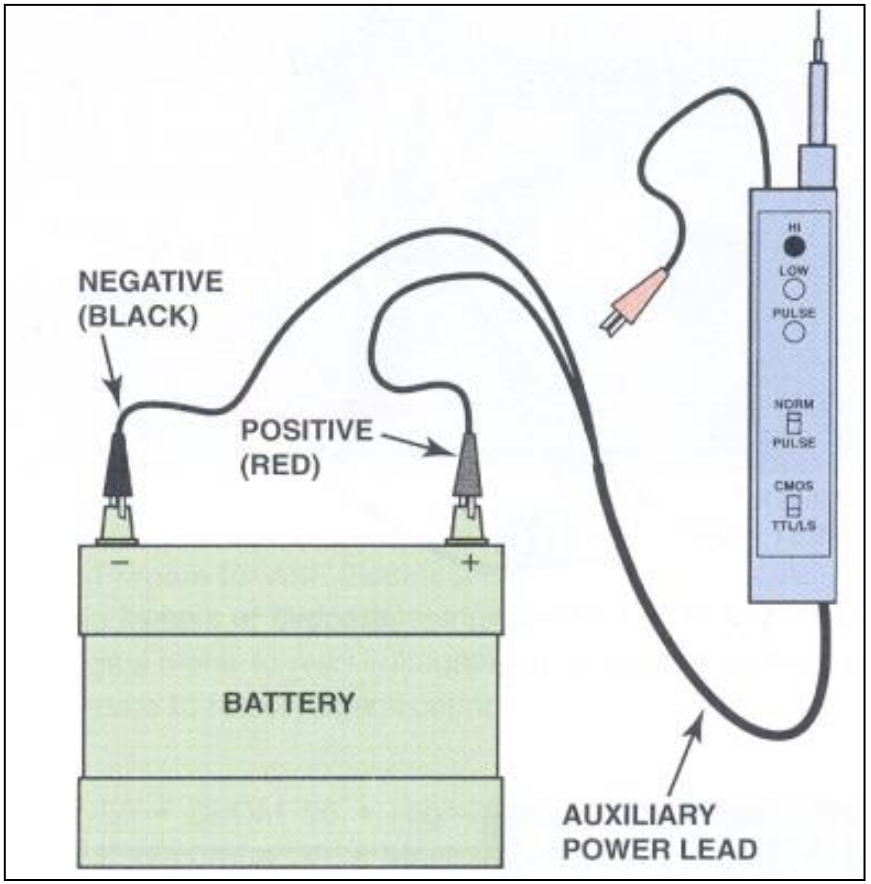
Ispitna lampica velike impedanse

Ispitna LED lampica koristi LED diode (LED) umesto standardne automobilske sijalice za vizuelnu indikaciju napona.

LED lampica zahteva samo oko 25 mA da bi svetlela, stoga se može koristiti i kod elektronskih kola i na standardnim kolima.

ISPITIVAČI KOLA

Logičke sonde (probe)



Logička sonda je elektronski uređaj kojoj LED svetli (obično):

- crveno, ako je sonda došla u dodir sa naponom baterije;
- zeleno, ako je sonda u kontaktu sa uzemljenjem (masom).

- Neke logičke sonde će treptati crveno svetlo kada se detektuje impulsni naponski signal,
- Neki će treptati zeleno svetlo kada se otkrije impulsni signal spojen na masu.

Ova funkcija je korisna prilikom provere promenljivog napona iz računara ili senzora paljenja.

DIGITALNI MULTIMETRI

REZIME

1. **Digitalni multimetar** (DMM) i **digitalni volt-ohm-miliampermetar** (DVOM) su pojmovi koji se obično koriste za elektronske ispitne instrumente visoke impedanse.
2. Korišćenje digitalnog instrumenta visoke ulazne impedanse je neophodno na bilo kom računarskom kolu ili komponenti.
3. Ampermetri mere struju i u kolu moraju biti spojeni u seriju.
4. Voltmetri mere napon i paralelno su povezani.
5. Ommetri mere otpornost komponente i moraju se povezati paralelno, sa sklopom ili komponentom koja je isključena iz napajanja.
6. Logičke sonde mogu ukazivati na prisustvo napajanja, uzemljenja ili impulsnih signala.

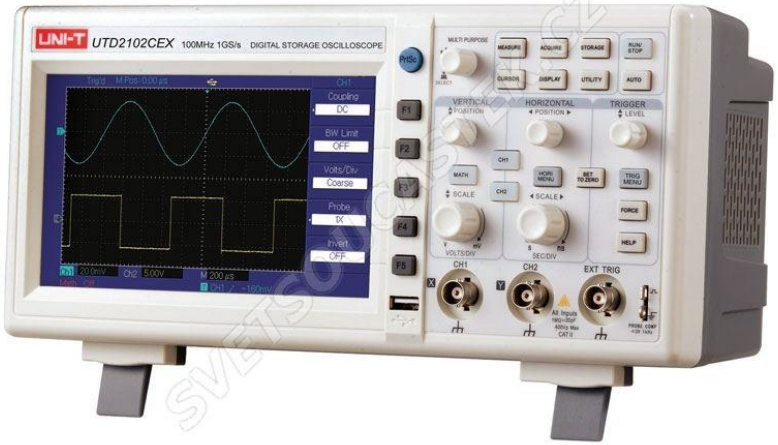
DIGITALNI OSCILOSKOPI

Vrste osciloskopa

Osciloskop je vizuelni voltmetar sa tajmerom, koji pokazuje kada se napon menja.

- **Analogni osciloskop** koristi katodne cevi (CRT- *cathode ray tube*) slične TV ekranu za prikazivanje naponskih oblika. Osciloskopski ekran prikazuje električni signal stalno.
- **Digitalni osciloskop** obično koristi LCD (LCD- *liquid crystal display)* , ali CRT se takođe može koristiti na nekim digitalnim osciloskopima.
- Digitalni osciloskop koji uzima uzorke signala koji se mogu zaustaviti ili sačuvati zove se **digitalni memorijski osciloskop** (DSO-***digital storage oscilloscope***).

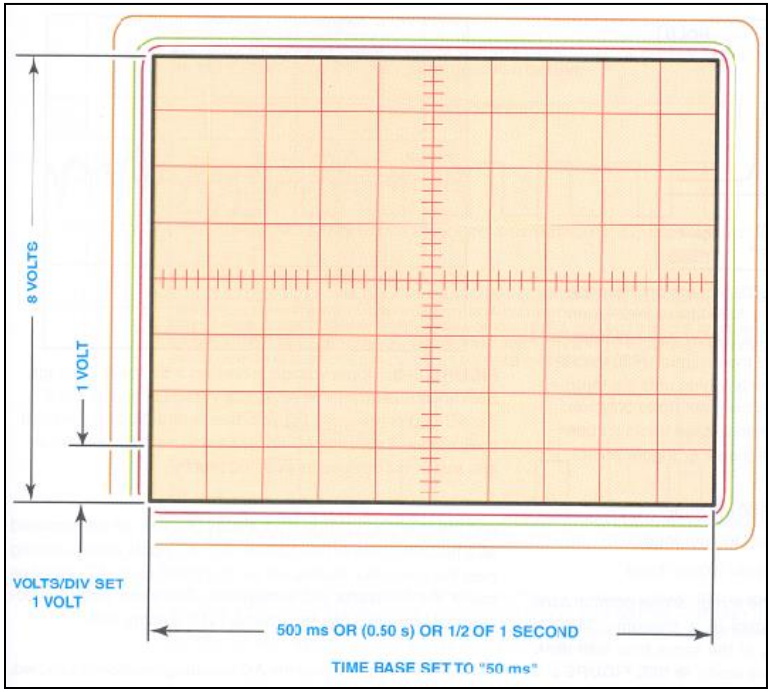
- Ova karakteristika DSO čini savršenim alatom koji pomaže u dijagnostici povremenih problema.
- DSO međutim, ponekad može da propusti događaje nazvane gličevi (*glitches)* koji mogu nastati između pojedinih uhvaćenih uzoraka.
- Zbog toga su poželjni DSO sa “velikom stopom uzorkovanja“
- Neki DSO imaju stopu uzorkovanja od 25 miliona uzoraka u sekundi.
- To znači da osciloskop može da uhvati događaj koji traje samo 40 ns (0,00000040 sekundi).



Podešavanje osciloskopa

PODEŠAVANJE VREMENSKE BAZE

- Većina osciloskopa koristi ekrane sa 10 podeoka sa leva na desno.
- Podešavanje vremenske baze znači podesiti koliko će vremena biti prikazano u svakom kvadratu pod nazivom podeok.
- Na primjer, ako je osciloskop podešen na 2 sekunde po podeoku (označeno *s/div*), onda će ukupno biti prikazano 20 sekundi (2x10 podeoka = 20 s.).
- Vremenska baza treba da bude podešena na vreme koje omogućava prikazivanje dva do četiri događaja.
- NAPOMENA: Povećanje vremenske baze smanjuje broj uzoraka u sekundi.
- Podešavanje vremenske baze može se značajno razlikovati pri merenjima na automobilu:
  - MAP/MAF senzori: 2 ms/div (ukupno 20 ms),
  - CAN komunikaciona mreža: 2 ms/div (ukupno 20 ms),
  - Senzor položaj gasa (TP senzor) 100 ms/div (ukupno 1s)
  - Injektor goriva: 2 ms / div (ukupno 20 ms),
  - Senzor lambda sonde: 1 s/div (ukupno 10 s).



PODEŠAVANJE VERTIKALNE NAPONSKE OSE

- Većina osciloskopa koristi ekrane sa 8 podeoka.
- Naponska osa (označena sa V/div) treba biti podešena tako da se može videti celi očekivani talasni oblik

DIGITALNI OSCILOSKOPI

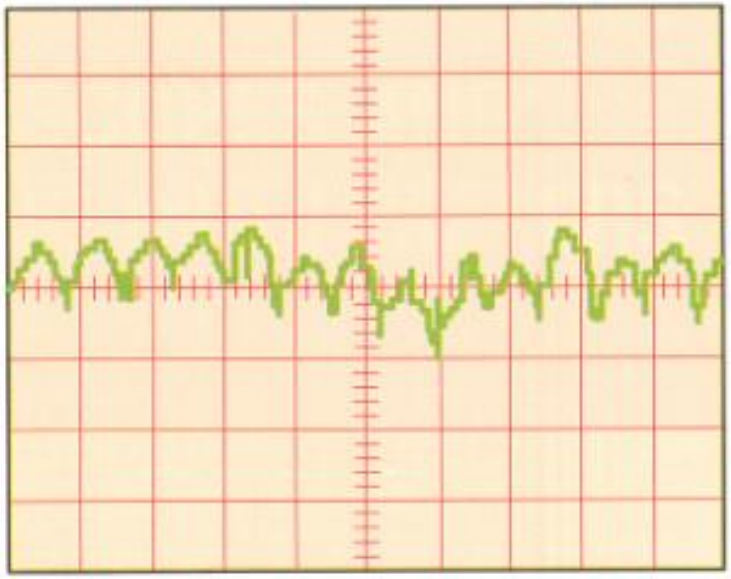
Priključivanje signala

Signal koji se posmatra moće biti priključen:

- **Direktno** (DC-sprega) za prikaz kompletnog signala, kao što je napon napajanja sa alternatora
- **Preko kondezatora** (AC-sprega) za prikazivanje samo promenljivih (naizmeničnih) komponenti signala

AC-sprega se može koristiti za prikazivanje talasnih oblika izlaznih signala sa senzora kao što su:

- Induktivni senzor brzine točkova
- Induktivni senzor položaja kolenastog vratila
- Induktivni senzori položaja bregastog vratila
- Induktivni senzori brzine vozila



Talasni oblik napona sa alternatora preko AC-sprege.

Ako valovitost prelazi 0,5 V onda je najverovatniji uzrok neispravna dioda. Prekomerno valovitost može dovesti do lošeg rada mnogih električnih i elektron-skih uređaja na vozilu.

DIGITALNI OSCILOSKOPI

Impulsni signali

Povorka impulsa

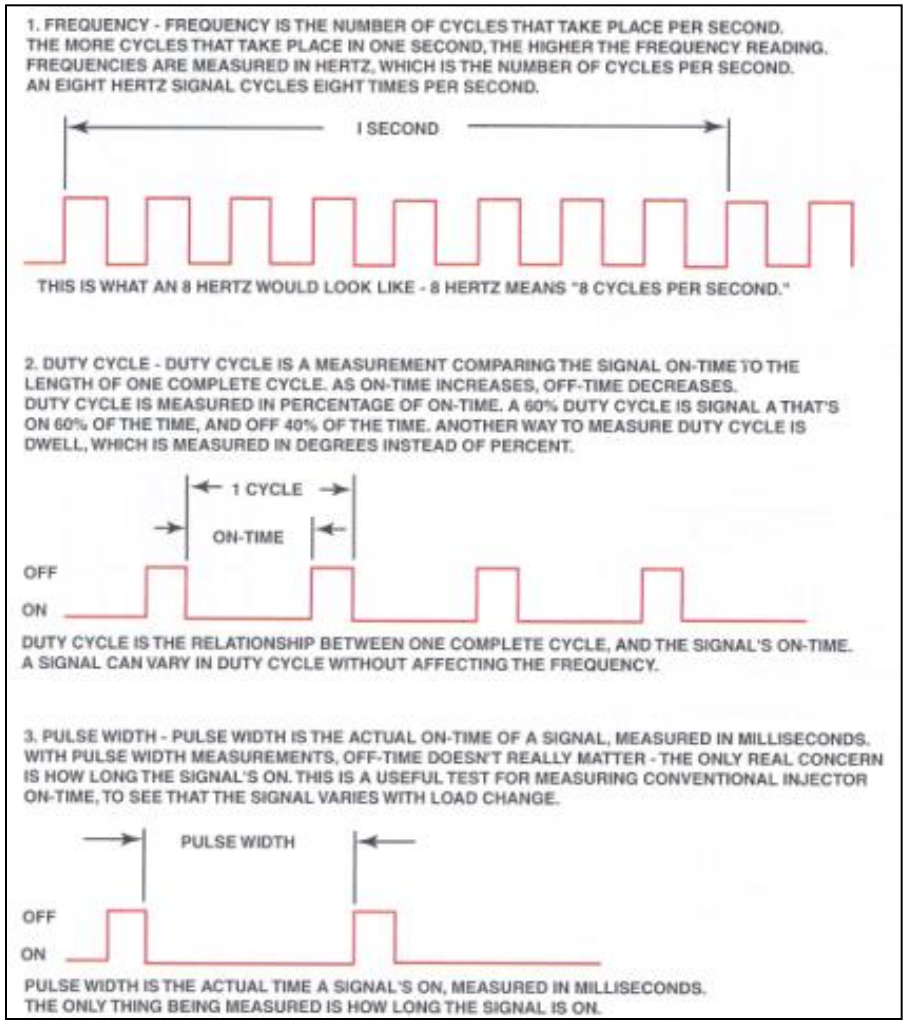
- DC napon koji se uključuje i isključuje u seriji impulsa naziva se povorka impulsa.
- Povorke impulsa se razlikuju od AC signala jer ne idu ispod nule.

Frekvencija je broj ciklusa po sekundi meren u Hz (herc).

- Signal obrtaja motora u minuti (rpm) je primer signala koji se javlja na različitim frekvencijama.

Faktor popunjenosti (*duty cycle*) je veličina koja se odnosi na procenat uključenosti signala tokom jednog ciklusa i obično se meri u procentima.

Širina impulsa (*pulse width*) je mera stvarnog uključenosti merena u milisekundama. Injektori goriva se obično upravljaju promenom širine impulsa.



Impulsi za ubrizgavanje goriva su primeri signala tipa povorke impulsa

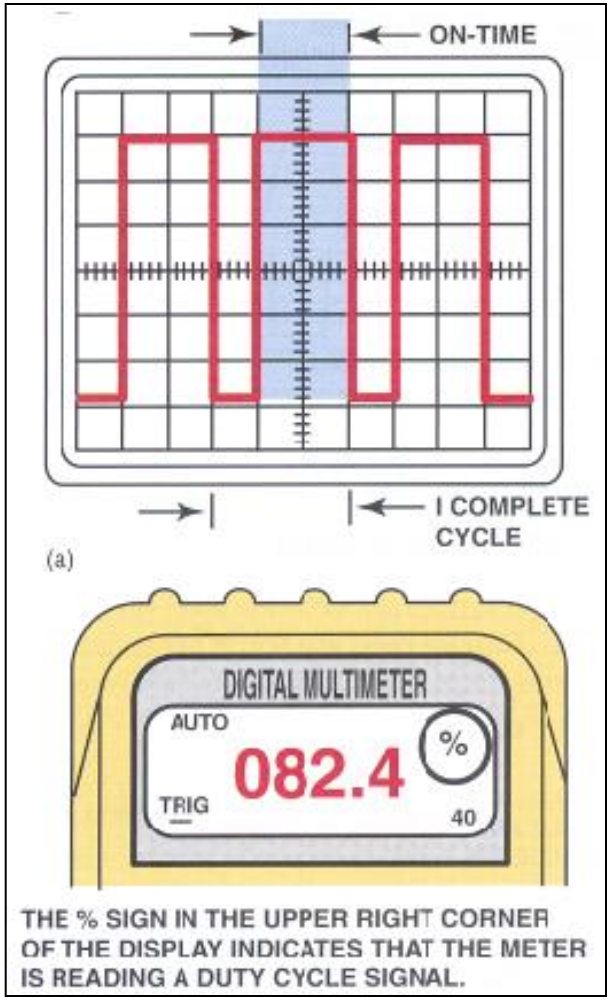
DIGITALNI OSCILOSKOPI

Faktor popunjenosti se naziva i **širinsko pulsna modulacija (PWM**- *pulse-width modulation*) i može da se meri u stepenima.

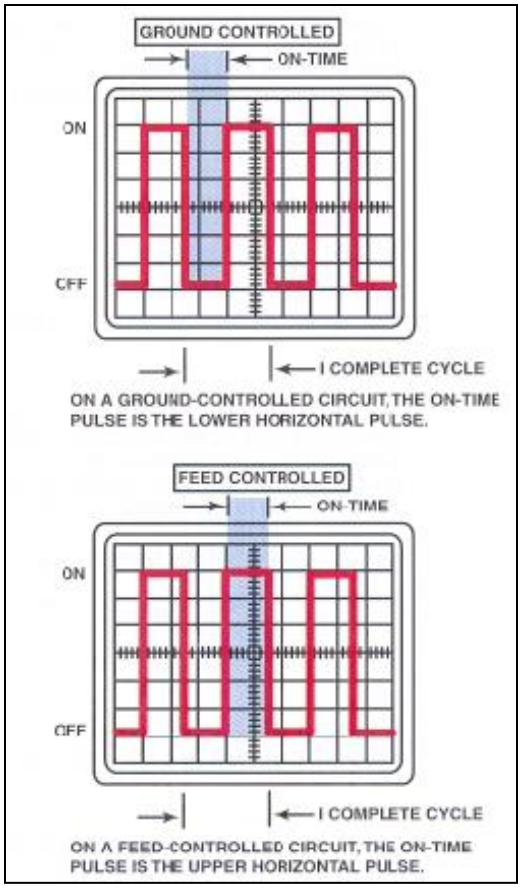
Faktor popunjenosti pokazuje koliki deo vremena je PWM signal u stanju visokog izlaznog napona (logičke „1“), a koliko vremena u stanju logičke „0“, odnosno niskog naponskon nivoa.

Osciloskopski prikaz pokazuje celokupan ciklus, kako vreme uključenosti, tako i vreme isključenosti.

Multimetar prikazuje samo faktor popunjenosti u procentima (%).



THE % SIGN IN THE UPPER RIGHT CORNER OF THE DISPLAY INDICATES THAT THE METER IS READING A DUTY CYCLE SIGNAL.



ON A GROUND-CONTROLLED CIRCUIT, THE ON-TIME PULSE IS THE LOWER HORIZONTAL PULSE.

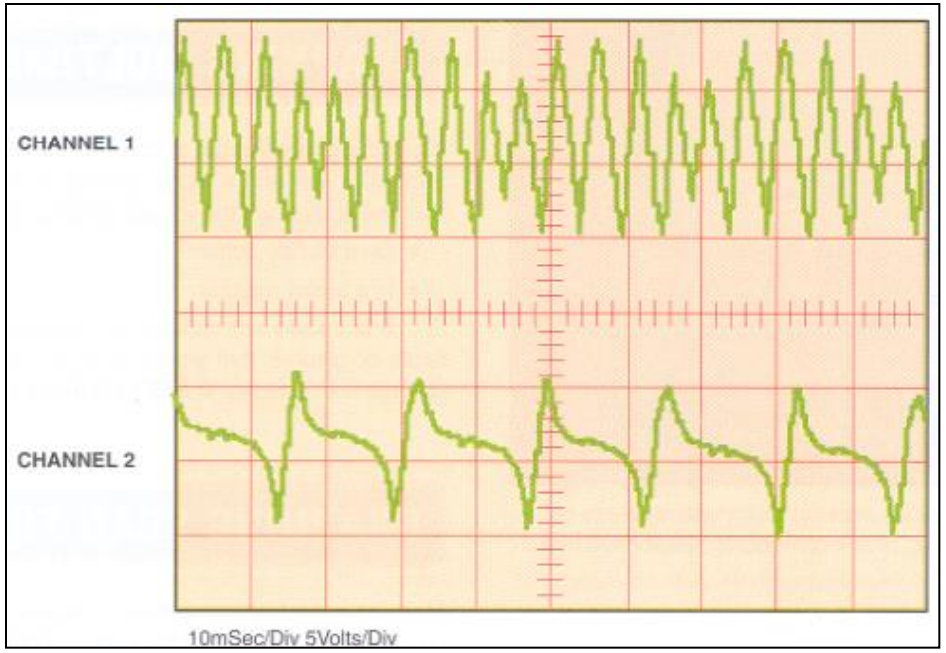
ON A FEED-CONTROLLED CIRCUIT, THE ON-TIME PULSE IS THE UPPER HORIZONTAL PULSE.

Većina automobilskih računarskih sistema upravlja uređaj uključivanjem i isključivanjem mase na komponentu

DIGITALNI OSCILOSKOPI

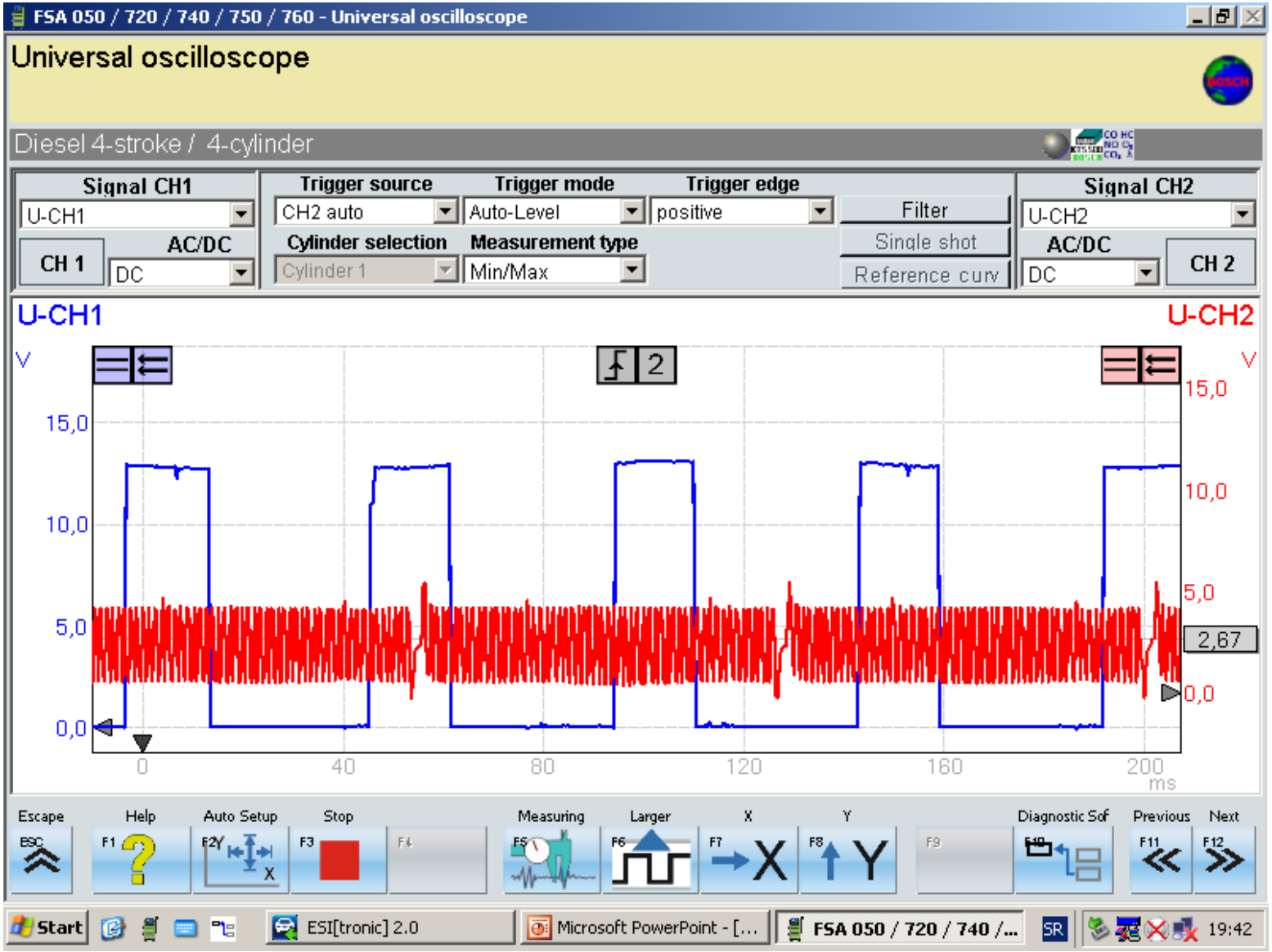
Broj kanala

- Osciloskopi omogućavaju istovremeno posmatranje na ekranu više događaja (signala sa više senzora).
- Broj događaja koji zahteva poseban provodnik je broj kanala (kanal je jedan ulaz u osciloskop).
- Obično dostupni osciloskop su:
  - **Jednokanalni**, može prikazati samo jedan talasni oblik signala nekog senzora;
  - **Dvokanalni**, može istovremeno prikazati talasni oblik sa dva odvojena senzora ili komponente. Ovo je od velike pomoći prilikom testiranja rada dva komponente, kako bi se utvrdilo da li su usklađene (vidi sliku);
  - **Četvorokanalni**, omogućava serviseru da posmatra četiri različita senzora ili aktuatora na jednom ekranu.



Dvokanalni osciloskop koji se koristi za upoređivanje dva signala na istom vozilu

Testiranje senzora položaja bregastog vratila i kolenastog vratila motora kako bi se utvrdilo da li su pravilno podešeni



CH1- signal bregaste CH2 – signal radilice

Napon na strani brizgaljke 4. cilindra u PH i struja brizgaljke

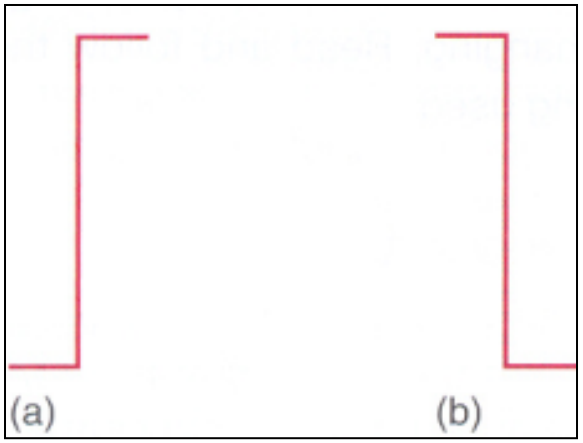
DIGITALNI OSCILOSKOPI

Okidanje (trigerovanje)

- Iscrtavanje dijagrama (grafa) započinje okidanjem (*trigger*) elektronskog mlaza, koji se dešava u trenutku kada sinhronizacioni signal dostigne odgovarajući nivo okidanja (*trigger level*).
- Nagib (ivica) okidanja (*trigger slope*) je smer promene vrednosti napona koji talasni oblik mora imati za pokretanje prikaza. Najčešće, okidač za pokretanje prikaza talasnog oblika signala uzima se iz samog signala.
- Ivica okidanja može biti:

  - prednja rastuća (uzlazna) i

  - zadnja opadajuća (silazna).



a) Simbol za pozitivni okidač - pokreće se na rastućoj ivici signala (talasnog oblika)

b) Simbol za negativni okidač - pokreće se na padajućoj ivici signala (talasnog oblika)

DIGITALNI OSCILOSKOPI

Namenski osciloskop KTS-670

KTS 670 – Multimedia-capable, mobile diagnostics tester

The new KTS 670 diagnostics tester meets the highest demands for depth of testing and ease of use. It provides the operator with practical functions for every diagnostics case and offers a full set of equipment for complex measurements and displays the results clearly.

Maximum functionality for practical diagnostics

- The KTS 670 masters all current diagnosis protocols:
  - ISO systems of European vehicles
  - SAE systems for American and Japanese vehicles
  - OBD-CAN protocols for testing state-of-the-art CAN bus systems in new vehicles
  - High speed to middle speed to low speed and single-wire CAN
- Software-controlled, integrated OBD-exchange adapter (box 01) means that even CAN protocols outside the OBD standard can be diagnosed
- The system automatically detects the control unit, reads out actual values, fault memory and control unit specific data

Network and multimedia-capable

- The KTS 670 is network-capable (LAN integrated and WLAN can be upgraded via commercial-type PC card).
- AWN capability
- Built-in loudspeaker and headset connection
- State-of-the-art connectivity options are provided (e.g. DVD drive, video output, PS/2 keyboard)

Full range of equipment for complicated measurements

- The KTS 670 comes with a convenient 2-channel oscilloscope. Advantage: The mechanic can view and evaluate, for example, both lambda sensors on one screen
- The tester comes with a 2-channel multimeter for performing voltage, resistance and current measurements
- Diagnostics oscilloscope: In ECU diagnostics, parallel to each test step, the signals of the diagnostics cables such as K and L line, CAN and J 1850 can be tested using the diagnostics oscilloscope

Workshop-compatible equipment for everyday use

- Effective protection against impact and water splashes
- High mobility by means of practical carrying handle and power supply from vehicle battery or rechargeable batteries during road testing

Greater mobility in the workshop and on the vehicle

- Together with ESI[tronic], the KTS 670 is the professional diagnostic system for vehicles in your workshop and during road tests
- Screen with ideal resolution for a brilliant display, even where light conditions are poor (high brightness and large angle of view, and a touchscreen)
- Switch on and off and call up a virtual keyboard via a touch-sensitive key

KTS 670: New 2-channel oscilloscope for optimal troubleshooting


KTS 670: Equipped with connections for a secure future

Engine System Testing FSA | FSA 750

Improved performance through
- **Expanded main memory**
- **Internal OBD exchange adapter**
- **Simplified adapter concept "Easy Connect" (see page 24)**

asanetwork

FSA 750: The professional diagnostics system of the future

Combined top technology from FSA 740 and KTS 670
The combination of the vehicle system analysis FSA 740 and the mobile ECU diagnostics tester KTS 670 is the perfect high-end solution at Bosch:
- Synergy effect through additional use of the integrated diagnostics tester KTS 670 as operating, display and computing unit for the vehicle system analysis
- Complete system for flexible use in the workshop

More reliable troubleshooting
To locate the defective part exactly, the vehicle system analysis is required in conjunction with the ECU diagnostics:
- Timesaving testing of components when installed (removal/installation of parts from/in vehicle is unnecessary)
- Menu-guided test steps for effective diagnostics
- Signal generator for simulating sensor signals
- Optimized tuning between SIS troubleshooting instructions, ECU diagnostics and measuring technology
- Simple vehicle selection using ESI[tronic]
- High market coverage of all popular vehicles

KTS 670 – Maximum functionality for practical diagnostics
Together with ESI[tronic], the KTS 670 is the professional diagnostic system for vehicles in your workshop and during road tests. It includes:
- 2-channel multimeter for rapid tracing of faults through simultaneous testing of two components
- 2-channel oscilloscope for complex measurements on state-of-the-art vehicle-system components
- Screen with ideal resolution for a brilliant display
- The KTS 670 masters all current diagnostics protocols
- Software-controlled, integrated OBD-exchange adapter
- The system automatically detects the control unit, reads out actual values, fault memory and control unit specific data

28 **Further information on the KTS 670: Page 16 ff.**

FSA 750 | Engine System Testing FSA

Scope of delivery FSA 750
Trolley
Charging tray
Measurement module with sensor carrier
Power unit with mains connection cable
Printer
Remote control (transmitter and receiver)
System tester KTS 670
System software SystemSoft[plus][1]

Sensors
Connecting cable for Multi 1
Connecting cable for Multi 2
Connecting cable for B+/B-
Connecting cable for term. 1/15 (Uni-line IV)
Measurement transmitter 3 x KV+/Rt
Measurement transmitter 3 x KV-/Sw
Trigger clamp
Clamp-on probe 1000 A
Clamp-on probe 30 A
Stroboscope
Oil temperature sensor
Air pressure measurement with hose line

Accessories	Order number
Air-temperature sensor	1 687 230 060
Connecting line for air-temperature sensor	1 684 465 517
Supplementary-equipment set BEA 050	1 687 001 865
Supplementary-equipment set RTM 430 (function only in conjunction with BEA 050)	1 687 001 577
Package: Primary ignition Connecting cables: BMW, Opel	0 688 100 017
Package: Secondary ignition Connecting cables: Audi, BMW, MB Test adapter: A, B, C/D, E, F/X, Y	0 688 100 002

Technical data	
Dimensions (H x W x D)	approx. 1785 x 680 x 670 mm
Weight	approx. 93 kg
Voltage for power supply unit	90 – 264 VAC / 47 – 63 Hz
Operating temperature range	5 °C to 40 °C

Variants of FSA 750

FSA 750 (with German keyboard)	0 684 010 753[2]
FSA 750 (without keyboard)	0 684 010 754

[1] The SystemSoft[plus] contains the software for the signal generator, multimeter and scope, as well as general test steps and general testing and connection instructions
[2] For German-speaking countries

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DIGITALNI OSCILOSKOPI

REZIME

1. Analogni osciloskopi koriste katodnu cev za prikazivanje uzoraka napona.
2. Talasni oblik prikazan na analognom osciloskopu ne može se sačuvati za kasniji pregled.
3. Digitalni memoriski osciloskop (DSO) stvara sliku ili talas na displeju povezivanjem hiljada tačaka snimljenih osciloskopskim provodnicima.
4. Mreža na ekranu osciloskopa se zove "graticule". Svaki od 8 x 10 ili 10 x 10 podeljenih kvadrata naziva se podeok.
5. Postavljanje vremenske baze znači utvrđivanje koliko vremena predstavlja svaki podeok.
6. Postavljanje napona po podeoku omogućava tehničaru da vidi ceo talasni oblik ili samo njegov deo.
7. DC i AC priključak su dva izbora koja se mogu napraviti da bi se posmatrale različite vrste talasnih oblika.
8. Grafički multimetar nije pogodan za snimanje događaja kratkog trajanja, ali može prikazati mnoge korisne talasne oblike.
9. Osciloskop prikazuje napon tokom vremena. DSO može da snima i sačuva talasni oblik za naknadno pregledanje.