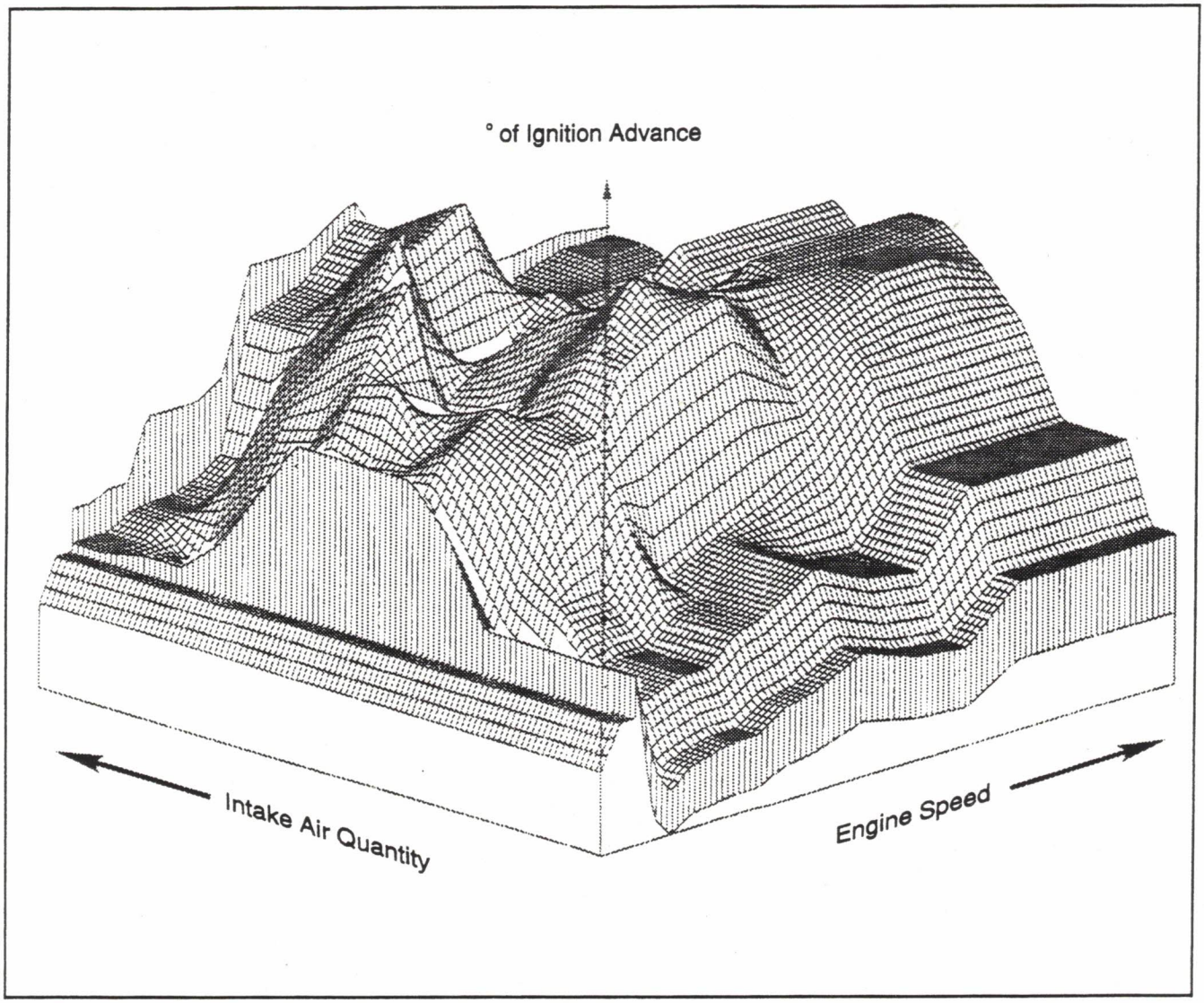
Level 2:

Motronic
(M2.1 & M2.2)

Training
Reference
Book



BMW of North America, Inc.
Motorcycle Service Department

Disclaimer

This training reference book is not intended to be a complete and all inclusive source for repair and maintenance data. It is only part of a training information system designed to assure that uniform procedures and information are presented to all participants at the BMW Motorcycle Service Training Center.

The technician must always refer to and adhere to the following official BMW service publications:

1. Service Information Bulletins
2. Repair Manuals/Microfiche
3. Specifications Microfiche
4. Electrical Wiring Diagrams

The information contained in the training course material is solely intended for participants in this training course conducted by the BMW Motorcycle Advanced Level Training.

Information Status, October 1993.

For changes/additions to the technical data, please refer to the current information issued by the BMW North America, Inc., Motorcycle Group.

Contents

Motronic System Overview

General

With the introduction of the 1990 K1, Motronic made its debut on US Market BMW Motorcycles.

The designation *Motronic* is a Bosch trade name, to represent *Digital Motor Electronics*.

At present there are two motronic systems found on BMW motorcycles:

- **M2.1.** K1 and the K100RS 16V. This version is known as an "open loop" system (**no** O_2 Sensor control)
- **M2.2.** K1100 RT & RS, R1100 RS. This version is known as a "closed loop" system (O_2 Sensor control)

The differences in these versions will be described in the electrical system operation section further on.

The Motronic system's primary functions are:

- Deliver filtered, metered fuel, proportional to calculated quantities of intake air at specific engine speeds.

- Ignite the air/fuel mixture at precisely the right time to achieve optimum combustion.

As described in the LE Jetronic system, Motronic also requires the same three elements to perform its primary functions:

- **Air**
- **Fuel**
- **Electricity**

All of the systems controlled functions are managed by **one** Motronic control module.

The Motronic system as outlined in this section will be described as an improvement to the information outlined in the LE Jetronic section. The sub-systems and components will be described generally (information recap) when similar or identical to LE Jetronic. When the components of the Motronic system differ from that of LE Jetronic (new or changed) they will be covered in detail and noticed easily with the use of ***a italicized type face.***

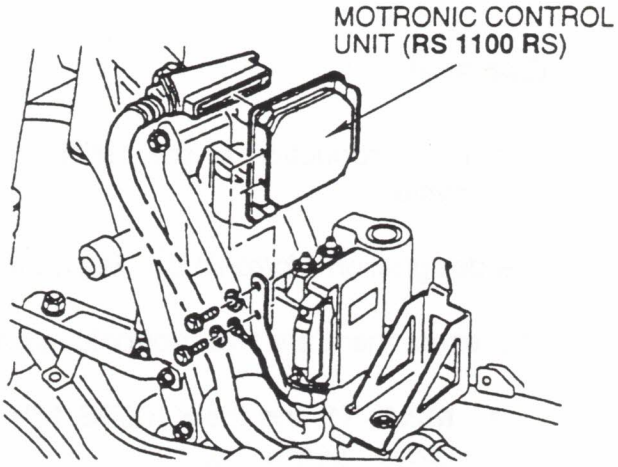
Motronic Control Unit

The location of the Motronic control unit is as follows:

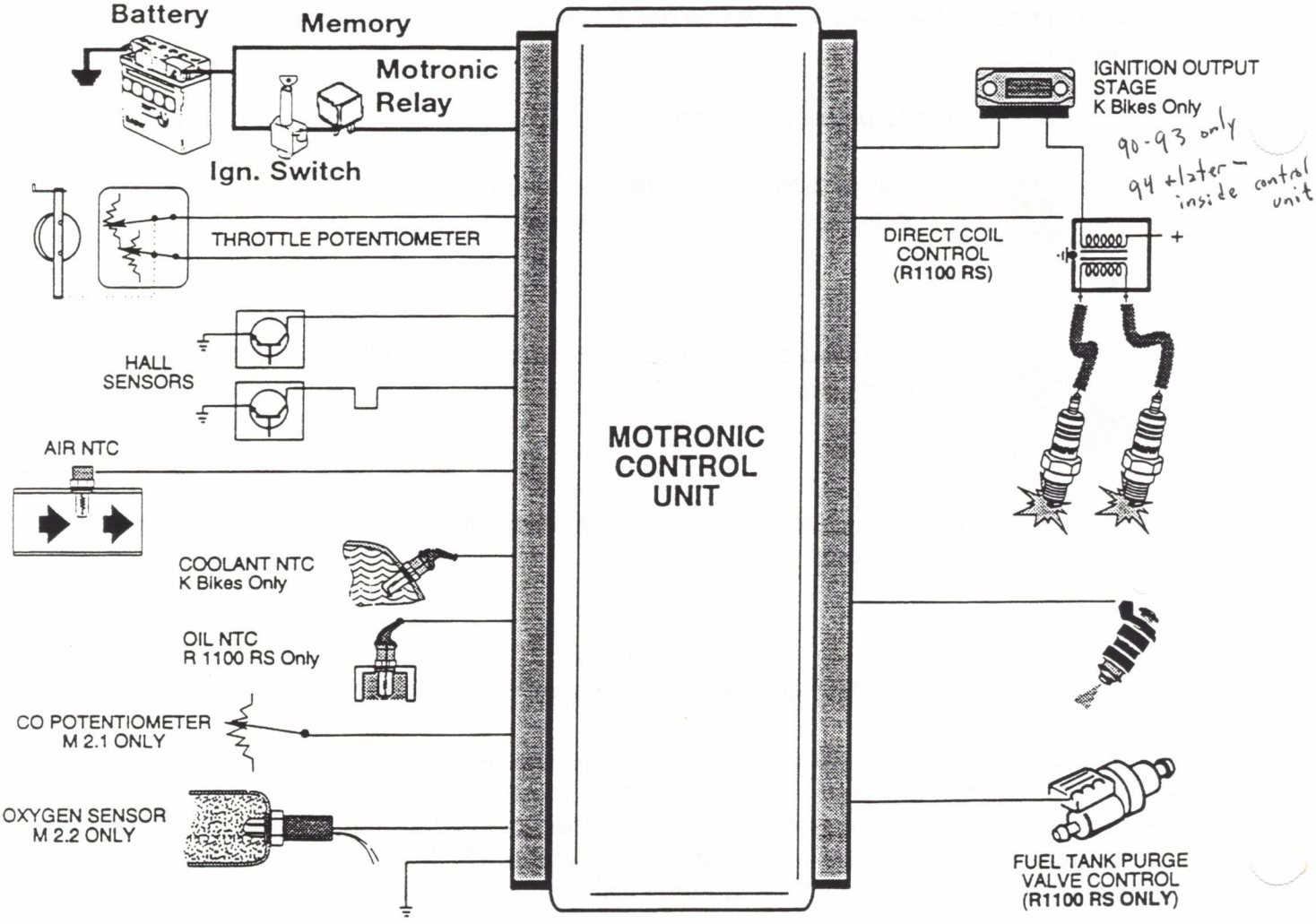
K Bikes: Under the seat, above the battery

R1100 RS: Under the fuel tank forward of the ABS Electric/Hydraulic Unit.

The Motronic Control Unit has a 35 pin multi-plug.



Motronic Basic IPO



Motronic Air System

Operation

The Air System is comprised of the following components:

- Air Filter Housing
- Intake Manifolds
- Intake air Collector
- Throttle Housings
- Intake Air Temp Sensor (NTC)
- Throttle Potentiometer

As compared to the LE Jetronic system, *you will notice the Air Flow Meter has been eliminated. The intake air flow dynamics have been improved since there is less restriction in the intake air system. This change has contributed to the engine's quicker throttle response.*

1. As intake air is drawn into the engine it first passes through the air filter, then directly into the intake air collector. Mounted to the air collector is the Air temperature sensor (NTC). The NTC produces an electrical signal directly proportional to the intake air present in the air collector.

2. The air is then drawn into each intake manifold as needed per cylinder.

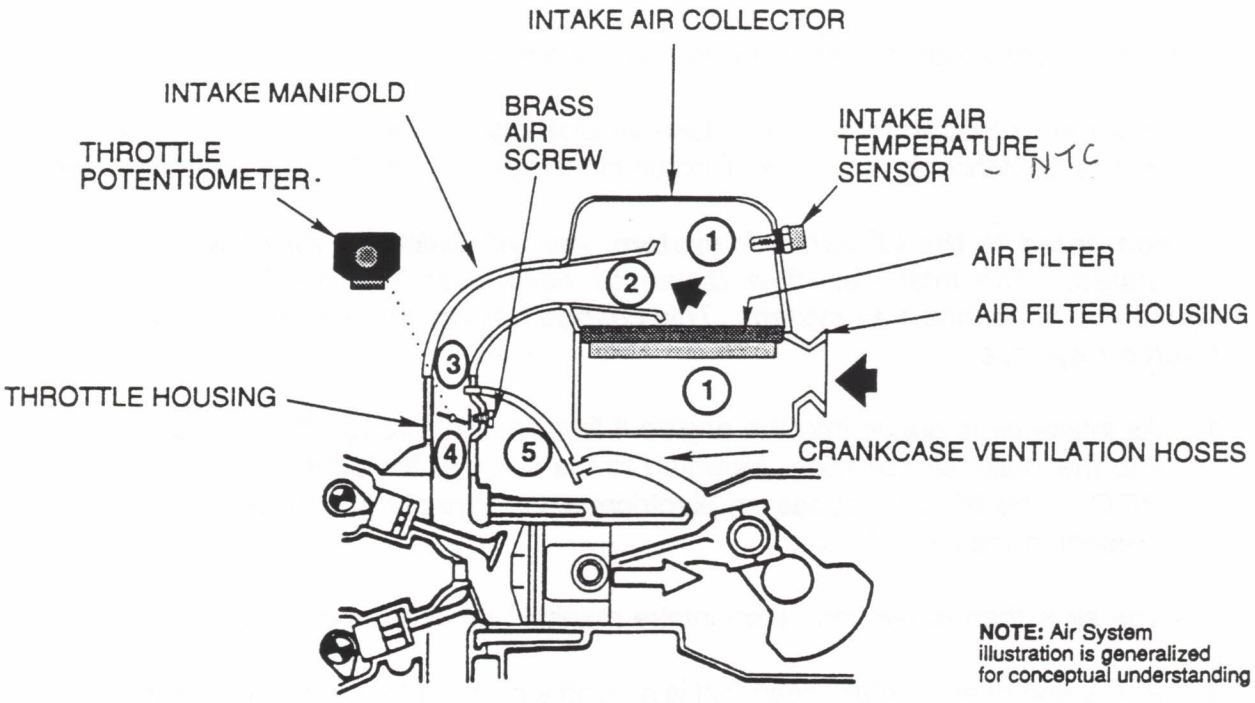
3. At the end of each intake manifold is a throttle housing that regulates the intake air with a throttle plate. ***Mounted to the throttle housing*** *of cylinder 4 on K bikes and the throttle housing of cylinder 1 on R1100 RS is a throttle potentiometer. The potentiometer translates the exact throttle position to the Motronic control unit by a varying DC voltage signal.*

   The throttle plates slow or increase the flow of intake air to each cylinder. At idle the throttle plates are completely closed, the signal from the throttle position sensor represents minimum quantity of intake air. A bypass port in each throttle housing allows a precise quantity of air to pass the throttle plate and maintain the engine's idle speed air quantity.

4. Past the throttle housings the air is mixed with a fine mist of injected fuel where it enters the cylinder head, passes the intake valve and into the combustion chamber for ignition.

5. Blow-by gasses from the combustion process accumulate in the engines crankcase. A ventilation/distribution hose assembly allows these gasses to be drawn into the intake air stream for re-use. This ensures a cleaner crankcase environment and recycles the unburned portions of the air/fuel mixture.

The mechanical integrity of the Air system should always be considered before any electrical troubleshooting is started.


INTAKE AIR COLLECTOR
INTAKE MANIFOLD
BRASS AIR SCREW
INTAKE AIR TEMPERATURE SENSOR - NTC
THROTTLE POTENTIOMETER
AIR FILTER
AIR FILTER HOUSING
THROTTLE HOUSING
CRANKCASE VENTILATION HOSES
1
2
3
4
5
1
NOTE: Air System illustration is generalized for conceptual understanding

Air System Components

INTAKE AIR TEMPERATURE SENSOR (NTC)

This sensor works identically to the sensor as found in the air flow meter on an LE Jetronic system.

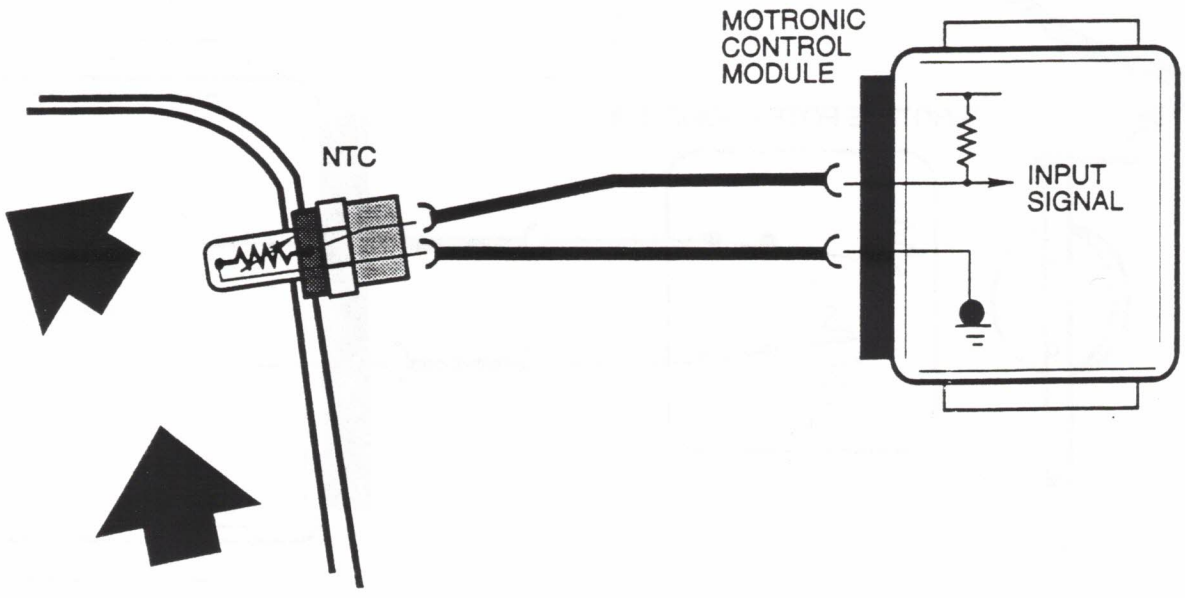
- Increase in air temperature = Decrease in resistance value.
- Decrease in air temperature = Increase in resistance value.

Cold air is denser than warm air of the same volume. When intake air temperature changes, the Motronic control unit must make slight corrections for "Ti" to maintain the correct air / fuel mixture.

***The Motronic control unit also** uses this signal for a correction factor for ignition timing. Referring to the ignition timing map the control unit will compare the intake air temperature signal and if necessary retards the ignition timing slightly with an increase in temperature. This is a knock control preventative.*

The slightest change in the intake air temperature is detected by the sensor. The control unit receives a varying DC voltage input signal that is directly proportional to the air temperature .

The Motronic Control Unit needs this signal to establish and maintain "Ti" (length of time fuel injector is injecting fuel) to correspond with the correct air/fuel ratio.



THROTTLE POTENTIOMETER

The throttle potentiometer converts the mechanical position of the throttle plates into a varying DC voltage signal.

5 volts

The sensor is a potentiometer that varies the voltage signals at two pins of the Motronic control unit. It produces a comparative voltage range of 0 to ~~8~~ volts DC. At idle the throttle plates are closed, the potentiometer produces a signal in the range of ~~0~~ volts. As the throttles are opened, the voltage increases linearly to the position of the throttle plates. At full throttle the sensor produces a signal in the range of ~~8~~ volts DC.

.35-.38 ✓

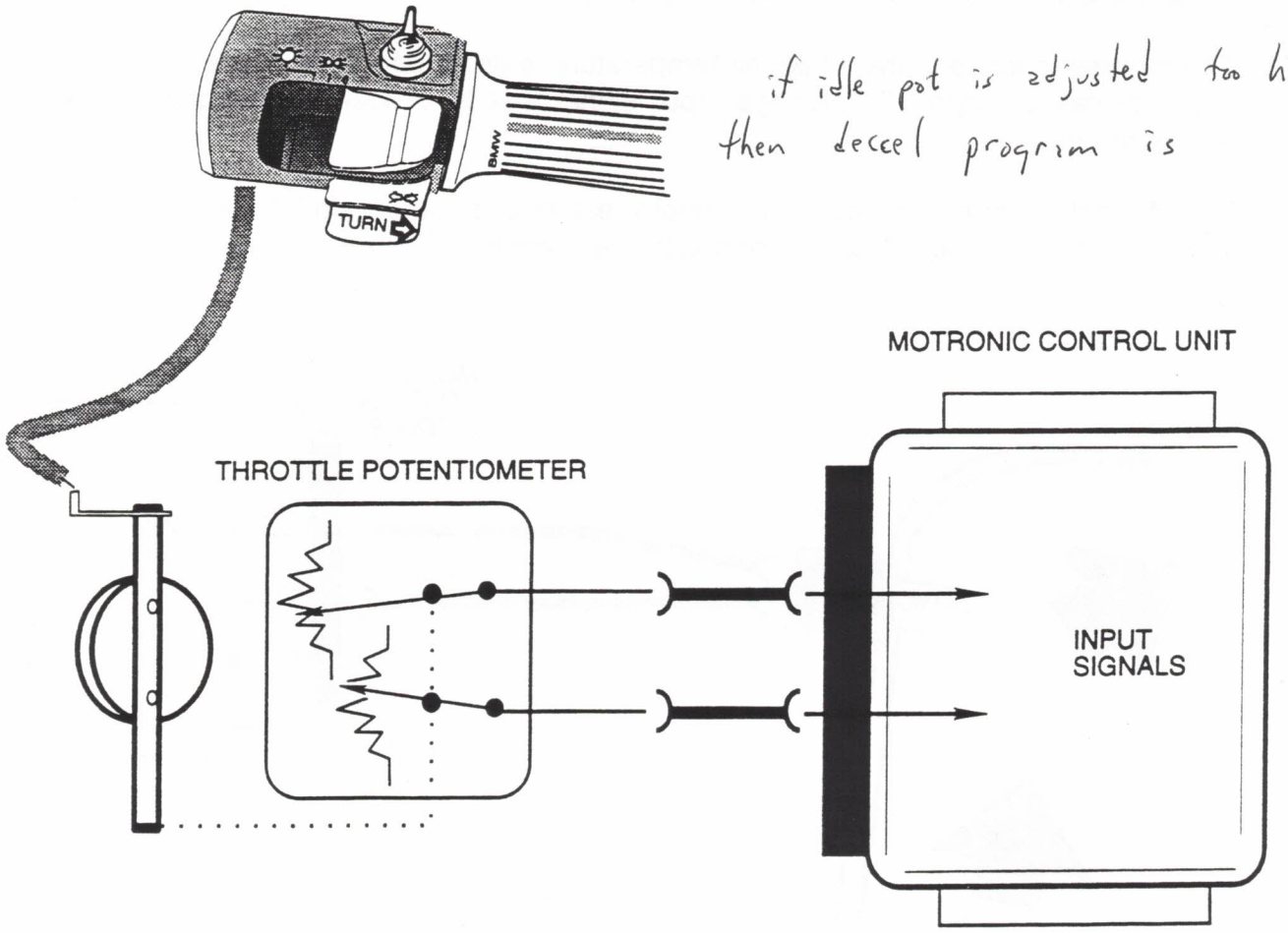
5

The Motronic Control Unit utilizes the throttle plate position angle ∝ (alpha), and the engine speed signals from the Hall Sensors (N) to calculate the inducted air. These Motronic systems are at times referred to as "alphan" Motronic systems.

one pot - idle → ½ that

2nd pot · ½ → full (4.7 v)

if idle pot is adjusted too high then decel program is



Motronic Fuel System

Operation

The Fuel System is comprised of the following components:

- Fuel Tank • In Tank Electric Fuel Pump • In Line Fuel Filter • Fuel Hoses
- Fuel Rail • Pressure Regulator • Fuel Injectors
- Fuel Vapor Purge Valve (R1100 RS) • Fuel Vapor Charcoal Canister (R1100 RS)

1. The Electric Fuel Pump located in the fuel tank is energized by the Fuel Pump relay. It pumps fuel through a fuel filter and out of the fuel tank through a fuel hose.

2. From the fuel hose the pressurized fuel flows into the fuel rail. The fuel rail is a manifold that links the fuel injectors to one common fuel supply at a constant pressure.

3. The constant pressure of the fuel rail and all of the fuel injectors is maintained by the fuel pressure regulator. The regulator maintains nominal fuel pressure @:

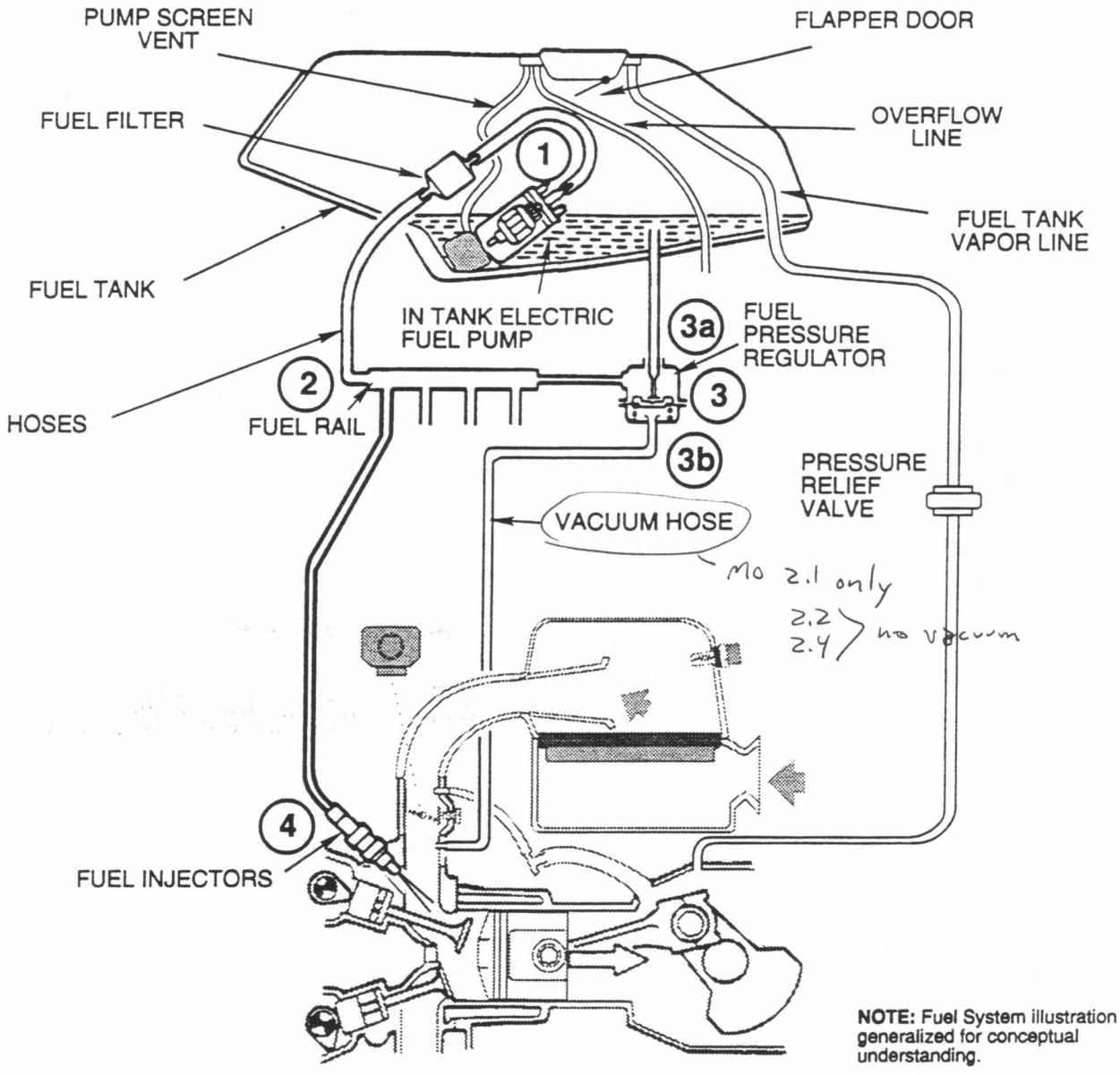
   - K series motorcycle = 2.5 ± .05 bar K12 - 3.5 bar
   - R1100 RS = 3.0 ± .05 bar. Mo 2.2
     No 2.1 1.8-2.0 bar idle
     2.0-2.5 bar above idle

   The pressure regulator consists of a fuel side and a vacuum side.

3a. The fuel side receives return fuel from the fuel rail. This fuel is regulated by a valve held closed by spring pressure. When the fuel overcomes the spring pressure it vents the return port and allows the fuel to return to the fuel tank.

3b. The vacuum side is connected to the throttle housing by a vacuum port located downstream of the throttle plate close to the tip of the fuel injector. This location enables the fuel supply pressure to meet the constantly changing vacuum pressure at which the fuel injector tip is exposed to. The vacuum source will maintain the pressure differential between the fuel pressure and the vacuum pressure by overcoming the spring pressure. This mechanical function will be fully explained further on in this section.

4. The Fuel injector is filled with fuel at a constant pressure to match that of the vacuum environment in the intake port. Based on the engine's intake air quantity, speed and correction factors, the Motronic control unit applies a pulsed ground to the solenoids in each fuel injector simultaneously allowing the injector to open. The pulsed ground equates to the "Ti" of the injectors. To maintain the proper air/fuel ratio, taking into account all of the correction factors, "Ti" will be 1.5 to 9 ms (milli-seconds).



The R1100 RS is equipped with a fuel system vapor purge system. It consists of a fuel tank vapor hose, charcoal canister, overpressure vent valve, and an electrically controlled purge valve that vents the fuel vapors into the intake air stream.

The fuel system is an area to consider when diagnosing a problem related to poor response and performance. Fuel pressures not within specification will change the final air/fuel ratio. Areas to consider, clogged fuel filter, pinched or crimped feed or return hoses, poor or no vacuum connection to the pressure regulator, defective pressure regulator, mechanically defective fuel injectors and purge valve (R1100 RS only).

Fuel System Components

The following Motronic fuel system components operate as described in the LE Jetronic fuel system components section,

- Fuel Pump
- Pressure Regulator (except for nominal pressure difference)
- Fuel Injectors

The Motronic system incorporates a new fuel system component as described below.

FUEL VAPOR RECOVERY SYSTEM (PURGE VALVE) - R1100 RS ONLY

The fuel vapor recovery system on the R1100 RS consists of:

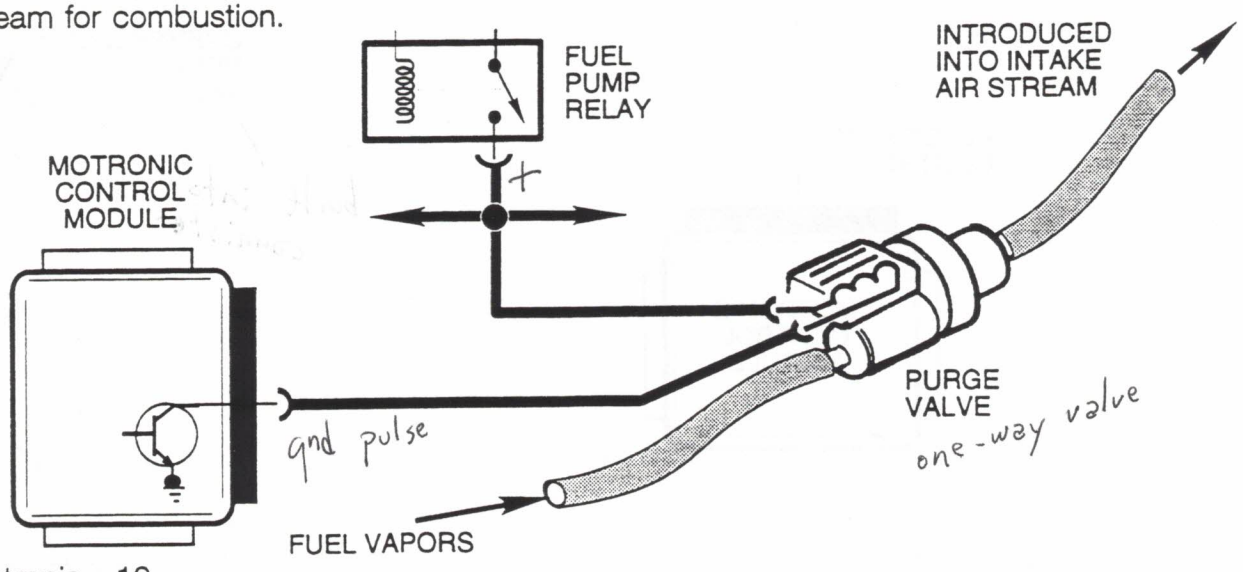
- The fuel tank
- Charcoal canister
- Overpressure Relief Valve
- Purge Valve

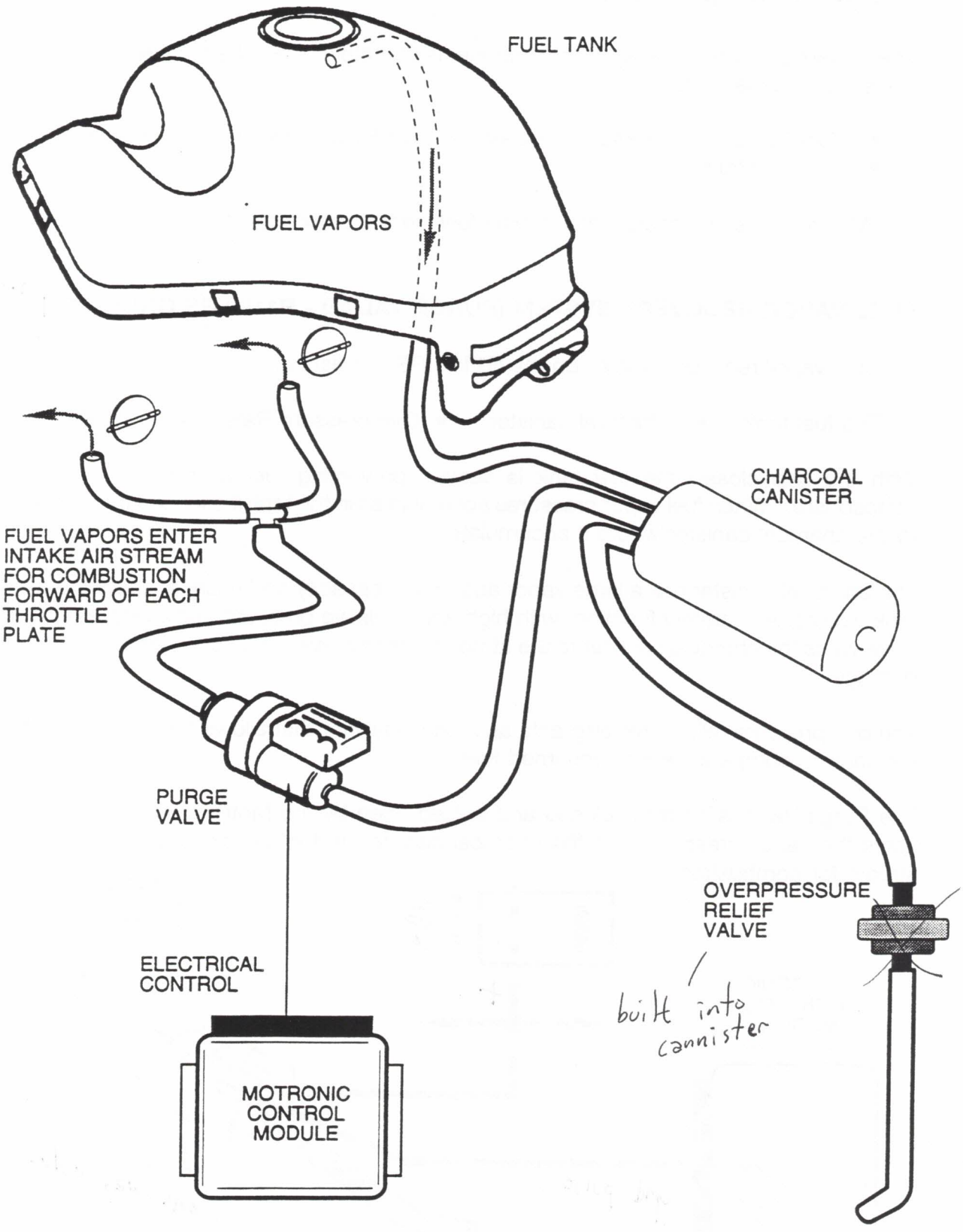
With the cap closed the fuel tank is sealed, preventing fuel vapors escaping to the atmosphere. When fuel vapor pressures accumulates in the tank it escapes through a hose to the charcoal canister where it accumulates.

The charcoal canister has a large vapor absorption capacity and easily accepts the excess tank vapors. As a safety function, with high accumulative pressure, the overpressure relief valve vents the charcoal canister to the atmosphere to prevent a safety hazard and fuel tank damage.

The overpressure relief valve also acts as a one way vent that allows fresh air to reach the fuel tank to compensate for consumed fuel.

The Purge Valve is normally closed and pulsed open by the Motronic Control Unit. This vents the vapor pressure from the charcoal canister and introduces it into the intake air stream for combustion.




FUEL TANK
FUEL VAPORS
CHARCOAL CANISTER
FUEL VAPORS ENTER INTAKE AIR STREAM FOR COMBUSTION FORWARD OF EACH THROTTLE PLATE
PURGE VALVE
OVERPRESSURE RELIEF VALVE
ELECTRICAL CONTROL
built into cannister
MOTRONIC CONTROL MODULE

Motronic Electrical System

General

The electrical system is comprised of the following components, signals and signal paths. They are grouped by:

- **Inputs** (operating power, grounds and electrical signals required)
- **Processing** (electronic control units)
- **Outputs** (electrical control of components)

INPUTS

- Constant battery power
- Control Unit grounds
- Intake Air Temperature Signal
- Throttle Potentiometer Signals
- CO Potentiometer Signal (M2.1 Only)
- Motronic Relay
- Switched battery power
- Engine Speed Signal (Hall Sensor)
- Engine Coolant Temperature Signal
- Engine Oil Temperature - (R1100 RS Only)
- Oxygen Sensor Signal (M2.2 Only)

PROCESSING

- Motronic Control Unit

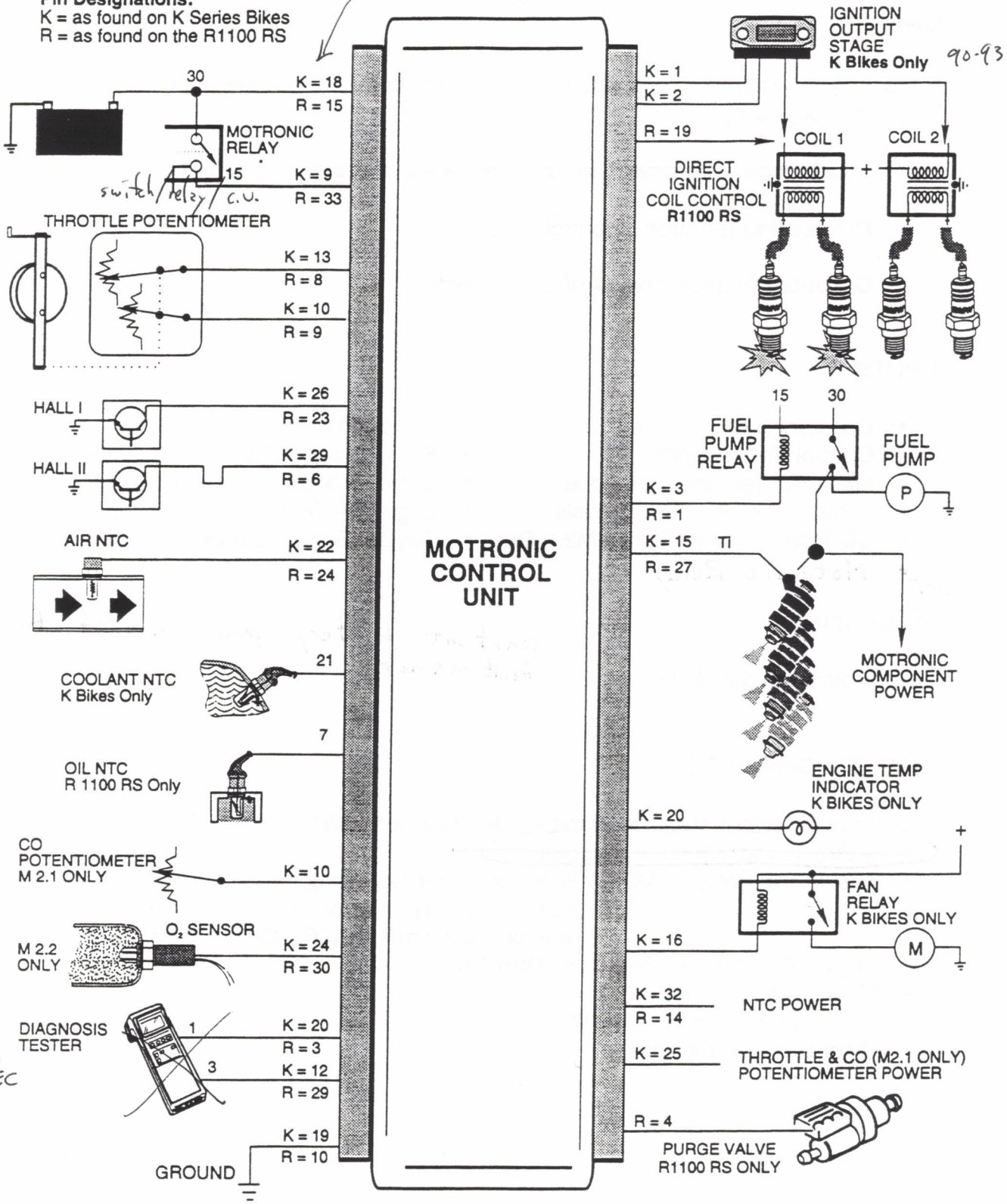
constant battery power needed for fault memory

OUTPUTS (Control Of)

- Ignition Output stage (to primary side of ignition coils)
- Motronic Relay (Power distribution)
- Fuel Pump Relay: M2.1- (Fuel pump and fuel injector operating power)
  M2.2- (Fuel pump, fuel injector and O_2 Sensor Heater, Fuel Tank purge valve{R1100 RS Only} operating power)
- Engine Coolant Fan Relay - K Bikes Only
- Control of Fuel Injectors
- Purge Valve Control - R1100 RS Only
- Diagnosis Communication

Motronic IPO (Input-Processing-Output)

pin designations only for early models



MoDiTec

Motronic Electrical System

Operation - K Series Motorcycles

1. Battery voltage is applied to the open contacts of the ignition switch. When the ignition key is switched to "ON", 12 volts flows to the primary side of the ignition coils and through the normally closed contact of the kill switch to provide power to:

   A. **The Side Stand safety switch,** which when closed provides power to the coil of the fuel pump relay

   B. **The Motronic relay coil,** which has a hard wired ground. Power is distributed to pin 9 of the Motronic control unit (operating power), instrument cluster, and to the normally open contacts of the neutral safety switch.

   C. The Motronic control unit will activate the fuel pump relay for a few seconds to bring fuel system pressure up. It will switch the relay off until it receives the hall sensor input to indicate the engine is running. It is in this brief time period the motronic control unit will perform static and dynamic tests of its components for self diagnosis.

2. With the motorcycle transmission in neutral or the clutch lever depressed power flows to the starter switch. When the starter switch is closed, power flows to the starter relay coil and activates the starter.

3. With the starter turning the engine over (cranking), Hall sensors will produce the engine speed and reference signals. The control unit will detect the engine's cranking from these signals. The Motronic control unit will then simultaneously:

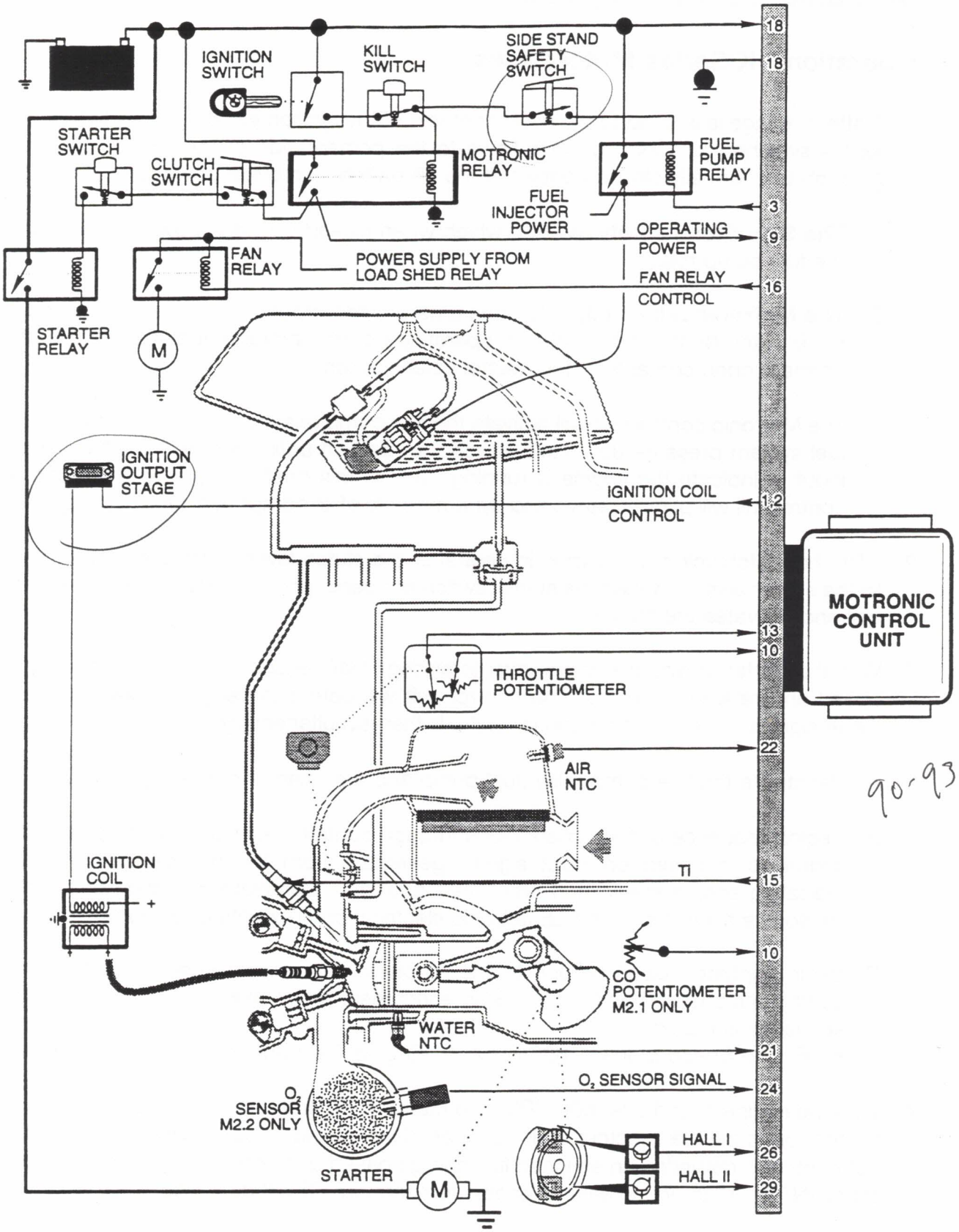
   A. Reactivate the fuel pump relay (fuel pump and fuel injector operating power).

   B. Begins sequence of firing spark plugs through control of ignition output stage. This sequence is based on input signals generated from the hall sensors that are indicating engine speed and crankshaft position. Complete operation of the hall sensors is explained in the LE Jetronic electrical components operation section.

   C. Begin applying pulsed ground to the injectors. With a cold engine, the Motronic control unit bases Ti on the Cold Start enrichment program in the control unit. This sequence is based on:
      - Engine Speed Signal < 600 RPM • Engine Temperature Sensor Signal (NTC)

4. With the engine speed over 600 RPM, the Motronic control unit continues injecting fuel by controlling the fuel injectors. Ti is now based on TD and calculated intake air quantity but continues delivering an enriched fuel charge based primarily on engine temperature signal (NTC). With an increase in engine temperature, Ti will decrease.

sidestand down - starter spins but no fuel pressure



90-93 K

Operation - R1100 RS

1. Battery voltage is applied to the open contacts of the ignition / light switch. When the ignition key is switched to "ON", 12 volts flows to the primary side of the ignition coil and through the normally closed contact of the kill switch to provide power to:

   A. The Side Stand safety switch, which when closed provides power to:
      - The coil of the fuel pump relay
      - The open contacts of the starter switch
      - **The Motronic relay coil,** which has a hard wired ground to battery (-). Power is distributed to pin 33 of the Motronic control unit (operating power).

   B. The Motronic control unit will activate the fuel pump relay for a few seconds to bring fuel system pressure up. It will switch the relay off until it receives the hall sensor input to indicate the engine is running. It is in this brief time period the motronic control unit will perform static and dynamic tests of its components for self diagnosis.

2. With the motorcycle transmission in neutral or the clutch lever depressed a ground will be available for the starter motor when the starter switch is depressed. When the starter switch is closed, power flows to the starter relay coil and activates the starter.

3. With the starter turning the engine over (cranking), Hall sensors will produce the engine speed and reference signals. The control unit will detect the engine's cranking from these signals. The Motronic control unit will then simultaneously:

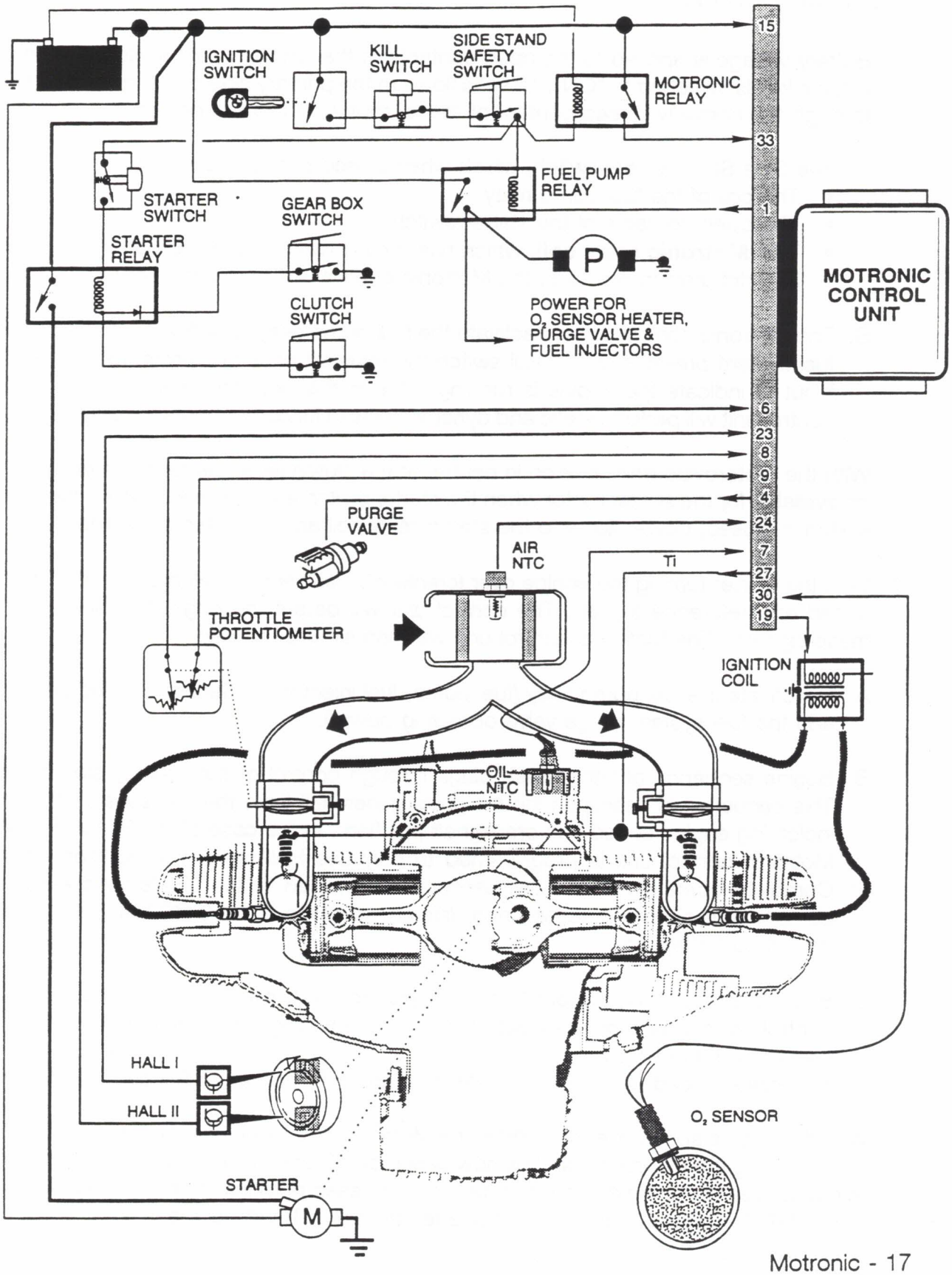
   A. Reactivate the fuel pump relay (fuel pump, fuel injector, O_2 Sensor Heating Element, and the fuel system purge valve operating power).

   B. Begins sequence of firing spark plugs through control of the primary side of coil. This sequence is based on input signals generated from the hall sensors that are indicating engine speed and crankshaft position. In the case of the R1100 RS, the Motronic control unit is programmed to only use Hall signal I for ignition timing. Complete operation of the hall sensors is explained in the LE Jetronic electrical components operation section and differences of the R 1100 RS Hall Sensors are described further on.

   C. Begin applying pulsed ground to the injectors. With a cold engine, the Motronic control unit bases Ti on the Cold Start enrichment program in the control unit. This sequence is based on:
      - Engine Speed Signal < 600 RPM • Engine Temperature Sensor Signal (NTC)

4. With the engine speed over 600 RPM, the Motronic control unit continues injecting fuel by controlling the fuel injectors. Ti is now based on TD and calculated intake air quantity but continues delivering an enriched fuel charge based primarily on engine temperature signal (NTC). With an increase in engine temperature, Ti will decrease.

94 & later
sidestand down
nothing works



Electrical System Components and Signals

The following Motronic electrical system components operate as described in the LE Jetronic electrical system components section,

- Hall Sensors (K Motorcycles)
- Ignition Coils

The Motronic system incorporates new or changed components as described below.

top - fires coils
lower - reference for TD signal

Hall Sensors - R1100 RS Only!

The Hall sensor assembly on an R1100 RS is different only in the design of the rotor. The rotor is mounted inside of the crankshaft pulley and its window opening is 43° of the rotor circumference. This larger window is necessary due to the large displacement 2 cylinder design of the engine. The control unit needs more area to interpret the TDC position to formulate the optimum dwell angle.

The R1100 RS produces an engine speed signal identical to the 4 cylinder K motorcycles. Both hall sensor signals are utilized to calculate the engine speed (two pulses per 360° of crankshaft rotation).

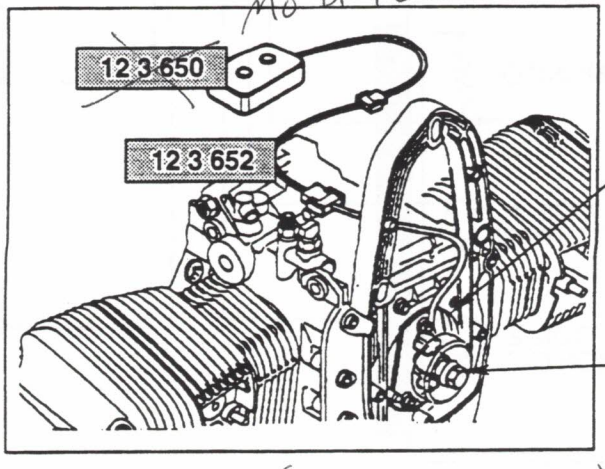
Since the R1100 RS engine only uses one double spark ignition coil for both cylinders, It triggers the primary side of the coil when both pistons are at TDC regardless (compression and exhaust).

The Motronic Control Unit on an R1100 RS is programmed to recognize only the signal from Hall sensor I for ignition timing.

When the Motronic Control Unit receives Hall Sensor I's crankshaft reference signal it triggers the primary side of the coil simultaneously sending ignition spark to both cylinders. This occurs with every pulse from Hall sensor I (1 pulse per 360° of crankshaft rotation).

SET UP PROCEDURE FOR IGNITION TIMING ADJUSTMENT. FOR COMPLETE INFORMATION REFER TO THE REPAIR MANUAL.

MOTRONIC



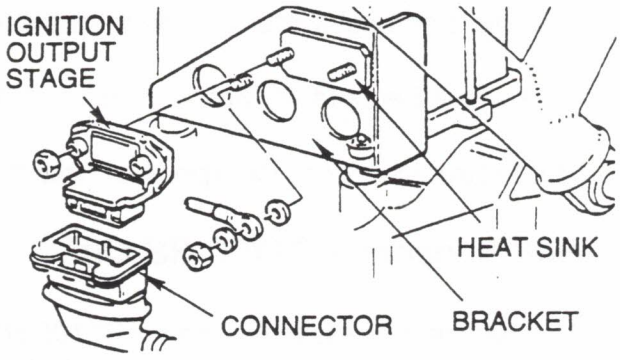
HALL SENSOR MOUNTING PLATE LOCATED BEHIND CRANKSHAFT PULLY.

THE HALL ROTOR IS INCORPORATED THE CRANKSHAFT PULLY

loss of signal (opening of window) - crank position reference

Ignition Output Stage - K Series Motorcycles Only!

The Motronic Control Unit controls the ignition coils through the activation of the remote Ignition Output Stage.



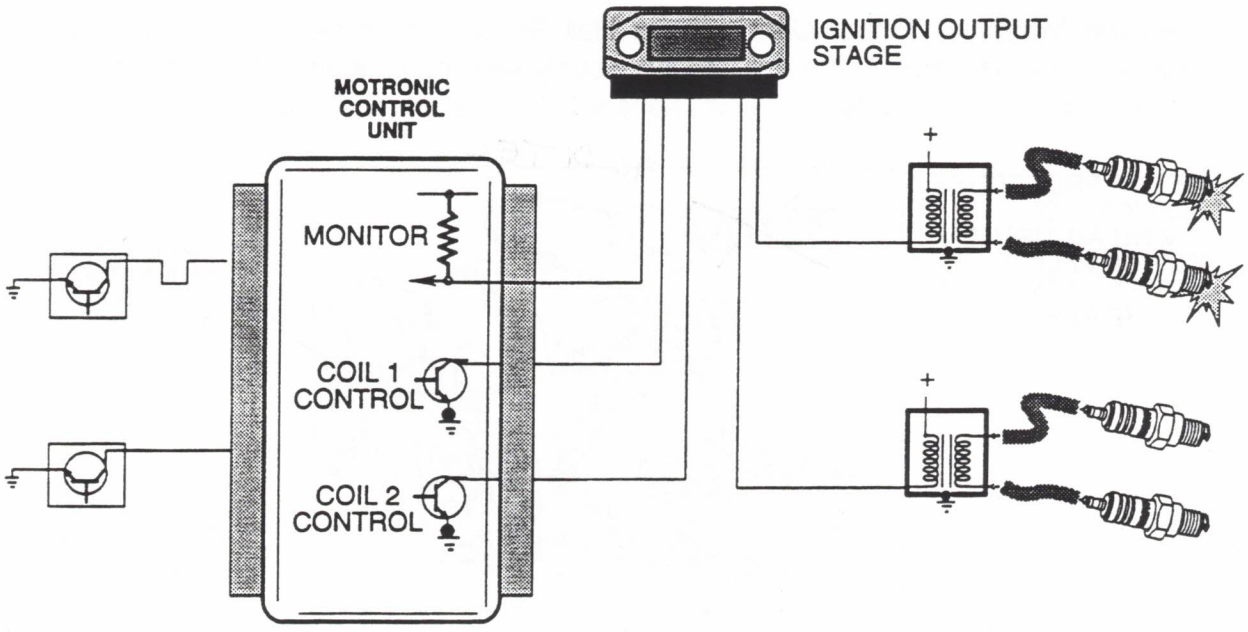
The additional functions Motronic handles compared to the LE Jetronic system increased the generated heat internal of the control unit. The control signal to the remote Ignition Output Stage carries a low voltage compared with direct ignition coil control. This helps to reduce the internal control unit heat.

The Ignition Output Stage is mounted on a bracket behind the battery.

Identical to the LE Jetronic system, the Motronic Control Unit bases ignition timing on the input signals generated by the Hall sensors.

When the Motronic control unit receives the crankshaft reference signal from:

- **Hall sensor I,** it triggers the control circuit to the Ignition output stage that controls coil 1. The Ignition Output Stage then triggers the primary side of Coil 1, simultaneously sending ignition spark to cylinders 1 & 4.
- **Hall Sensor II,** it triggers the control circuit to the Ignition output stage that controls coil 2. The Ignition Output Stage then triggers the primary side of Coil 2, simultaneously sending ignition spark to cylinders ~~1 & 4~~. 2 + 3



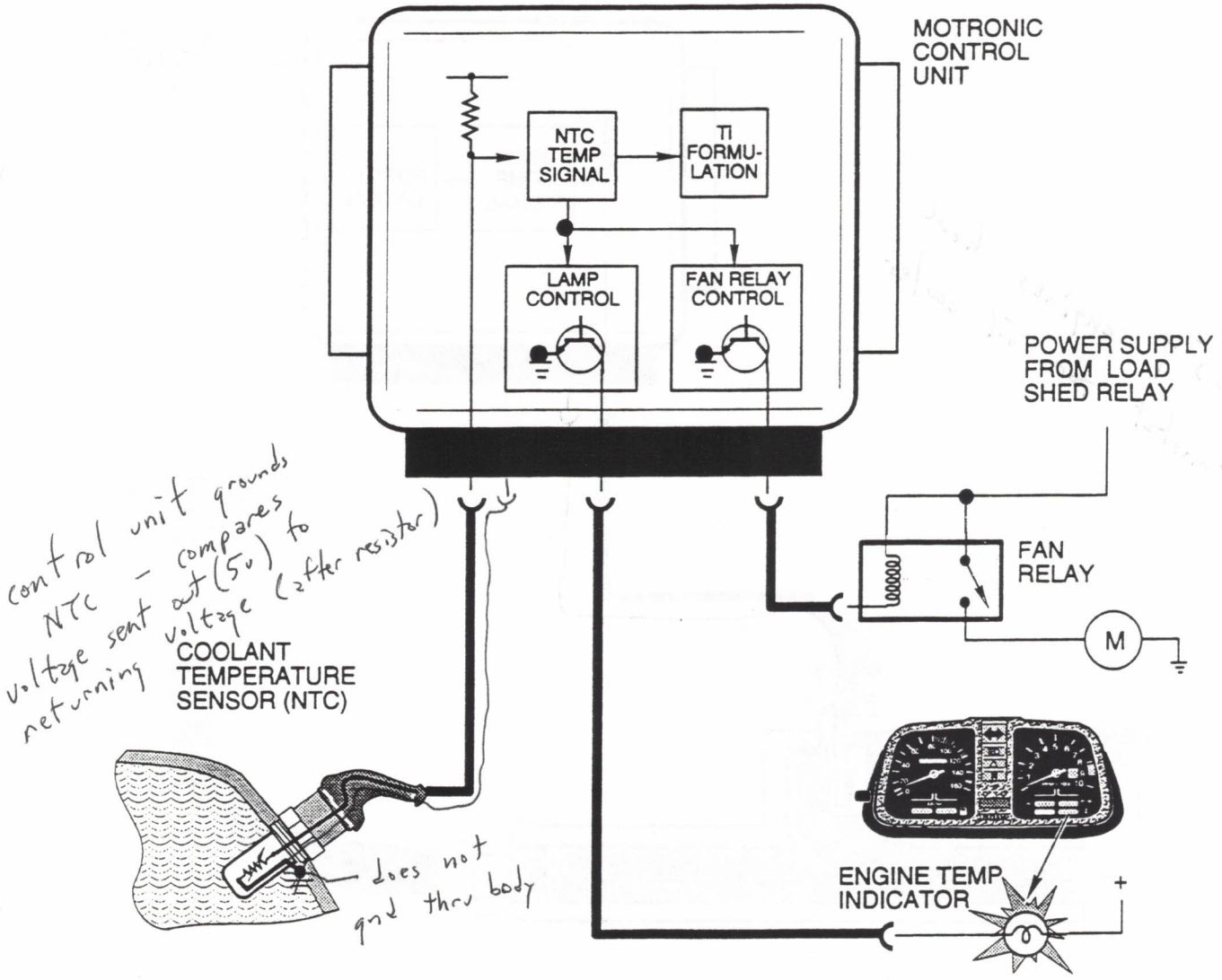
Engine Coolant Temperature Sensor (NTC) - K Motorcycles Only!

The Motronic system's Coolant temperature sensor is an NTC resistor. It has only one NTC *resistor element as compared with the LE Jetronic sensor having two.*

The Sensor is located in the outlet pipe on the cylinder head.

The Motronic Control unit monitors this signal for two functions.

- *Control of the radiator fan relay and engine temperature indicator in the instrument cluster (described further on).*
- Calculation for formulation of Ti of the injectors to compensate for engine temperature. Based on this signal, the Motronic control unit provides fuel enrichment for cold starting, and engine warm up and reduces the length of Ti as the engine warms up to normal operating temperature. **ie:** cold engine = longer Ti.



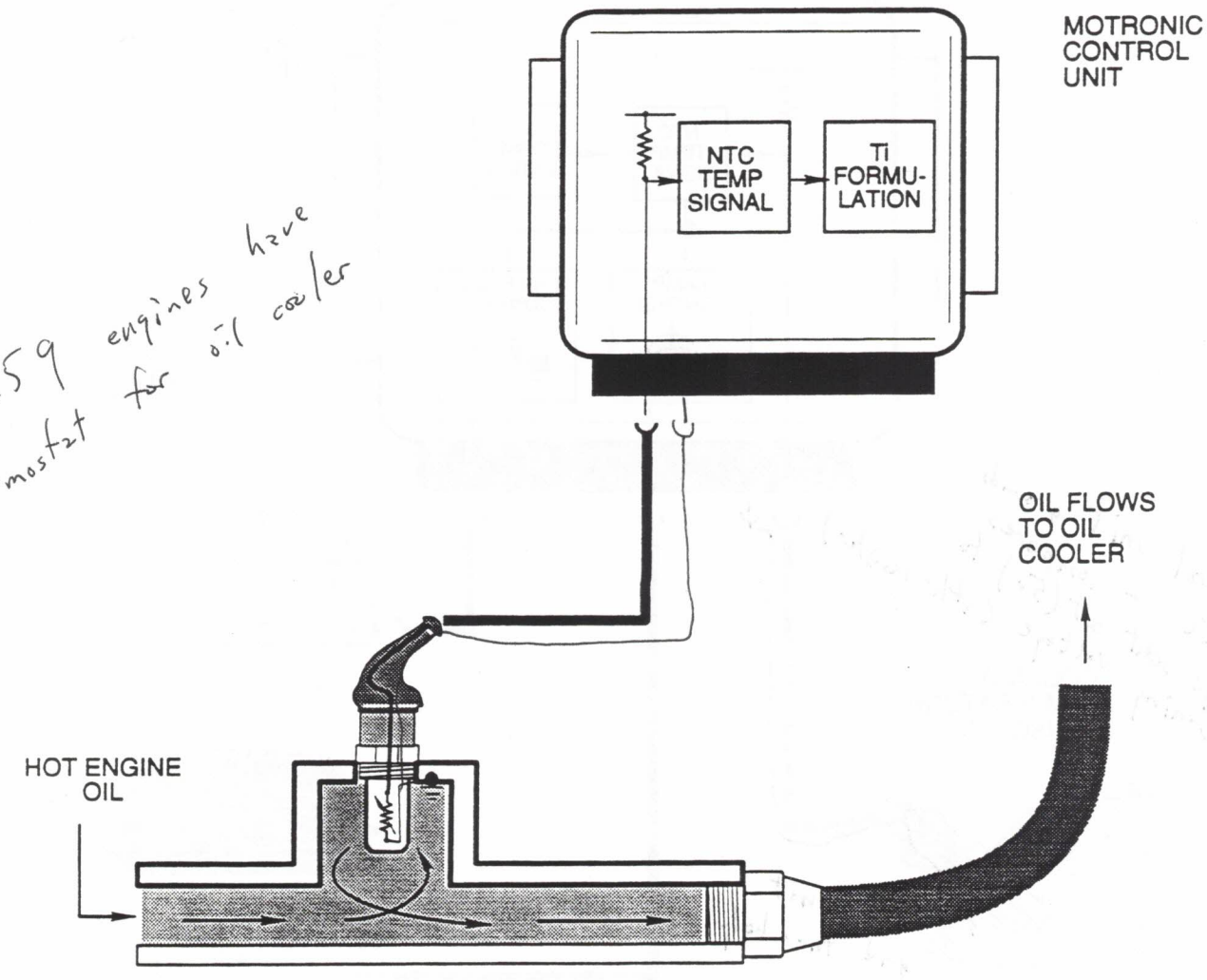
Engine Oil Temperature Sensor (NTC) - R1100 RS Only!

Since the R1100 RS has an air cooled engine the Motronic Control Unit must monitor engine temperature from the engine oil.

This sensor is located on the top of the engine next to the oil cooler inlet hose. The sensor element is positioned in an oil gallery, sensing the heat in the oil as it flows to the oil cooler.

This NTC functions identically to the Engine Coolant Temperature Sensor on a K series motorcycle.

- Increase in oil temperature = Decrease in resistance value.
- Decrease in oil temperature = Increase in resistance value.



R259 engines have thermostat for oil cooler

CO Potentiometer - All M2.1 ("Open Loop System")

The term "Open Loop" refers to the Motronic Control Units method of formulating Ti. The M2.1 Motronic system is open loop, meaning, it relies on the preprogrammed map and the input signals it receives to calculate for the optimum air/fuel ratio.

Open Loop Sequence:

1. Motronic Control Unit determines Ti through input signals and MAP.
2. Injectors are opened by the Motronic Control Unit to deliver the "proper" amount of fuel.
3. Combustion process takes place using the mixture supplied to the cylinders.

The CO potentiometer, along with an exhaust gas analyzer, is the only input component that can have an effect on the air fuel mixture by sampling the exhaust gas content and slightly change the control units map for Ti formulation.

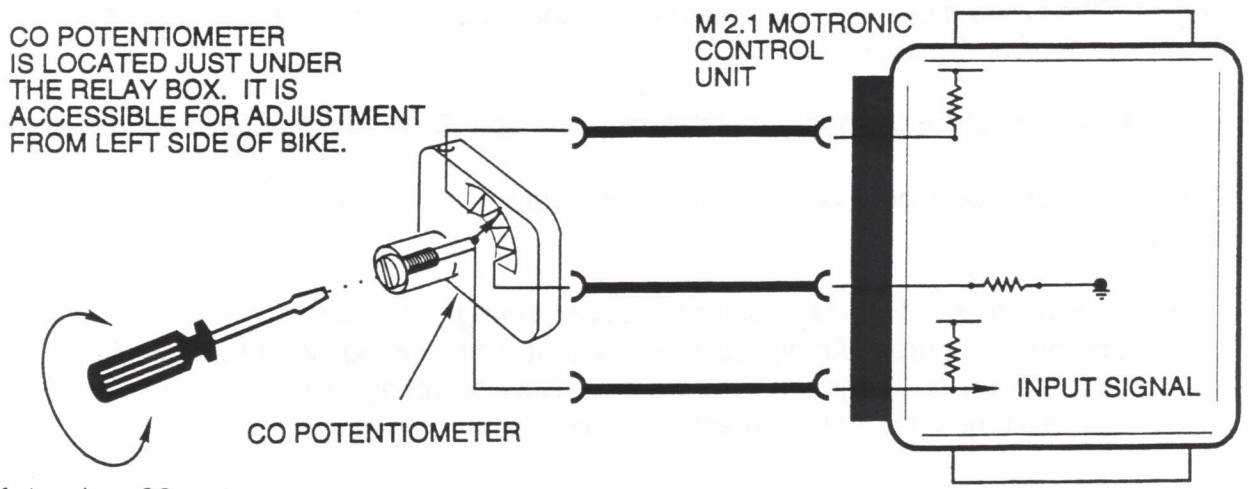
CO (Carbon Monoxide) is an odorless, colorless, toxic gas. CO is formed in the combustion chamber of an internal combustion engine when there is not enough air in the air/fuel mixture to burn all of the fuel.

The CO levels present in exhaust gas:

- rise with richer mixtures
- fall with leaner mixtures

Note: Refer to appropriate repair manual fiche, follow all pre test conditions and test set up procedures.

If the CO level is not within repair manual specifications, turning the screw on the potentiometer will slightly increase or decrease Ti to either enrich or lean the air fuel mixture (always turn screw slowly and in small increments, allow gas analyzer to produce stable reading)



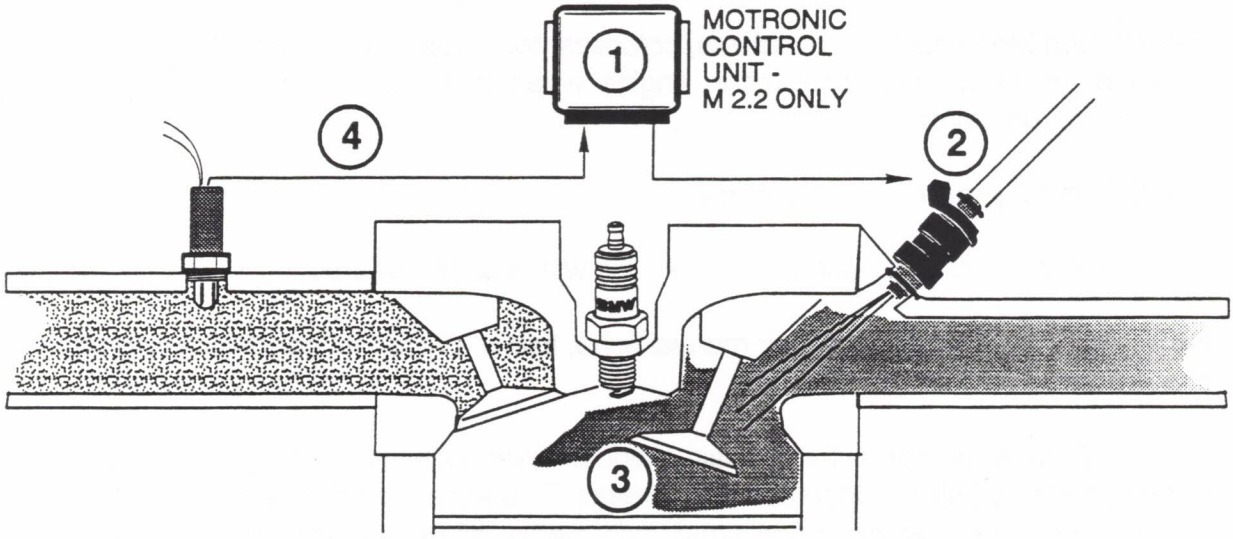
wurth - black - silicone safe

Oxygen (O_2) Sensor - All M2.2 ("Closed Loop Systems")

The term "Closed Loop" refers to the Motronic Control Units method of formulating Ti. The M2.2 Motronic system is closed loop, meaning, it relies on the preprogrammed map and the input signals it receives to calculate for the optimum air/fuel ratio. The closed loop system has one additional input component that the open loop does not have; an oxygen sensor.

Closed Loop Sequence:

1. Motronic Control Unit determines Ti through input signals and MAP (without O_2 sensor input).
2. Injectors are opened by the Motronic Control Unit to deliver the "proper" amount of fuel.
3. Combustion process takes place using the mixture supplied to the cylinders.
4. O_2 Sensor informs control unit of oxygen content in exhaust gas. Control unit constantly monitors and re-formulates the optimum Ti.



The Oxygen Sensor monitors the amount of oxygen present in the exhaust gas of a running engine. The amount of oxygen present in the exhaust is a direct link to the delivered air/fuel ratio used for combustion:

- High O_2 Content = Lean air/fuel mixture
- Low O_2 Content = Rich air/fuel mixture

The O_2 Sensor produces a varying low voltage signal (0.2 - 0.8 volts) based on the oxygen content:

- Lean mixture = High O_2 Content = Lower voltage produced (down to 0.2 volts)
- Optimum mixture = Acceptable O_2 Content = Median voltage produced (0.45-0.50 volts) sensor is designed to be most sensitive to voltage fluctuations in this range.
- Rich mixture = Low O_2 Content = Higher voltage produced (up to 0.8 volts).

OXYGEN SENSOR (Cont'd)

The probe of the O_2 Sensor is threaded into the exhaust system (similar to a spark plug) just forward of the catalytic converter. With the engine running, the probe is immersed in the exhaust gasses flowing past.

The probe is a hollow round tipped cone made of a porous ceramic material that is coated on the outside with a layer of porous platinum. The probe becomes efficiently conductive when heated to its operating temperature (~~600~~ 400° C).

On the inside of the hollow probe is ambient air. Ambient air is accessible to this area of the sensor through holes and channels in the body of the sensor.

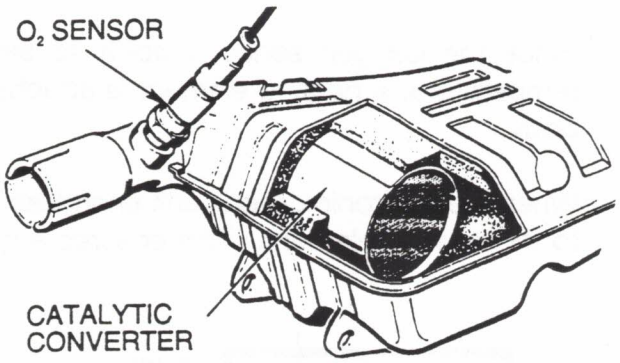
When the level of oxygen ions (present in both the ambient air and exhaust gas) on both sides of the probe are unequal, a milli-voltage is produced.

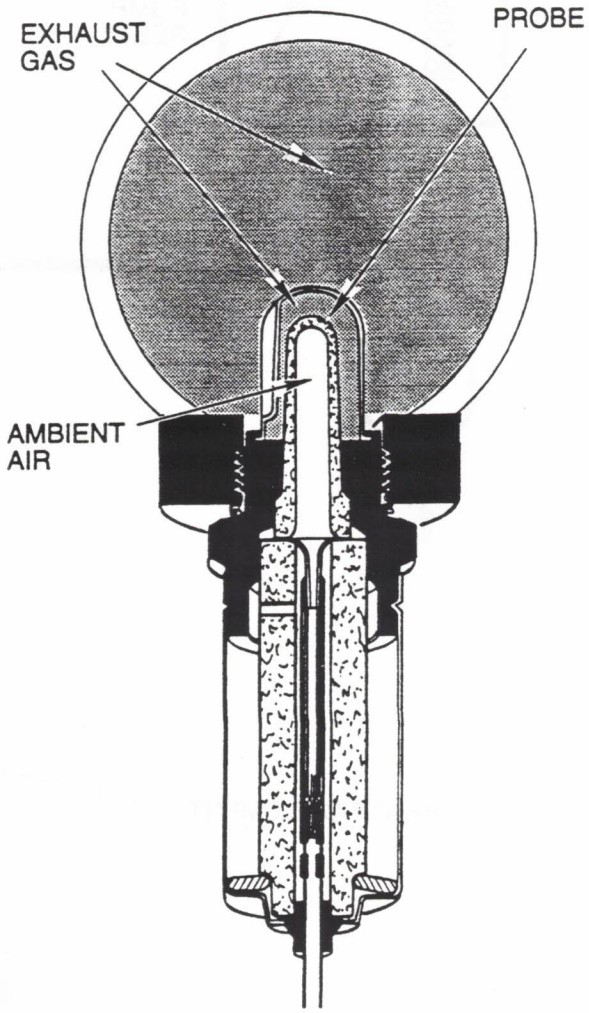
This milli-voltage is produced when the high content of oxygen ions from the ambient air side of the probe migrate through the porous ceramic body to try and equalize with the low oxygen ions on the exhaust side of the probe.

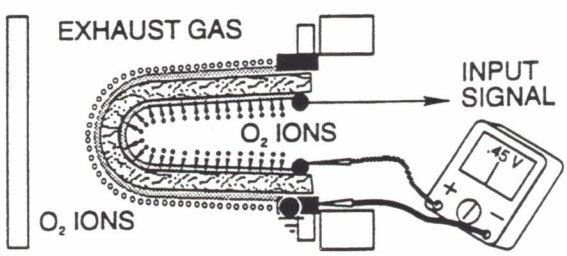
With a high oxygen content in the exhaust gas (lean mixture), the produced voltage is low (down to 0.2 volts).

With a low oxygen content in the exhaust gas (rich mixture), the produced voltage is high (up to 0.8 volts).

The control unit compares this varying voltage to a pre-programmed voltage quantity (.45 v) and determines the oxygen content in the exhaust gas.







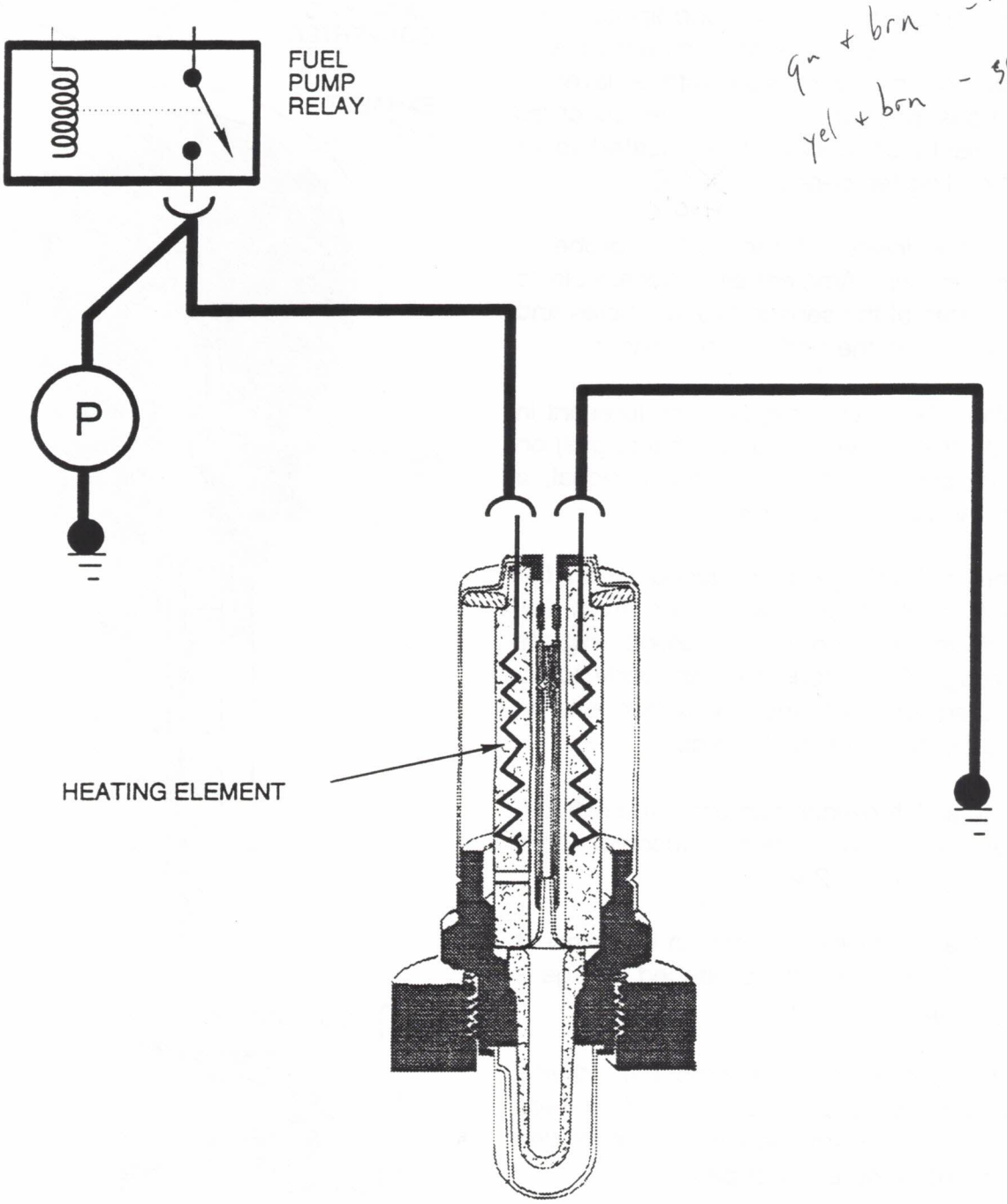
OXYGEN SENSOR HEATING

Since the Oxygen sensor's ability to sense oxygen is effected by the ceramic probes temperature, a heating element is attached to the ceramic internal of the oxygen sensors body.

When the Motronic control unit energizes the coil of the Fuel pump relay, voltage is applied to the heating element. This ensures a quicker response from the sensor.

gn + brn - heater

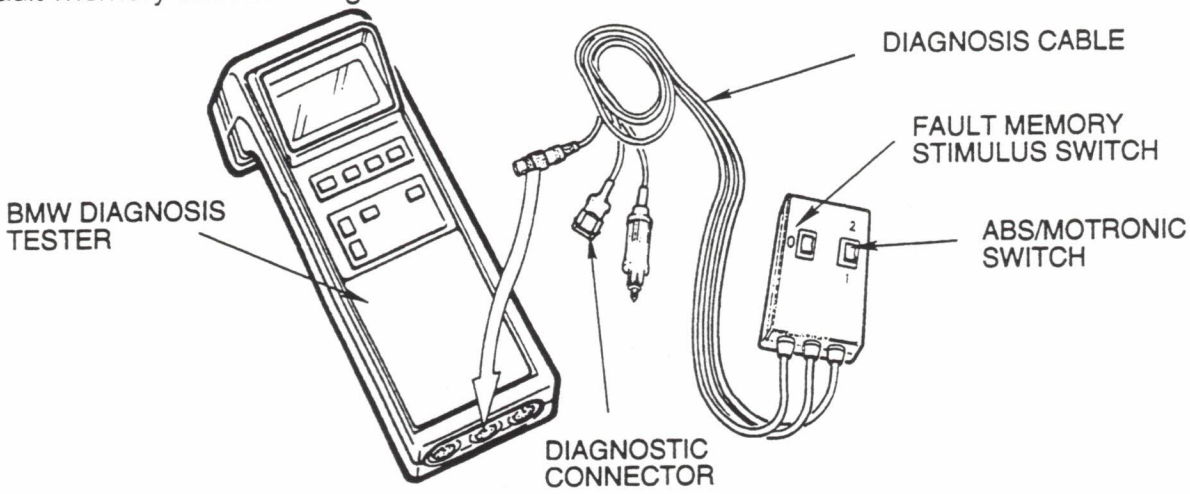
yel + brn - sensor signal



Motronic Self Diagnostics

The Motronic Systems (M2.1 & M2.2) like the ABS Systems are self diagnostic. When the control unit is switched on, it monitors the input components for functional plausibility and checks the wiring for opens or shorts.

If a fault is detected it will store the fault and identify it with a code number when accessing the fault memory with the Diagnosis Tester.



Unlike the ABS systems, the Motronic system will not shut itself down if a fault is detected. The Motronic control unit has substitute values programmed in the operating maps for continued operation in the "emergency program".

There may be a reduction in power or responsiveness when running in the emergency program. The convenience of this emergency program allows a rider to continue riding the motorcycle, even with a fault in the system, to obtain service.

The only input signal the control unit has no control over substituting is the engine speed and reference signals produced by the hall sensors. The control unit will set a fault code but can not function without these signals.

The fault codes are as follows:

4444 No fault stored
0000 No further faults stored
1111 CO Potentiometer
1122 Hall Signal I
1133 Hall Signal II
1223 Engine Temperature Sensor
1224 Air Temperature Sensor
1215 Throttle Potentiometer
2342 O_2 Sensor Signal un-realistic
2341 O_2 Sensor Control limit reached
2343 Mixture adjustment limit reached
2344 Short to (-), O_2sensor signal
2345 Short to (+), O_2 sensor signal

For additional information regarding Diagnosis procedures and Tester hook-up, refer to the service manual microfiche, other service / training manuals and Service Bulletins.