DOCTOR

Doctor DK-20 & DK-20/FV
Operating Guide

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Chapter 1 - Setting Up the DK-20

1.1 Using This Manual

This manual describes the setup and operation of the DK-20 and DK-20/FV instruments. If you have just received your system, then you will have to carry out some preliminary tasks. These are a) to install the crank pickups on your engine(s), and b) load details of your engine(s) into the instrument.

You will find installation instructions for the crank pickups in Chapter 3. Refer to this chapter together with the junction box configuration details supplied with your system.

Your instrument may already have been supplied with your engine details pre-loaded. If this is the case, then you can take measurements from your engines right away. Refer to Chapter 2 in this manual for details on operating the DK-20 instrument.

If your instrument does not contain engine data, refer to the Doctor software user guide for details on how to upload engine data into the DK-20.

1.2 The DK-20 and DK-20/FV Instruments

The DK-20 from Icon Research is a next generation version of the popular DK-2 instrument that has become a standard item of equipment for monitoring large diesel engines in the marine and on-shore power generation industries. The DK-20 incorporates many of the features that users of the DK-2 have grown to appreciate but the DK-20 now uses newer technologies for improved accuracy, even more user-friendly operation and increased ruggedness. The picture below shows the main features of the DK-20 .

The DK-20/FV has an additional input for fuel pressure measurements which provide additional information on fuel pressure and injection timing.

1.3 Getting Ready

Your Doctor instrument will have been delivered with the battery in a charged condition. However, before any readings are taken, it is suggested that you top up the charge on the battery. Connect the power supply to the mains using the appropriate plug, and charge the unit until the charge lamp goes from orange to green.

In order to take measurements on an engine, details of the engine must first be uploaded into the DK-20 instrument from the Doctor analysis software (version 6 or later). In the majority of cases the setup service will have been ordered and Icon will have programmed the DK-20 with engine details.

In some cases (e.g. service systems) where the Doctor system will be used for analysing a number of different engines the user must complete the engine data on the PC and download this into the DK-20. This procedure is described in the "Doctor Version 6 software step by step guide."

The sequence is that an engine hierarchy is created in the Doctor software and this is then uploaded into the DK-20. In this way, the instrument is always synchronised with the software and ensures correct transfer of data between the two.

It is essential that the information in the DK-20 and the software running on the PC are identical. This ensures that measurement processes are carried out correctly - for example, readings are automatically loaded into the correct cylinder - as well as providing useful information as you go through the measurement process. It also enables simple drag-and-drop operations when you come to transfer measurements into your computer.

A hierarchy typically holds all the data for all engines in a particular ship or site, though multiple ships and sites can be accommodated if desired. Multiple engine data can be uploaded together. Once uploaded, the upload procedure only has to be repeated if the parameters on one or more engines have changed.

Chapter 2 - Taking Measurements

2.1 DK-20 Operation

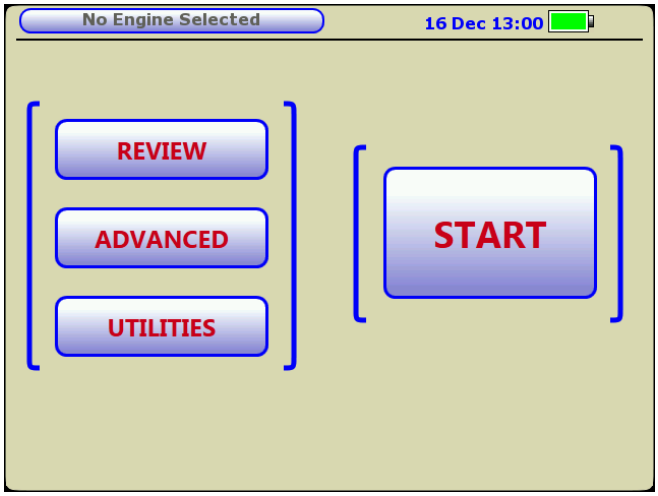
The touchscreen on the DK-20 enables quick and easy navigation of its features. Any button that has red text indicates that it is valid for a key tap and will take you to that screen or function.

When taking measurements at an engine, navigation of the required screens can be carried out solely by pressing the GO button. This enables gathering of data from all cylinders without having to remove protective gloves.

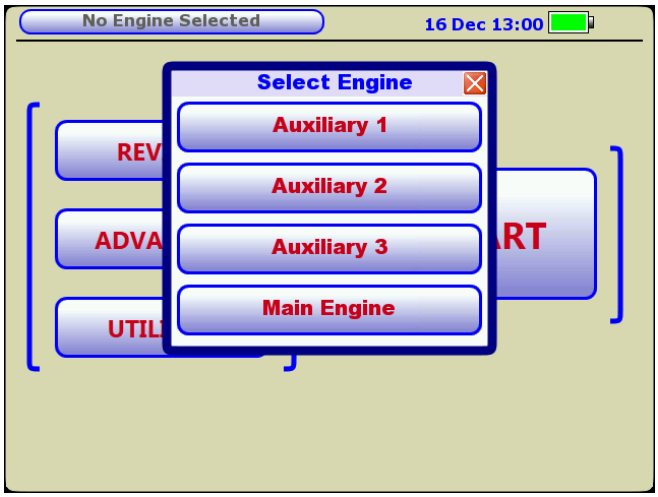
2.2 Taking Measurements with DK-20

Ensure that engine details are loaded into the DK-20 (either as part of Icon setup service or downloaded by yourself). If no details have been loaded, the word **START** in the screen below will be greyed out and inactive. If it is red it is active and you are ready to take measurements at the engine.

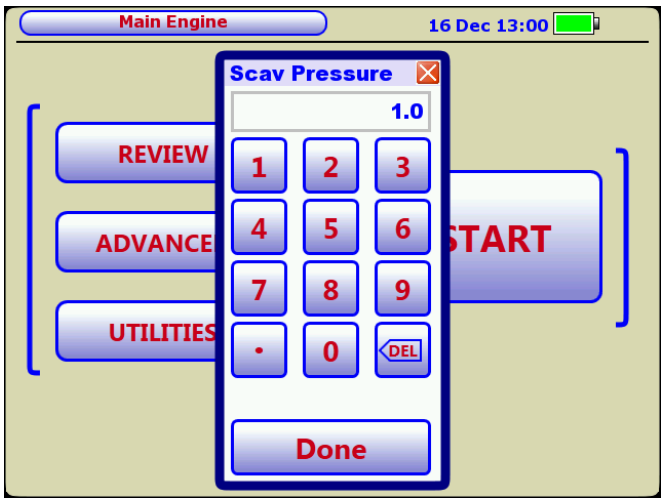
Start at cylinder 1 (on A bank if it is a V engine). Connect the pressure sensor and crank cable to the DK-20. Turn on the DK-20 and you will see the *Home* screen below. This example is for one main engine and three auxiliaries.



Tap **START** and the following screen will appear:

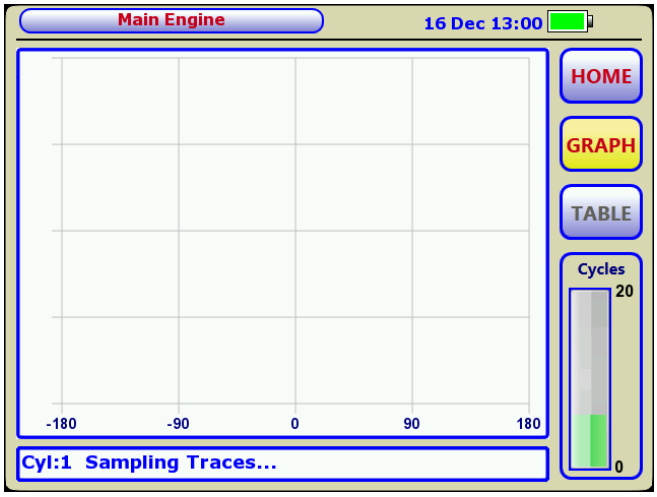


Select the engine that you wish to measure. In this example, we will select the **Main Engine**. The following screen will appear:

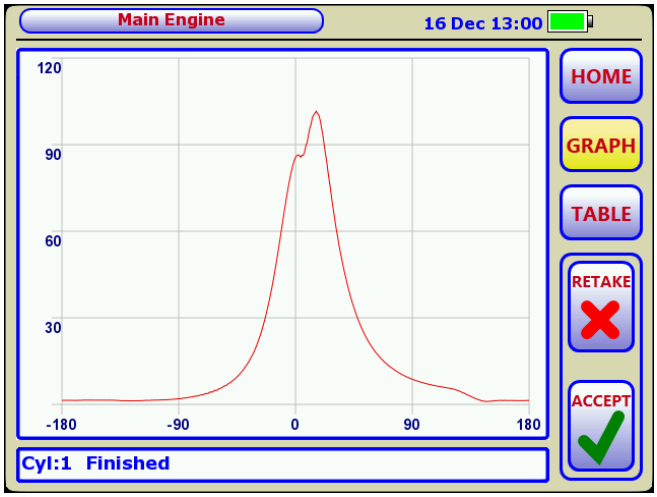


Enter the Scavenge Pressure if the value shown is different from the value indicated on the engine, and tap **Done**. (Note that the Scavenge Pressure is remembered for each engine). The following screen will appear:

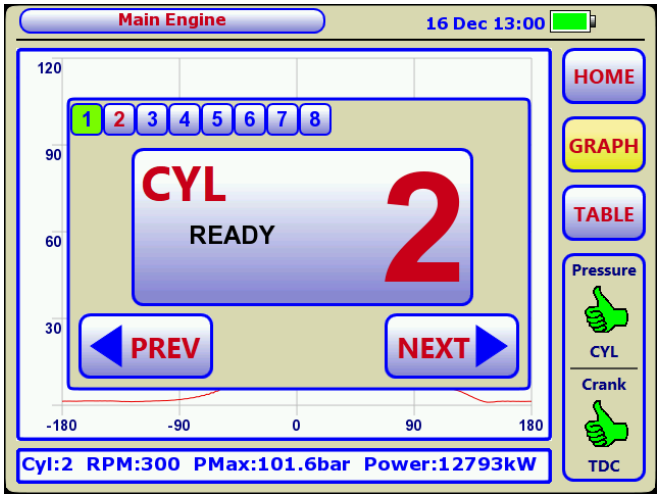
Open the indicator cock briefly to clear it and attach the pressure sensor. At this point the DK-20 will check for acceptable crank input signals (in this case a TDC marker) and indicates this by a green 'thumbs-up' in the *Crank* window. It also checks for a valid pressure signal and acceptable bias voltage (in this case cylinder only) and this is indicated by a green 'thumbs-up' in the *Pressure* window. Additionally, a check has been made that you are on the correct cylinder, and cylinder 1 is highlighted in red. If you are on the correct cylinder, the **GO** button will be solid green indicating that it is ready to be pressed. If you were on the wrong cylinder, a warning message would be shown and the **GO** button would blink to alert you (see later in this section – *Problem Detection*). Press the **GO** button or tap in the centre of the screen. The following window will appear showing the number of cycles incrementing on the vertical bargraph, and the **GO** button illumination will go off:



On completion, the trace will be shown as in the screen below, and the **GO** button will flash intermittently:

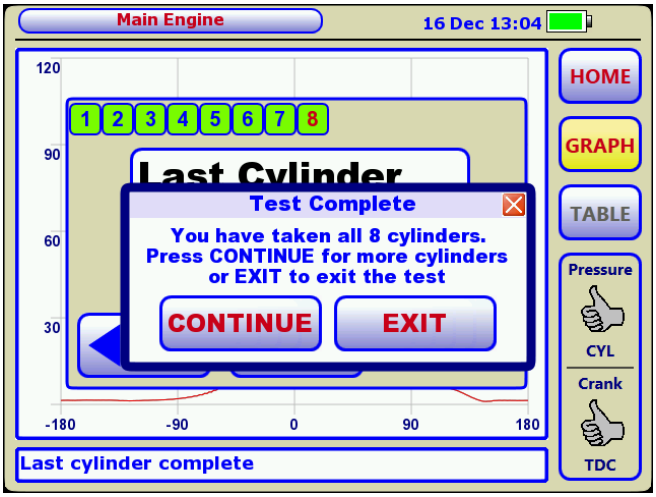


If you are happy with the trace, you can accept it by pressing the **GO** button or by tapping **ACCEPT**. (Note that, on the first reading on an engine where the TDC offset has not been adjusted, the trace may be offset). Close the indicator cock and move the pressure sensor to the next cylinder. If you wish to discard this measurement and retake it, tap **RETAKE**. Once you have accepted the measurement, the following screen will appear for the next cylinder:

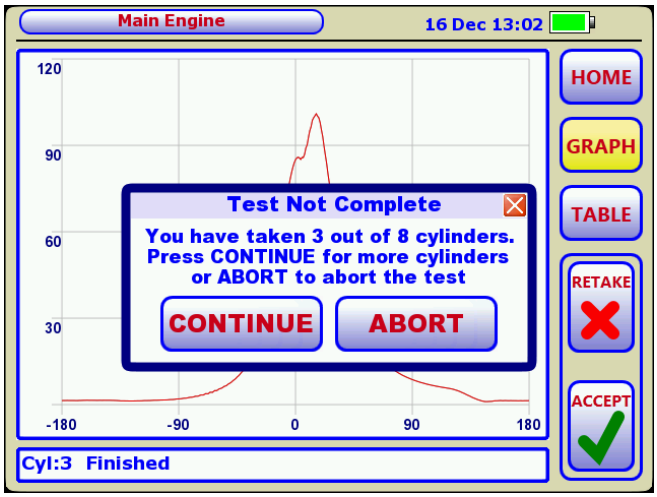


You will see that cylinder 1 is now coloured green to indicate that you have taken that cylinder. If you wish to take a second reading on cylinder 1, you can tap the **PREV** (previous) button and take another measurement (keeping the pressure sensor on cylinder 1, of course).

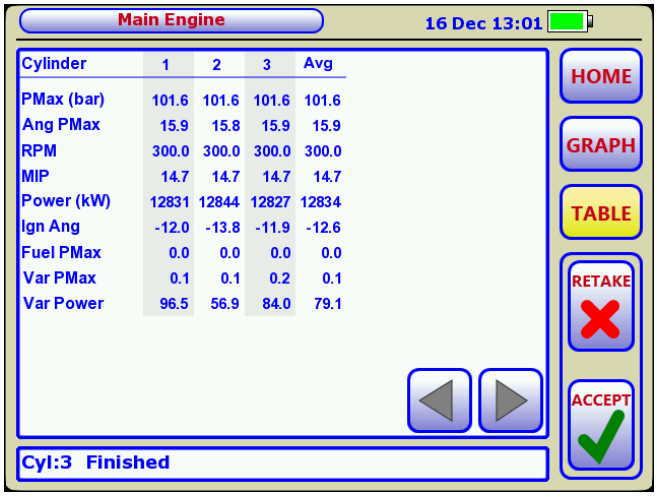
Once you have measured the last cylinder, the following screens will appear, and you can exit the measurement process by pressing **FINISH**.



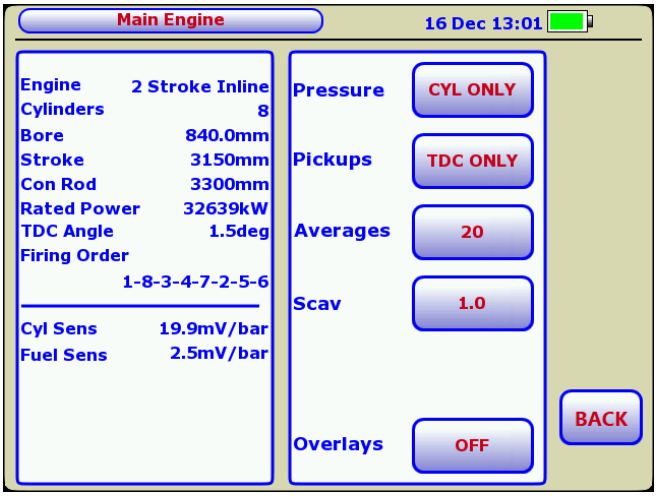
You can interrupt a series of measurements and continue later on or, if you wish, abort the engine test that you are doing. You can do this by tapping **HOME** during the test sequence. The following screen will appear enabling you to continue later or abort the test:



The example so far shows the measurement process looking at the graph at each step. You can also see a table of results by tapping the **TABLE** button. You can swap between graph and table view at virtually any time as indicated by the button text being in red. In the table view, the accumulated average is shown on the right hand column. The table view is shown below:



At any time, you can look at the engine configuration by tapping the engine name in the top left-hand corner. The screen below will appear, and you can tap **BACK** to return to where you were:



Note that, when in the engine configuration screen, you can alter some measurement parameters as highlighted by the buttons with text in red (but you cannot change engine geometry). These will be remembered until over-written by another engine upload. However, note that, once a test sequence has been started (eg. cylinder 1 has been read), no changes can be made to these settings.

The measurement parameters that can be changed are as follows:

The *Pressure* button selects between Cylinder Pressure (*CYL ONLY*) and Cylinder Pressure plus Fuel Pressure (*CYL & FUEL*) measurement. For a DK-20 it will always be set to *CYL ONLY*. For a DK-20/FV it can be selected to either *CYL ONLY* or *CYL & FUEL*.

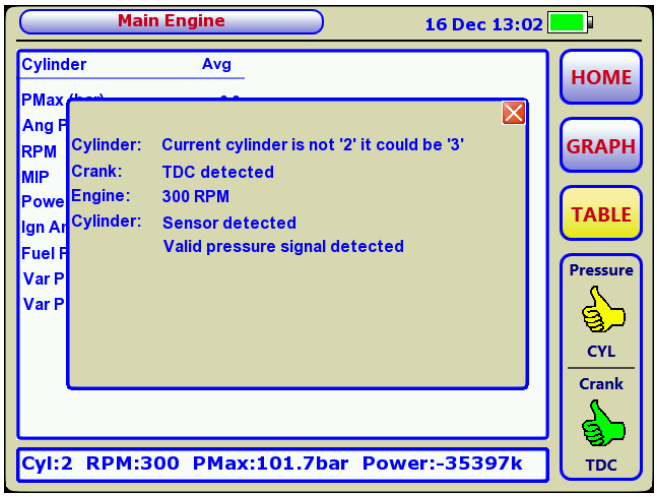
The *Pickups* button selects between *TDC ONLY* (single pickup), *DUAL* (two pickups) and *AUTO* (the DK-20 will automatically detect which mode, *TDC ONLY* or *DUAL*, is being used).

The *Averages* button allows selection of the number of averages for each sample that are taken during a reading. The default number is 20 for 2-stroke engines and 40 for 4-stroke engines. It is recommended that these values be used unless there is something specific about the engine that requires a higher number of averages.

The *Scav* button allows manual entry of the scavenge (boost) pressure. This number is usually entered before starting a test but, if necessary, can be modified here.

The *Overlays* button at the bottom of the screen enables the option of viewing multiple cylinder graphs when taking tests to be turned on and off. When off, only the current cylinder trace is shown. When on, the other cylinder traces are shown in grey.

At any time, you can tap on the *Pressure* and *Crank* windows to see a summary of what the DK-20 has automatically detected. The screen below shows an example of being on the wrong cylinder, but everything else being correct:



2.3 Problem Detection

The DK-20 incorporates a number of checks to ensure that good data is measured at the engine. If a reason for a potential erroneous measurement is detected, the operator is automatically alerted.

There are two thumbs on the lower right-hand side of the display, one marked *Pressure* and the other marked *Crank*. When the thumbs are both green, it means that the pressure and crank signals detected are good. The **GO** button will be solid green to indicate that it can be pressed and a good reading is expected.

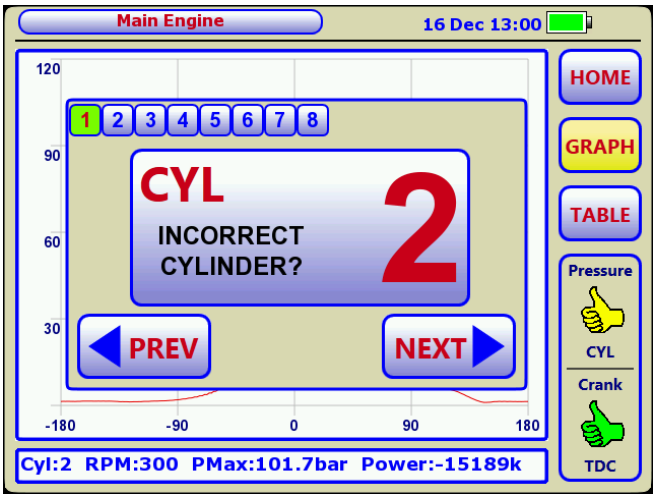
If either thumb is yellow, it means that a potential problem has been detected, but the measurement is still allowed. The **GO** button is green but blinks intermittently to alert the operator.

If either thumb is red, no measurement is permitted and the **GO** button is off.

Details of what problems can be detected and how to remedy them are shown below. At any time, you can tap on the thumb panel and a pop-up screen will appear with further details of the fault detected.

Incorrect Cylinder (Pressure Thumb Yellow)

If your pressure sensor is on the wrong cylinder (in this example, cylinder 1 was measured but the operator forgot to move the pressure sensor on to cylinder 2), the screen below would appear indicating that you might be on the incorrect cylinder. The Pressure thumb is coloured yellow.



Remedy: move the pressure sensor to the correct cylinder. Note that incorrect cylinder detection is only enabled once a TDC adjustment has been carried out on the engine. This is to avoid incorrect alarming before the offset has been correctly set.

Low Pressure Detected (Pressure Thumb Yellow)

If the instrument detects pressure below 10 bar (150psi), it flags low pressure by turning the Pressure thumb yellow. This is usually caused by the indicator cock not being opened or blocked.

Remedy: open indicator cock, blow out indicator cock passage or possibly change indicator cock. If the same problem occurs on other cylinders, check the pressure sensor.

Crank Pulse Variation High (Crank Thumb Yellow)

A variation in pulse repetition rate from one or both of the inductive pickups has been detected.

Remedy: check gap(s) between pickup(s) and marker(s).

Pressure Bias Voltage Fail (Pressure Thumb Red)

This indicates a problem with the pressure sensor and a good reading is unlikely. Tap the thumbs panel to see if a short or open circuit is detected. An open circuit usually means that the cable is damage.

Remedy: check pressure sensor and cable.

No Crank Pulses Detected (Crank Thumb Red)

No crank pulses have been detected so a measurement is not possible.

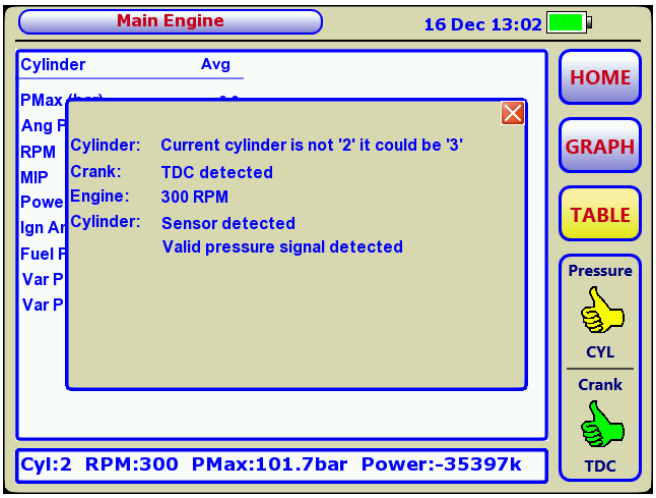
Remedy: check crank interface cable, junction boxes and inductive pickup(s).

Engine Too Fast/Slow

An attempt has been made to take measurements on an engine where the pulse rate from one or both of the inductive pickups is out of the range of the instrument.

Remedy: check that engine speed is within range, check pickups.

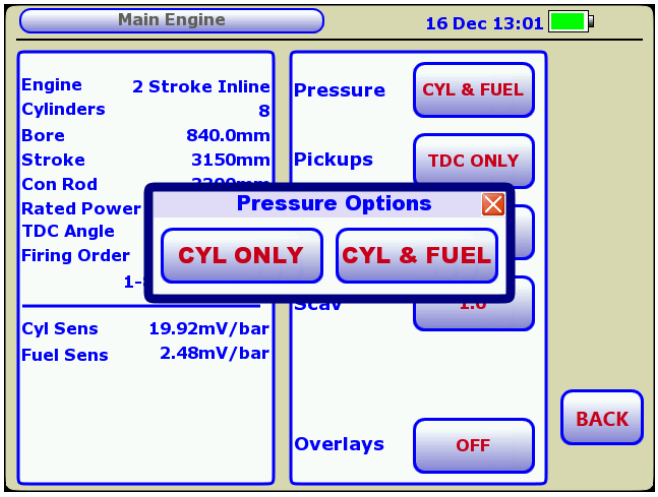
Remember that you can tap on the thumbs panel at any time for more details of a problem detected. A screen similar to the one below will appear.



2.4 Taking Measurements with DK-20/FV

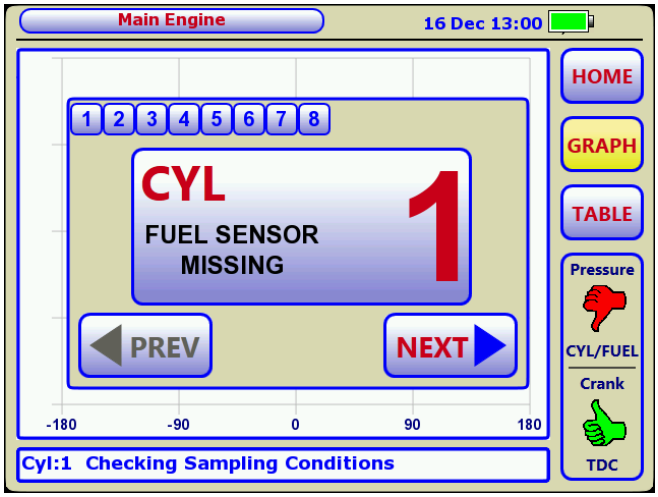
The DK-20/FV can measure either cylinder pressure only or cylinder pressure plus fuel pressure simultaneously. Fuel pressure cannot be measured on its own. If the Icon Setup service has been provided then the DK-20/FV will automatically have been loaded with an engine configuration including Fuel Pressure. If the setup service has not been provided then the setup should be undertaken as instructed in the *Doctor Version 6 Software Step by Step Guide*.

The default selection for a DK-20/FV is to take both cylinder and fuel pressure. The choice of cylinder pressure only and cylinder pressure plus fuel can be made by selecting the engine on the DK-20 screen and pressing the FUEL button, then select CYL for cylinder pressure only or FUEL for cylinder plus fuel pressure measurements.



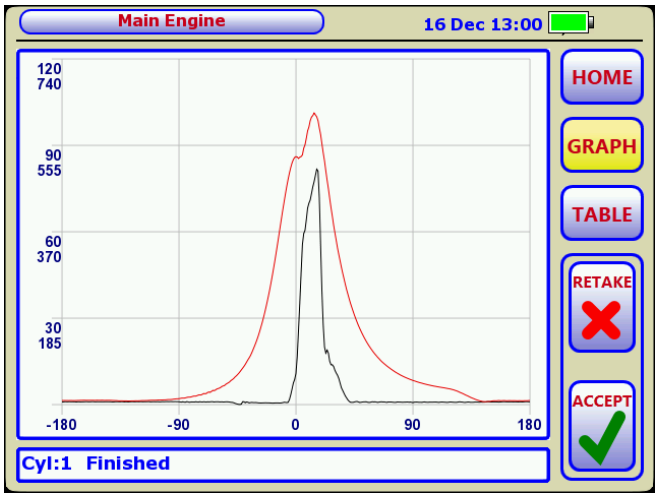
The measurement process can now proceed as per section 2.1

The DK-20/FV will provide appropriate warnings if cylinder or fuel pressure signals are too low or missing as per the example below:



More details of the problem can be viewed by selecting the appropriate Pressure or Crank windows.

After a valid reading is made both cylinder plus fuel traces will be shown on the DK-20/FV screen.



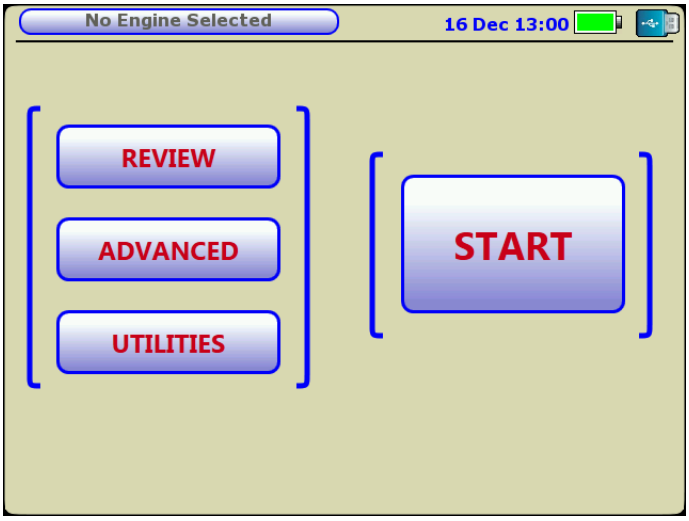
2.5 Downloading Tests from the DK-20

Once you have taken some tests, you can download them into your computer.

Connect the USB cable between the DK-20 and your computer. The DK-20 Connection window will appear momentarily. At this point, the *yellow box* symbol in the PC analysis software will go from grey to yellow. Click on the yellow box symbol on the computer and you will see a USB symbol in the top right-hand side of the DK-20 screen, as shown below. This means that data is

being successfully transferred between the DK-20 and the computer. Note that you do not have to tap any buttons or interact with the DK-20 while the USB cable is connected.

Refer to the Doctor software user guide for transferring tests into your library. This is accomplished by simple drag-and drop operations.



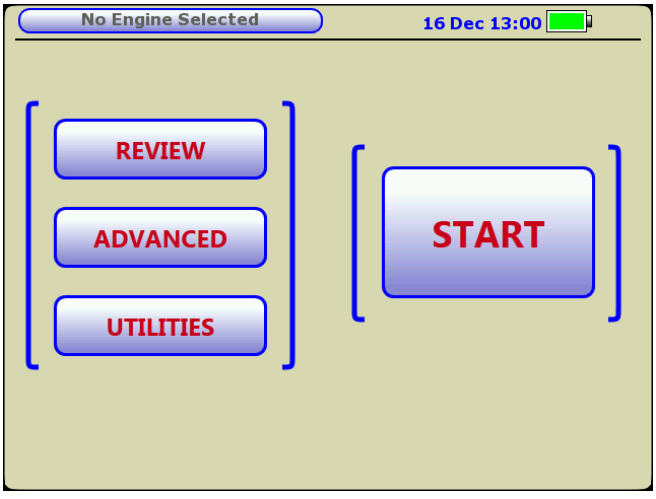
2.6 Deleting Tests from the DK-20

Once you have downloaded a test, you can delete it from the DK-20 through the Doctor software. Refer to the Doctor software user guide for details.

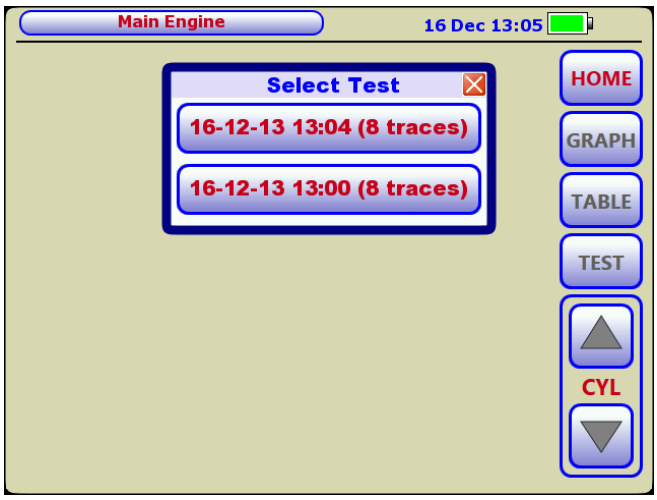
You can also delete all measurements and all engines from the DK-20 using the CLEAR MEASUREMENTS and CLEAR ALL commands in the UTILITIES menu. These should only be used to clear out data from the instrument. Refer to section 2.7 for details.

2.7 Reviewing Data

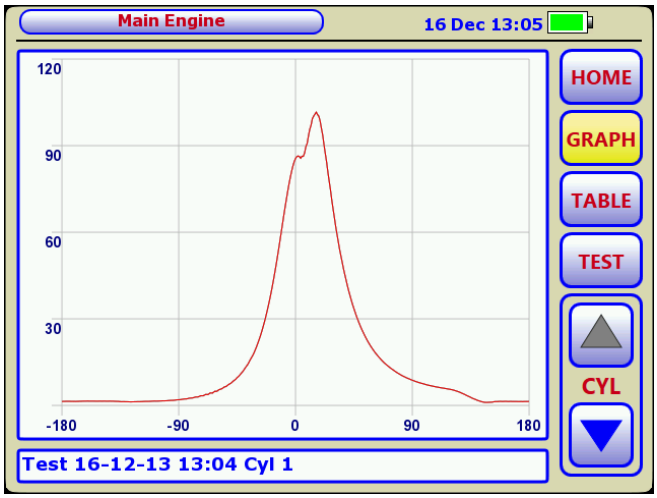
Tapping **REVIEW** in the *Home* screen enables you to look at the measurements you have just taken, together with any other measurements still stored in the DK-20.

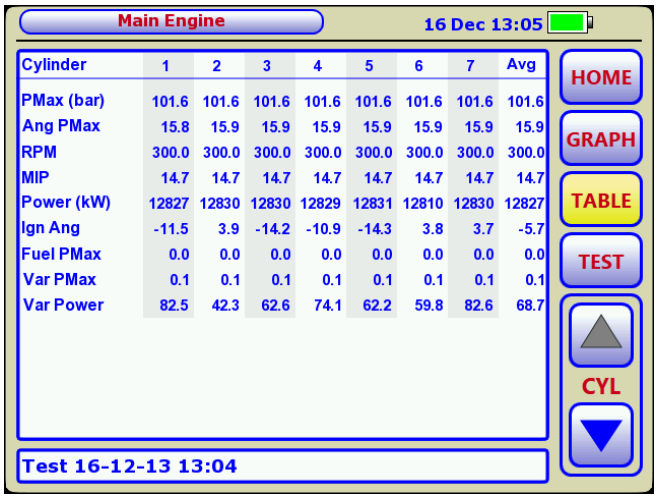


If there are more than one set of tests in the instrument, you can select the set that you wish to review by tapping on the appropriate button in the list.



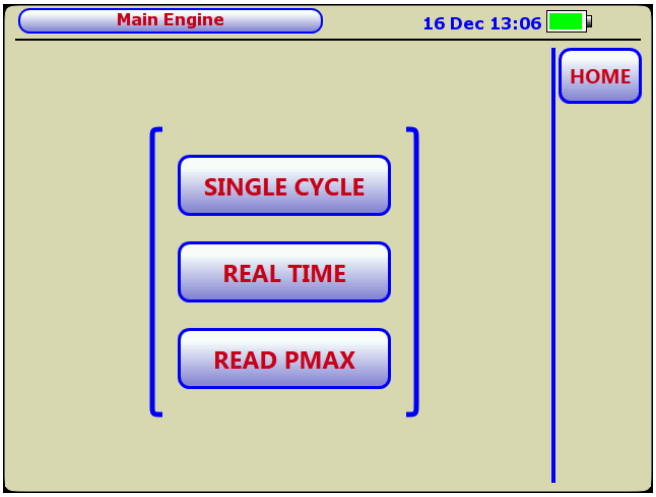
Measurements can be reviewed in both graph and table formats. The screen below shows graphs being reviewed. The up and down arrows scroll through the cylinders. Tap **TABLE** to see the table view of all cylinders.



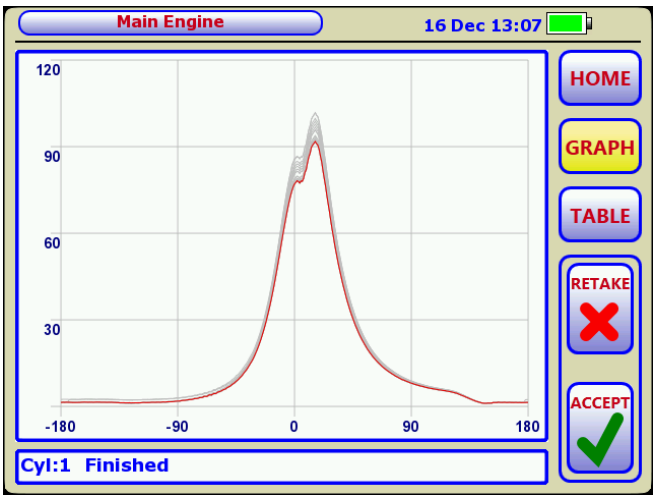


2.8 Advanced Measurement Modes

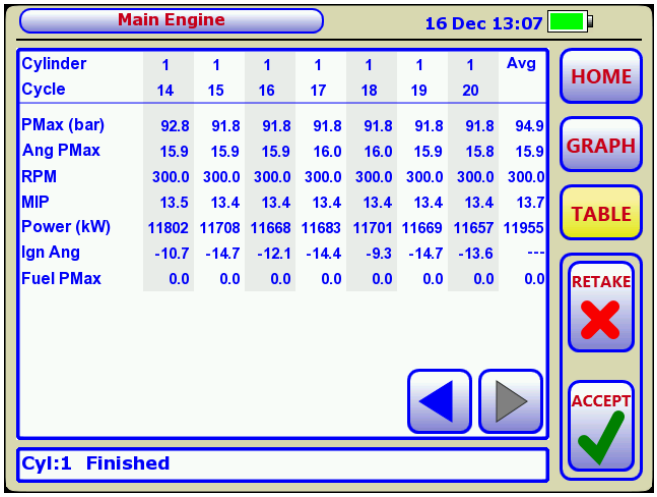
Tapping **ADVANCED** in the *Home* screen enables other measurement modes as shown below:



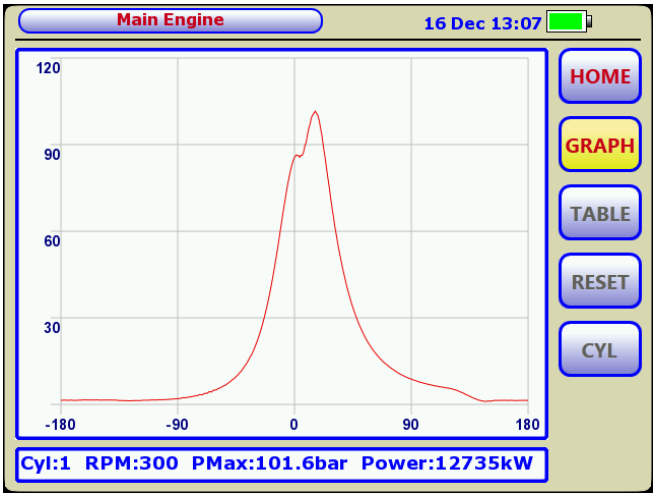
Tapping **SINGLE CYCLE** takes a number of single cycle measurements equal in number to the number of Averages. The screen below shows a single cycle series in graph view:



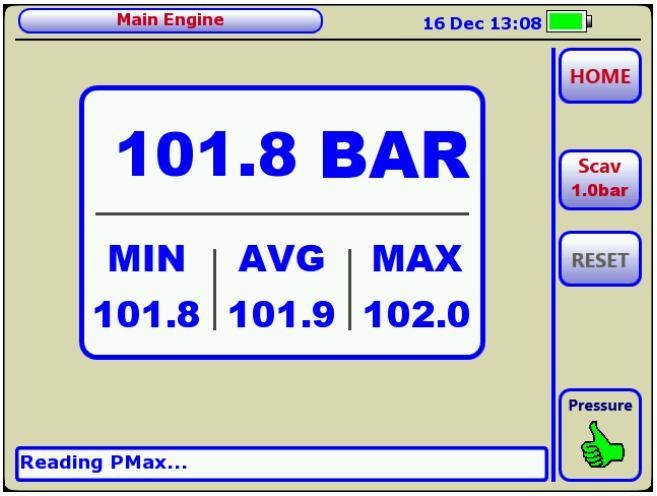
A series of single cycle measurements can also be viewed in table view as shown below:



Tapping **REAL TIME** shows a real-time update of cylinder pressure on the screen of the DK-20. The screen below shows a typical display:

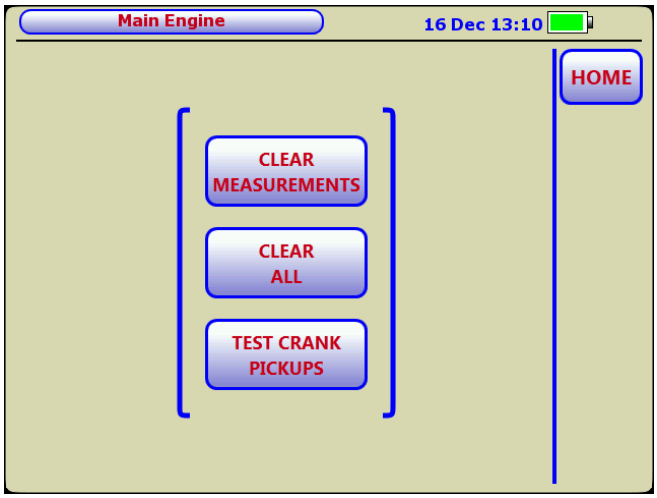


Tapping **READ PMAX** shows maximum cylinder pressure with min, max and average as shown in the screen below. A crank input is not required for *Read Pmax* mode.

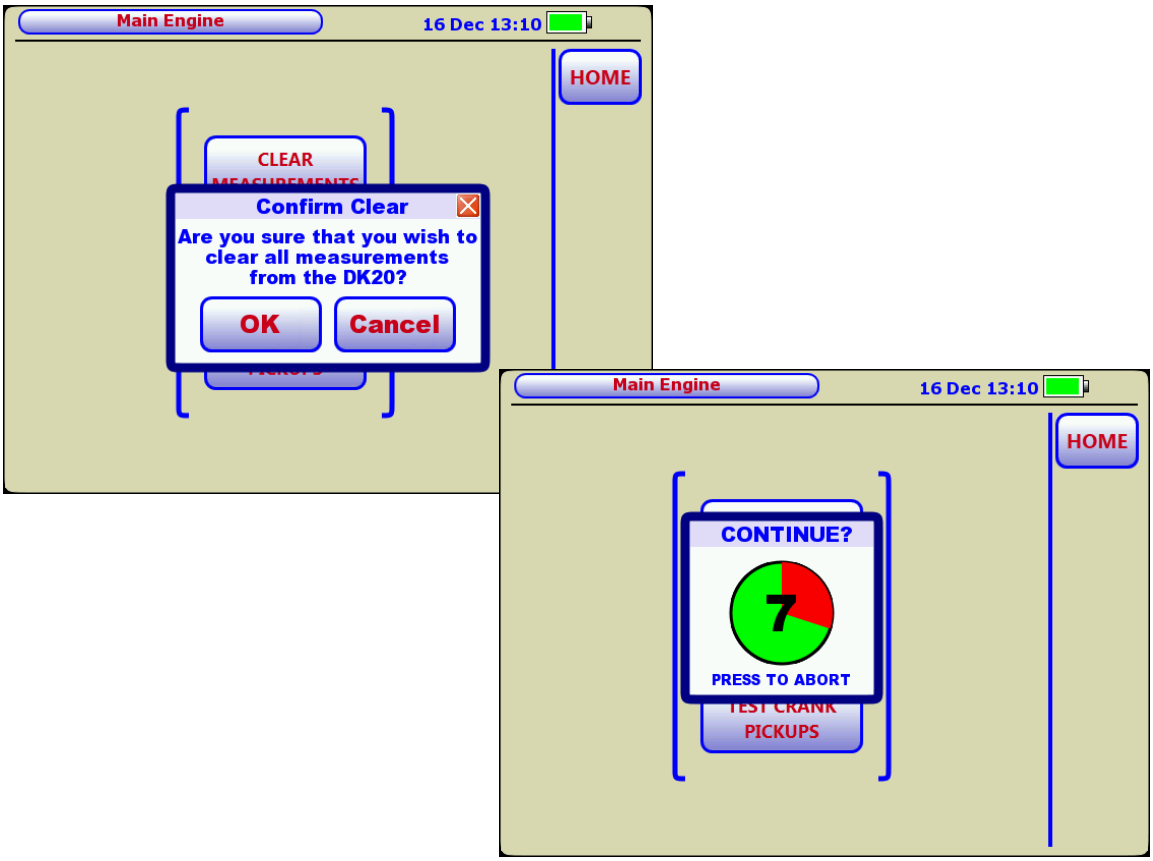


2.9 Clearing Measurement and Engine Data

Tapping **UTILITIES** in the *Home* screen brings up the screen below:

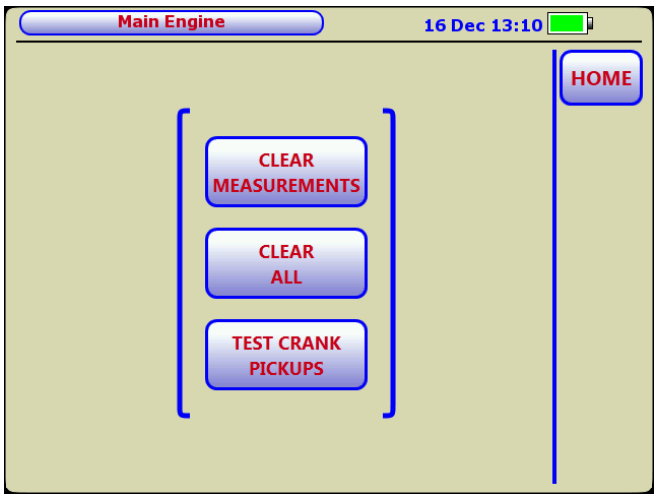


Tapping **CLEAR MEASUREMENTS** deletes all measurement data from the DK-20 while maintaining the engines that have been uploaded. Tapping **CLEAR ALL** deletes measurement and engine data, thereby totally clearing the instrument. You will be asked to confirm the operation you have selected as in the screen below. A further ten second timer as shown in the next screenshot is incorporated in case you change your mind as the clear measurements and clear all operations are irreversible.

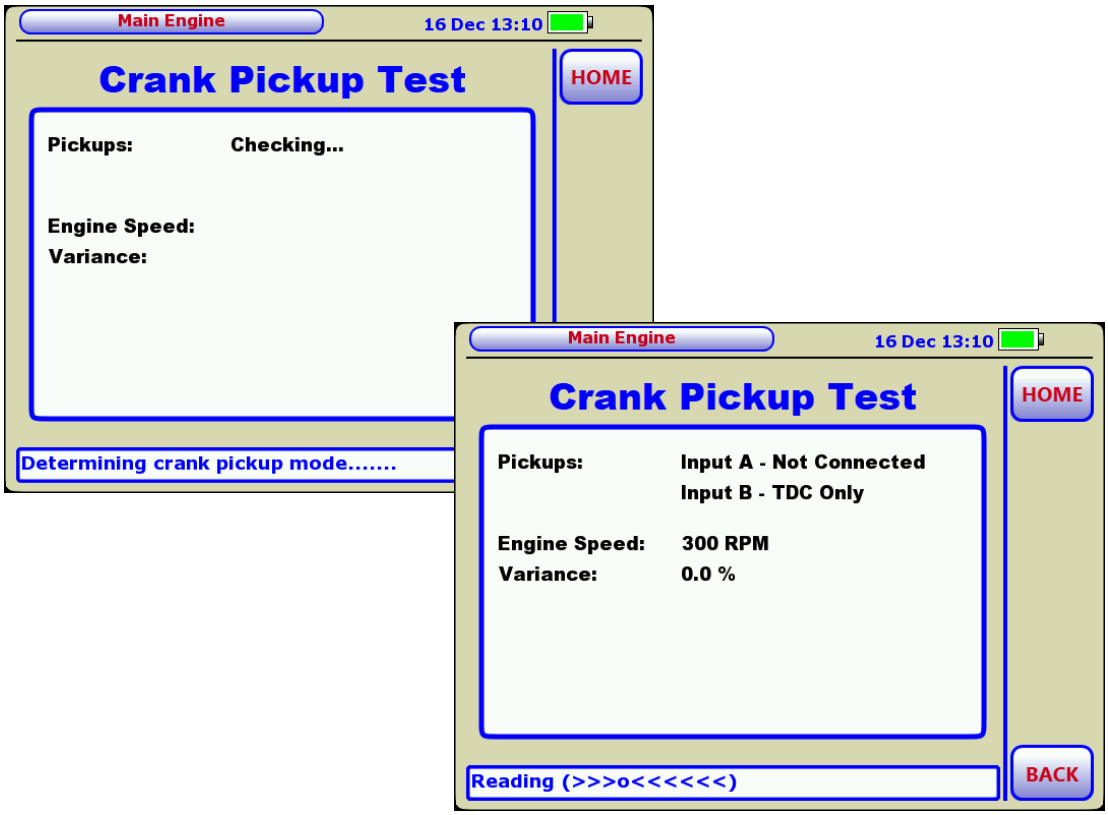


2.10 Testing Crank Pickups

Tapping **UTILITIES** in the *Home* screen brings up the screen below:



Tapping **TEST CRANK PICKUPS** checks the pickups, both FLY and TDC ONLY, that are connected to the DK-20. The screens below show an example check sequence. First, the instrument checks what pickups are connected and then displays the result of its checks. Note that the DK-20 auto-senses TDC and FLY pulses, so it does not matter if these have been swapped. The *Variance* indicates the jitter between pickup pulses as a percentage.



Chapter 3 – Installation

3.1 Introduction

Operation of the Doctor system requires two signal inputs, namely an analog signal from a pressure sensor and digital synchronisation pulses from pickups on the shaft or flywheel.

The pressure signal is obtained by moving the pressure sensor from cylinder to cylinder and connecting via the indicator cock.

Crank synchronisation pulses are usually obtained from an inductive pickup in close proximity to a marker which is attached to the shaft or flywheel. It is possible to use an optical pickup in place of an inductive pickup (refer to the section on optical pickups later). It is also possible to fit a second pickup to monitor the teeth on the flywheel. This provides more accurate synchronisation during each revolution of the engine.

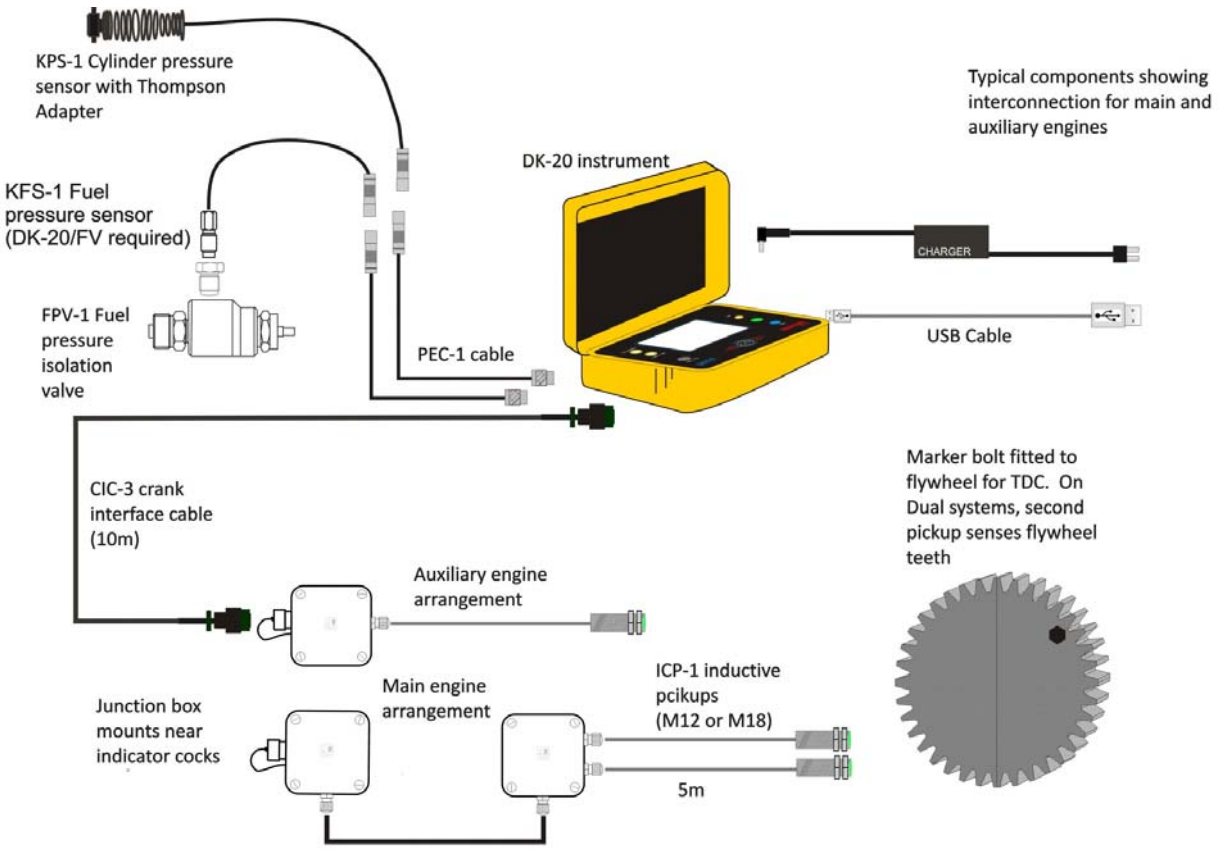
Medium speed auxiliary engines typically require a single pickup to sense a once-per-rev marker attached to the shaft or flywheel. This is called TDC ONLY mode. In this single flywheel pickup arrangement, each rev is divided into small equal intervals. For example, to achieve a resolution of 0.1°, each rev is divided by 3600. In TDC ONLY mode the single pickup is used in a conjunction with a marker (usually a metal bolt) that is attached to the flywheel or shaft of the engine

For higher accuracy on 2-stroke engines where the speed can vary slightly during each rev, a second pickup senses the flywheel teeth in addition to the TDC pickup. This is called DUAL mode. Each tooth provides a secondary reference and tracks the speed of the shaft more accurately. This arrangement is most effective when an engine is driving the propeller directly. DUAL mode increases overall accuracy on slow speed engines, resulting in more accurate power figures. Since the second pickup in a DUAL system is used to monitor the teeth on the flywheel, no additional marker is required for the second pickup.

For inductive systems the marker and pickups are permanently installed and the signal cabling is terminated in a local junction box. Therefore the installation requirements are:

1) Attach a single marker bolt to the flywheel for TDC pickup.
2) Fit one (TDC ONLY mode) or two (DUAL mode) pickups.
3) Fit the required junction boxes to each engine.

The diagram below shows the general arrangement for DK-20 interconnection with inductive pickups.



Several junction box configurations are available to suit different engine types (TDC ONLY or DUAL pickup modes, in-line or V-engine etc). The junction boxes and interconnecting cables compatible with your engines will have been supplied with your system. Note that no external power is required for the inductive pickups – they are powered directly from the DK-20 instrument when it is connected.

As mentioned earlier, there are two main types of pickup used, inductive and optical, as described below.

Inductive Pickups

Inductive pickups are immune to oil and dirt and are used for longer term regular measurement of engines. They sense the presence of metal, and a bolt is normally used as the reference for TDC ONLY systems. DUAL systems use a bolt for the TDC reference and the flywheel teeth as the secondary reference. The permanent fixing of these pickups ensures a consistent reference to flywheel position.

Different sizes of pickup are available to suit a particular size of engine, together with junction box alternatives to suit engine configuration. The table below shows typical configurations:

	Medium Speed		Slow Speed
	In-Line	**V- Config**	**In-Line**
Mode	TDC ONLY	TDC ONLY	DUAL
No of Pickups	1 x M12	1 x M12	2 x M18
Junction Box Config	JB-E	JB-C	JB-B

A configuration diagram and wiring schedule is included with the junction box(es) that have been delivered with your system to suit your engines.

Optical Pickups

An optical pickup is used for maximum portability and is easily moved from engine to engine. This arrangement is mostly used for service work and is not recommended for permanent or long-term installation. An optical pickup uses a signal reflected back by a piece of reflective tape attached to the flywheel. With these pickups, the reference angle may need to be adjusted for each set of readings if the pickup is positioned differently or if the reflective tape needs to be replaced. The sensitivity of the optical pickups may be adjusted by turning a screw mounted on the back of the pickup.

Both types of pickup are powered by the Doctor instrument when connected and the instrument is switched on. There is a LED indicator on the rear of each pickup that illuminates when it is powered and the target is within range.

3.2 Inductive Pickup Installation

Firstly a marker bolt needs to be attached to the flywheel that will line up with the TDC inductive pickup. This can either be done by tapping a screw hole or by bonding the marker to the flywheel. In either case the marker must be securely attached such that it cannot fall off in operation. Also ensure that any irregularities on the surface of the marker bolt (such as embossed text) are filed off. As the inductive pickup passes the marker it generates an electrical pulse from which the rpm of the engine can be measured.

Installation of inductive pickups requires fitting of two items, namely the pickups themselves and the junction box(es). Once these are mounted, the inductive pickups are wired into the junction box. **Wiring diagrams and physical dimensions for the junction box configuration(s) you have ordered are supplied with your system – refer to these documents for details.**

Select suitable locations for the pickup bracketing and junction box mounting. The total length of the cable fitted to the inductive pickup is 5m. Various mounting methods for inductive pickups, together with gap settings are described in this chapter.

Mounting of pickups to a flywheel guard or any other part of the engine which is vibrating should be avoided as the gap between pickup and marker will vary potentially causing erroneous readings.

Junction Box Installation

The junction box(es) can be fitted virtually anywhere, provided that they are easily accessible for connection of the CIC-3 cable from the instrument, and are within 5m of the inductive pickup(s). The picture below shows a typical installation.

TDC ONLY pickup

This section describes installation of a single pickup for TDC ONLY operation.

The inductive pickups used have a threaded body and two securing nuts. The thread pitch is 1mm on the pickups irrespective of diameter. A typical pickup of 12mm diameter is shown in the photo below.

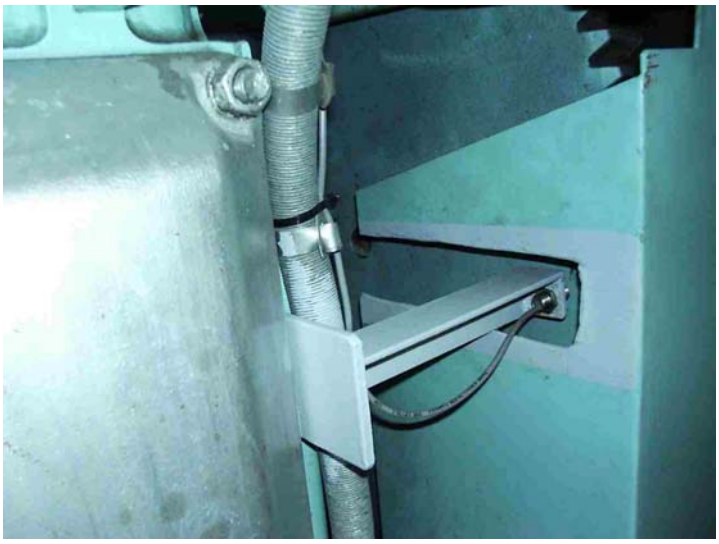
The pickup has a LED indicator on the rear of the body which will illuminate when the pickup is connected to the Doctor instrument and when metal is within the sensing range.

For TDC ONLY operation, the pickup must sense a single marker on the flywheel. This may be positioned either axially or radially.

The optimum sensing gaps and target sizes are shown in the table below.

Pickup Size	Ideal Gap (range)	Min Target Diameter	Min Target Height	Mounting Torque
M18	3mm (2-8mm)	20mm	8mm	18 Nm
M12	2mm (1-4mm)	15mm	5mm	12 Nm
M8	1mm (0.5- 3mm)	12mm	3mm	8 Nm

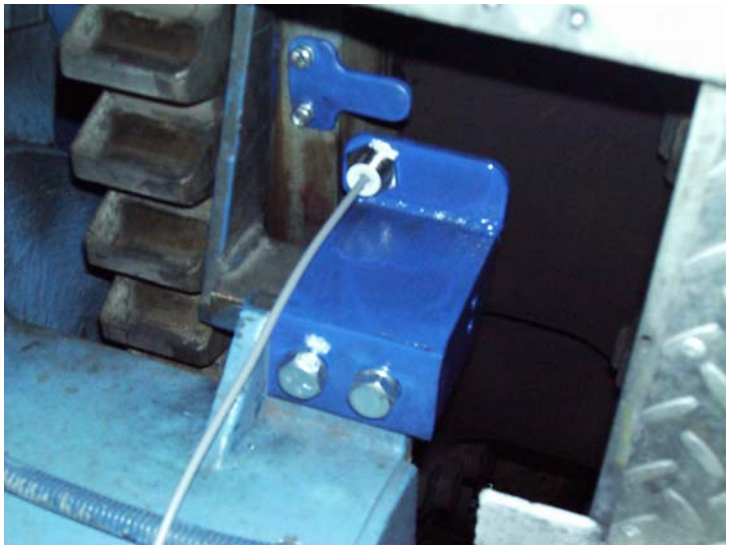
The pickup should be mounted on a sturdy bracket, ideally attached to the engine structure. In some cases it is acceptable to use the flywheel guard as a mount for the pickup. Do not overtighten the nuts on the pickup casing – the casing is thin and overtightening may fracture the outer threaded sleeve. Some examples of installations are shown below. Note that Icon Research does not supply brackets due to the large variation in engine mounting options.



Typical installation showing a sturdy bracket attached to the engine. The marker bolt in the flywheel is not visible here.

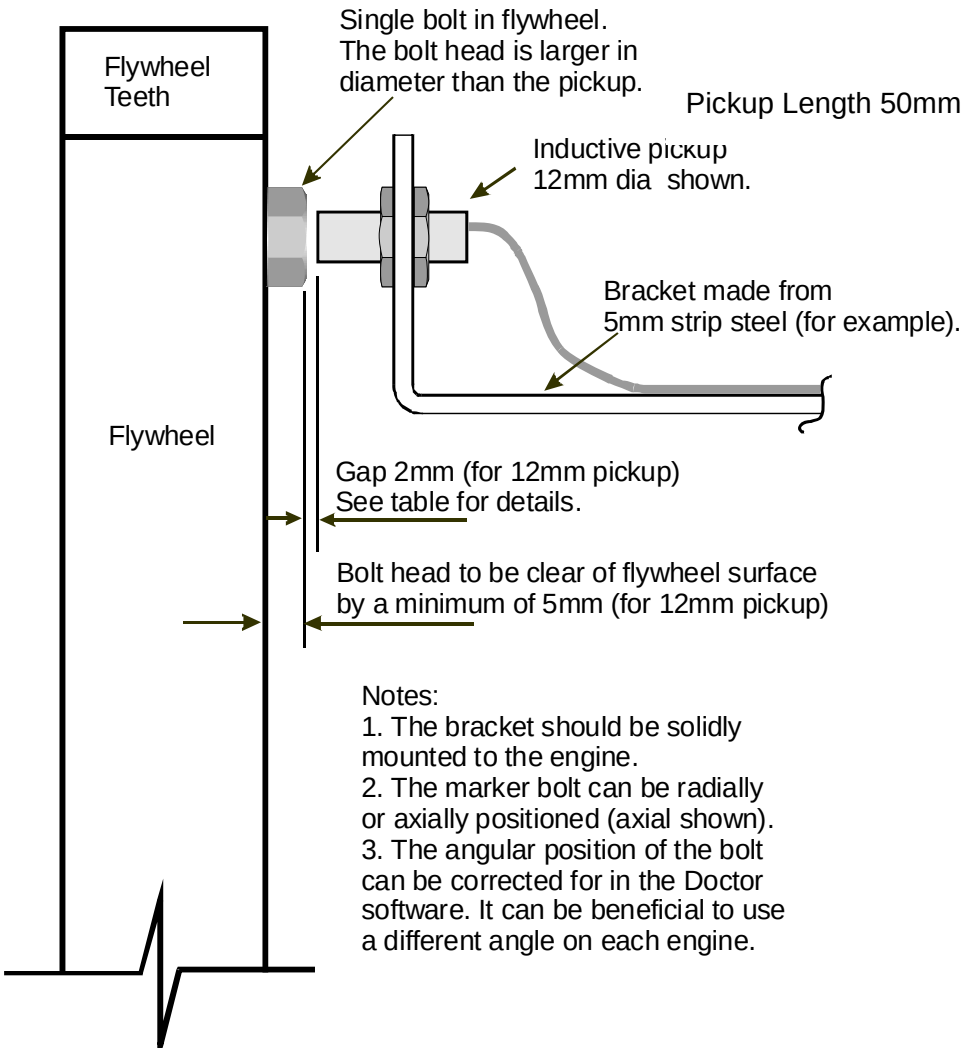
In this example, the marker bolt in the flywheel is clearly visible next to the inductive pickup.

Here is an example of an inductive pickup that has been fitted directly to the flywheel guard. This method is often used on smaller engines. The guard must be of the type that is rigidly attached to the engine.



In this case, it was not convenient to put a target bolt in the flywheel so a marker tab was attached instead. Any metal marker may be used - it does not necessarily have to be a bolt.

Shown below is a schematic, outlining the basic dimensions for a TDC ONLY axial pickup installation using a 12mm pickup. For 18mm pickups, refer to the previous table.



DUAL pickups

When DUAL pickups are used, one of the pickups senses the flywheel teeth, the other senses a single marker on the flywheel. This single marker is normally a bolt head of larger size than the pickup.

DUAL pickups are used to minimise the effect of small variations in speed during each rev of the engine. By sensing each tooth position, the Doctor is able to track these speed variations and compensate for the small changes in speed.

The Doctor automatically counts the flywheel teeth for you - there is no need to count them.

Normally, 18mm diameter pickups (M18) are supplied for DUAL pickup installation. This type of set-up is used mainly on 2-stroke engines.

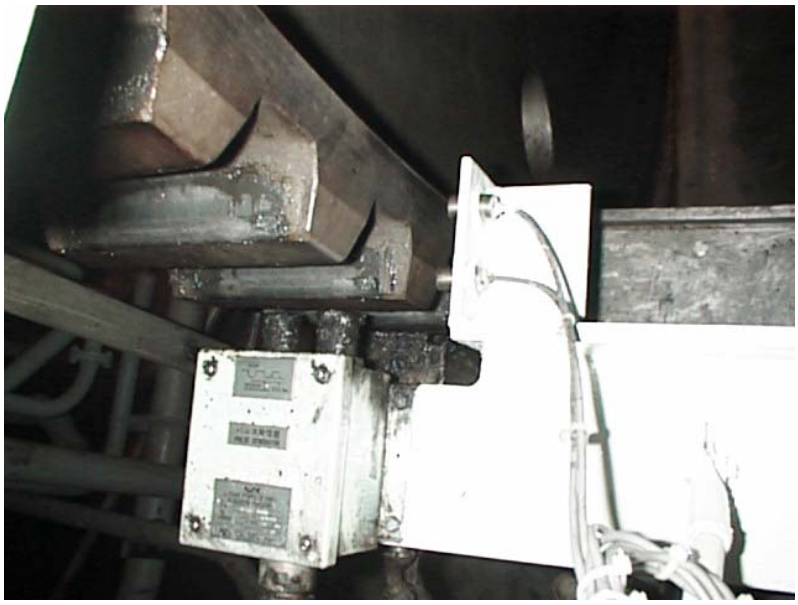
The gap settings and target sizes required for the pickups are shown below:

Pickup Size	Ideal Gap (range)	Min Target Diameter	Min Target Height	Mounting Torque
M18	3mm (2-8mm)	20mm	8mm	18 Nm
M12	2mm (1-4mm)	15mm	5mm	12 Nm
M8	1mm (0.5- 3mm)	12mm	3mm	8 Nm

The pickups should be positioned at least 50mm apart to avoid the risk of cross talk between them.

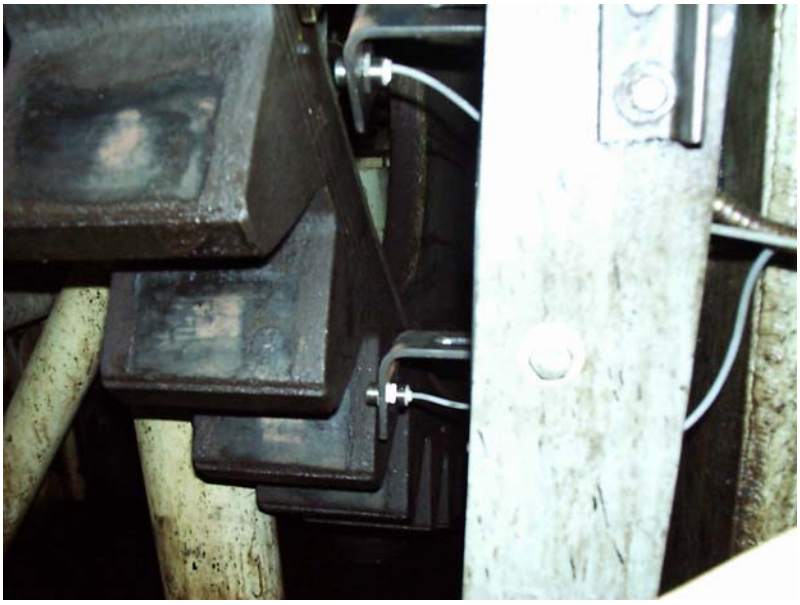
The flywheel teeth pitch should be at least 5 times the diameter of the pickup used.

Some examples of typical installations are shown below.

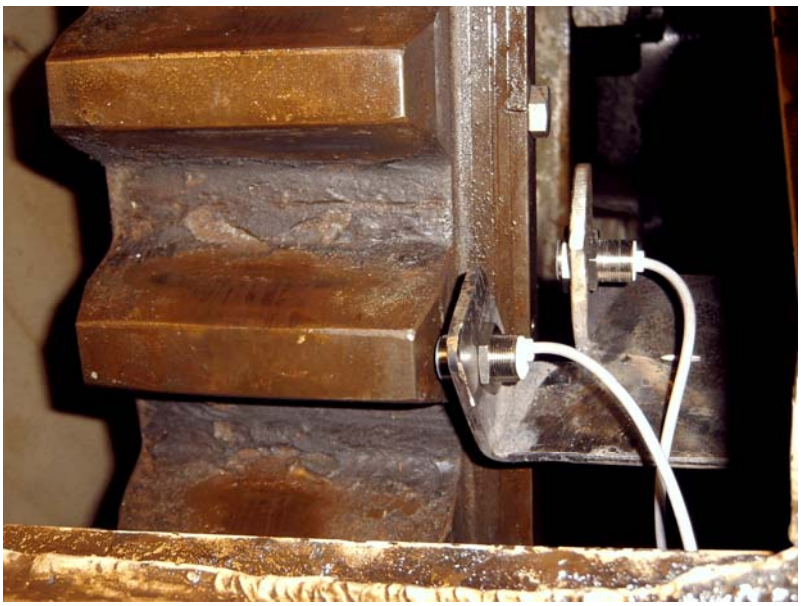


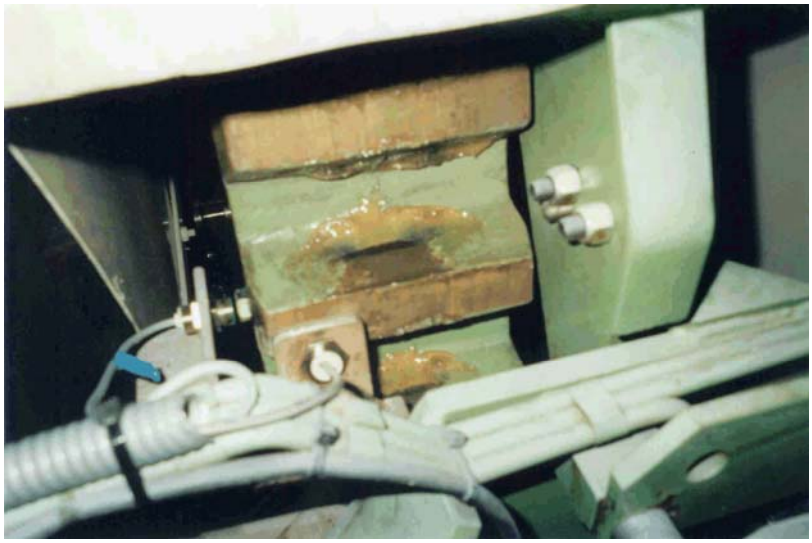
Here a single bracket supports both pickups.

In this case, two brackets have been used, one for each pickup.



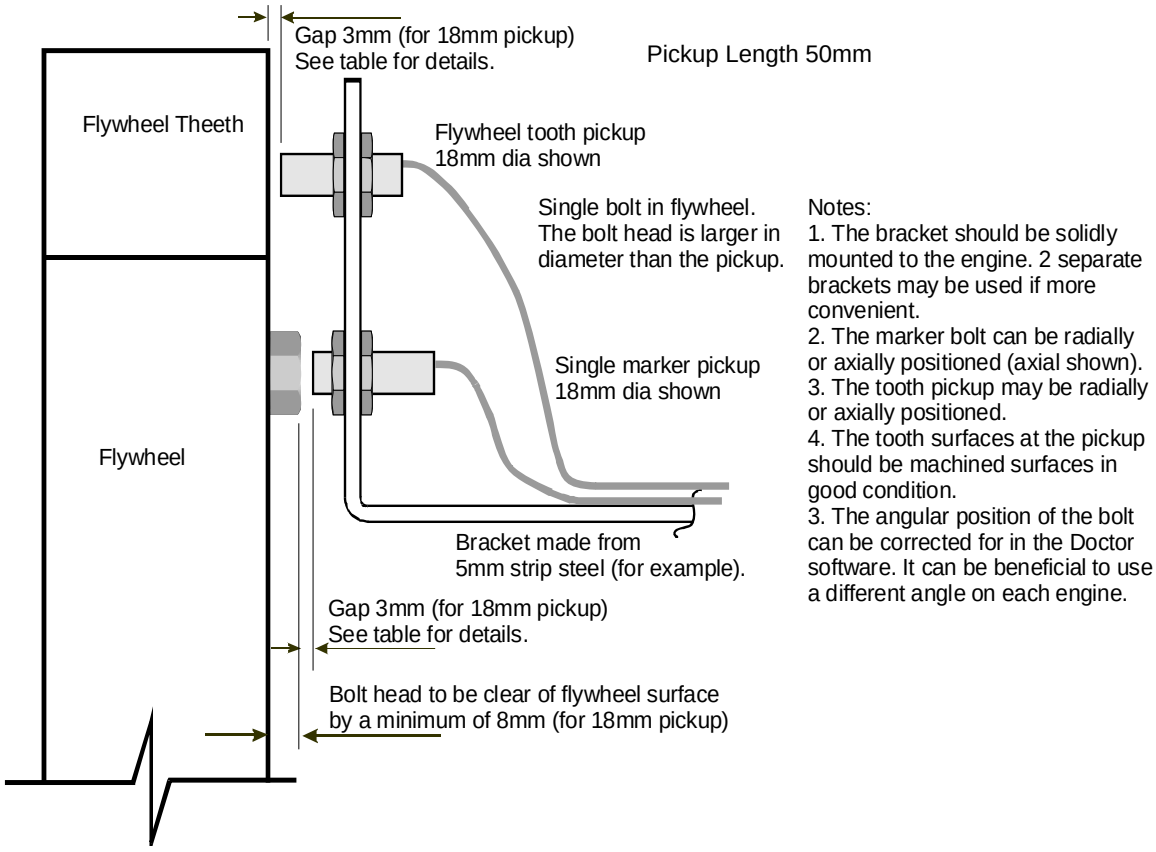
This installation used a single bracket that was split at the end to position the pickups. The marker bolt can be seen screwed into the flywheel just above the TDC pickup (upper in picture).





The tooth pickup can be either axial or radial. In this illustration, the FLY pickup is in the radial direction.

The schematic below shows a typical installation of DUAL pickups using a single bracket.



3.3 Performance of Inductive Pickups

Inductive pickups have a maximum frequency at which they can trigger. This is no problem for TDC pickups but can become important on flywheel teeth.

The required frequency for an engine can be calculated by the following formula:

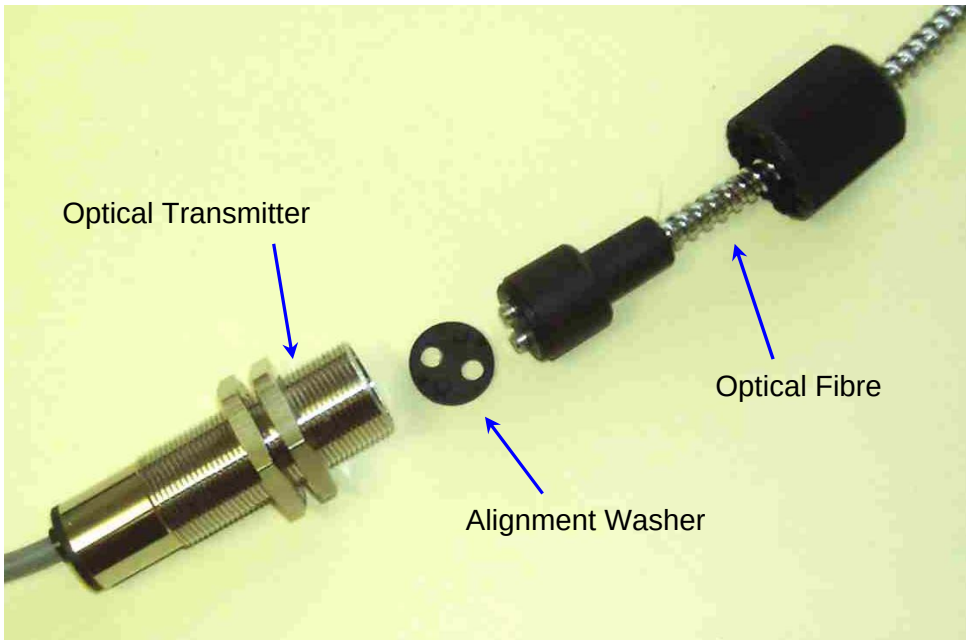
Frequency (kHz) = No of teeth on flywheel x RPM/60000

The frequency capabilities of the available pickups are:

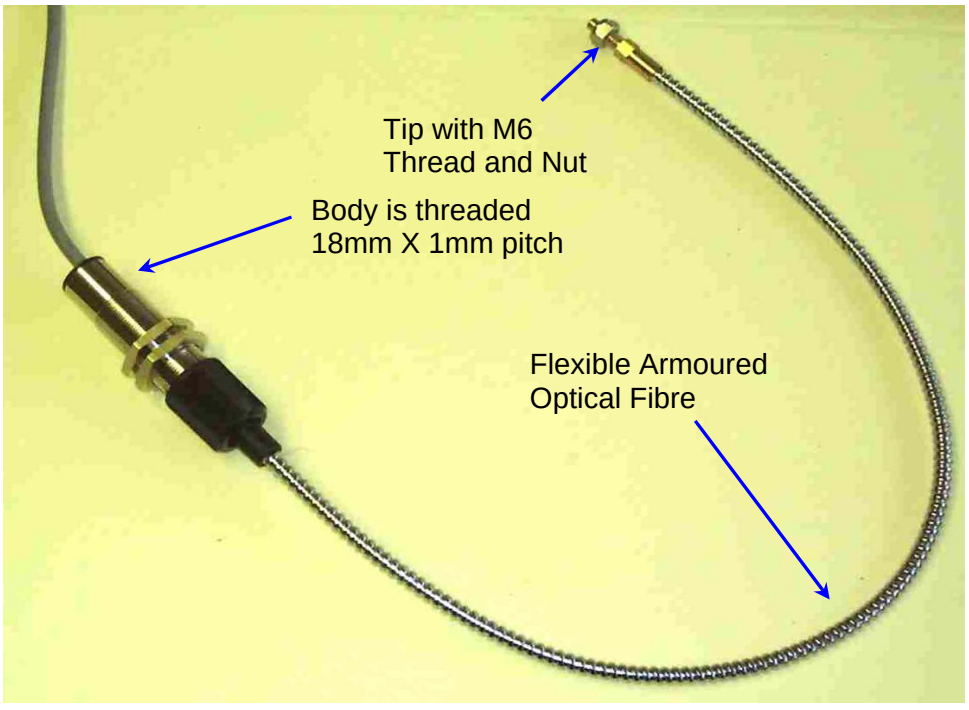
Pickup Diameter	Max Frequency
18mm	1kHz
12mm	2kHz
8mm	5kHz

3.4 Optical Pickup Installation

The optical pickup has two main parts – the optical transmitter (OCP-2) and the optical fibre (OFE-1). There is an alignment washer between the two parts; this is glued in position by Icon to prevent it being lost.



The picture below shows the flexible armoured optical fibre. The unit is normally kept assembled.



Optical pickups should be firmly held in place with a bracket. The distance from the optical fibre tip to the target tape should be as in the following table.

Optical Pickup Configuration	Minimum Separation	Maximum Separation
With Optical Fibre Extension	25mm	120mm
Without Optical Fibre Extension	50mm	250mm

It is recommended that the optical fibre extension is always used as the installation is then not sensitive to the orientation of the device. If only the main body of the optical pickup is used, the two lenses in the end of the body should always be kept in the same orientation relative to the flywheel for each set of readings.

In the installation above, the optical fibre is held in a small bracket that is clamped with a G-clamp to the flywheel housing. The gap where the engine's TDC sensor is placed has been used in this case. Axial or radial installation will work equally well. The reflective tape can be clearly seen on the flywheel, just under the end of the optical fibre.

In some installations, engines have the optical fibre extension mounted permanently on each engine (usually on the auxiliaries). In these cases, a bracket should be installed instead of using the clamp in the picture above. The fibre and its connection are then left in place and the main body of the optical pickup attached prior to taking a set of readings.

3.5 Troubleshooting the Crank Pickups

Inductive and optical pickups are fitted with LED's which will operate when the pickup is sensing its target. With the pickup(s) connected to the EPU and the EPU switched on, the first test is with the engine stationary to ensure that the pickups are operating and their LED is illuminated.

Once this has been checked, the next test is with the engine running and using the TEST CRANK PICKUPS function available in UTILITIES on both the DK-20 and DK-2.

The most common faults found are:

TDC Only Operation

RPM is double expected.	Two TDC markers on flywheel
RPM too low or unsteady.	Unreliable signal – check gap, pickup and marker.
RPM too high.	Pickup too close to flywheel.
RPM incorrect (Optical Pickup)	Adjust sensitivity by turning screw mounted on back of optical pickup.

Dual Operation

RPM is double expected.	Two TDC markers on flywheel.
RPM too low or unsteady.	Unreliable signal – check gap, pickup and marker.
RPM too high.	Pickup too close to flywheel.
RPM steady but number of teeth low and or unsteady.	Pickup too far from flywheel teeth. Check that target diameter is machined and there is no run-out on the flywheel.
RPM steady but number of teeth too high and /or unsteady.	Pickup too close to flywheel teeth. Check target diameter is machined and free of burrs or dents.
Max tooth variation > 3% and RPM and No of teeth steady.	Teeth probably worn or damaged – move pickup to a more uniform diameter on teeth or revert to TDC only operation.
RPM correct but tooth reading fails at higher RPM's.	The gap between the tooth readings is insufficient. Move the tooth pickup to a larger diameter where the gaps are larger or use a smaller diameter pickup with a higher response.

CHAPTER 4 - Electrical Connections

4.1 Channel Inputs

The DK-20 has a single pressure input channel and the DK-20/FV has twin channels. The channel inputs are standard TNC connector styles. These are two wire connectors i.e. power/signal and ground.

Each input is a standard ICP transducer type. The signal wire carries a constant 3.6mA which powers the transducer. The transducer outputs a voltage which moves positively and negatively around a quiescent voltage. The quiescent voltage is usually around 9-11V. The transducer power is derived from a 24V supply in the DK-20 which means that large voltage swings can be accommodated.

The voltage derived from the transducer swings around the quiescent voltage. This is then AC coupled to enable the signal to be referenced to ground. To avoid this AC coupling causing offset errors when a dynamic signal is applied, a very long time constant (tens of seconds) is used.

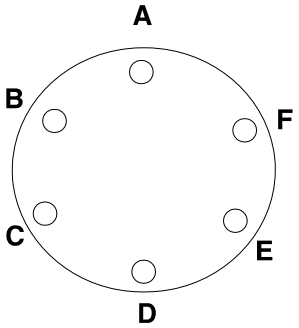
Any ICP transducer compatible with constant current power sources can be used.

Crank Interface

The two crank inputs accept CMOS/TTL (5V) logic inputs. The crank pickups produce these types of signal. If an alternative encoder to the standard pickups is used, then it must produce CMOS/TTL level pulses.

The pin-out of the crank connector is shown below.

Crank Pin-Out



pin A = FLYWHEEL
B = TDC
C = GND
E = 24V POWER

USB

The USB connector on the DK-20 is a standard mini-B socket.

Power

The DK-20 is powered from its internal rechargeable battery pack. The charger supplied can take any input voltage in the range 100 to 240Vac and 50 or 60Hz. Three different types of power cord are supplied, namely UK, US and Euro. These cover virtually any mains source encountered in the world.

The DC output of the charger is rated at 9V, 3A. The connection is shown in the diagram below.

If the charger supplied is lost, it is possible to use a supply as per the above rating and connection to charge the instrument. The dc plug is a standard type, the outer cylinder diameter being 5.5mm and the inner diameter being 2.5mm.

Alternatively, the DK-20 will charge via the USB connector, but at a slower rate.

CHAPTER 5 – Calibration Guidelines

5.1 Calibration Guidelines

There are two items in the Doctor DK system that require periodic calibration, namely the DK instrument itself and the pressure sensor. Icon Research carries out instrument calibrations, whereas the pressure sensor is returned to Kistler, the sensor manufacturer.

Experience in the field over many years has shown that both the instrument and pressure sensor hold their calibration very well. For this reason, the calibration interval can be extended beyond what might be expected for other electronic instruments, especially as the DK instrument and sensor are used relatively infrequently.

Icon suggests that the time interval for calibration of instruments should be two years or greater, depending on usage of the system. Even scheduling calibrations during dry-dockings, which can be several years apart, will often be sufficient.

The pressure sensor maker's recommendation for pressure sensors is to calibrate when operating hours exceed 300. In normal operation this can fit in with dry-docking intervals.

Icon Research recognises that organisations may have their own internal calibration policies, and Icon can provide calibration services as and when requested. Contact the factory for latest pricing and an RMA number (Return Material Authorisation) so that customer equipment can be traced through the calibration handling process.