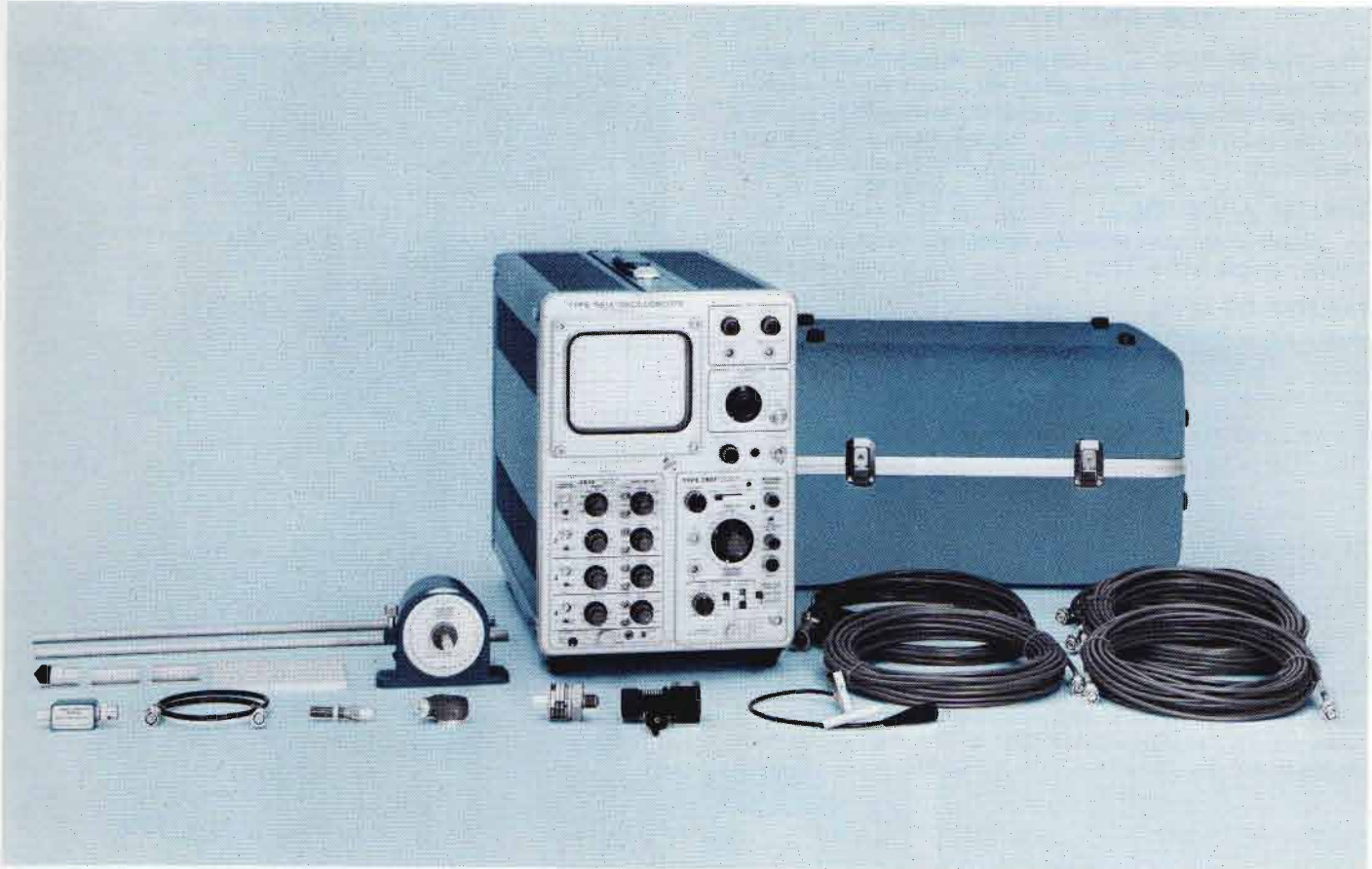




## ENGINE ANALYZER



- **ELIMINATES GUESSWORK**
- **REDUCES MAINTENANCE COSTS**
- **DETECTS MALFUNCTIONS**
  - FAULTY IGNITION**
  - FAULTY VALVES**
  - BLOWBY**
  - DAMAGED RINGS**
  - DAMAGED BEARINGS**
  - DAMAGED CYLINDER LININGS**
- **MEASURE AND DISPLAY**
  - PRESSURE VS VOLUME**
  - PRESSURE VS CRANK ANGLE**
  - PRESSURE VS TIME**
  - ENGINE VIBRATION**
  - ENGINE IGNITION**
- **CRANK-ANGLE MARKERS**

The Tektronix Engine Analyzer is designed to eliminate guesswork in locating possible failures in gas and diesel engines and compressors. The over-all performance of the engine can be determined by measuring engine parameters such as cylinder combustion pressure, vibration, ignition, timing and indicated horsepower. When used in conjunction with a preventive maintenance program, the Engine Analyzer can substantially reduce maintenance costs and increase engine and compressor life and efficiency.

The Engine Analyzer detects and locates malfunctions such as faulty ignition, timing, faulty valves, blowby, and broken or frozen piston rings. Damaged bearings, low compression pressures and other failures that impair the performance of the engine are also indicated on the oscilloscope. With the use of the Rotational Function Generator and pressure transducer, the engine horsepower can be calculated.

The Tektronix Engine Analyzer consists of a Type 561A Oscilloscope or Type 564 Storage Oscilloscope, a specially designed Type 2B67 Engine Analyzer Time Base with a Rotational Function Generator input, and a Type 3A74 Engine Analyzer Amplifier featuring four channels, with separate inputs for pressure, ignition, vibration, and crank-shaft rotation markers.

The Engine Analyzer Accessories package includes a Rotational Function Generator, pressure transducers, vibration transducers, ignition pickoff, magnetic pickup, cables and an accessory carrying case. Optional accessories include a Polaroid\* Trace-Recording Camera, Scope-Mobile® Cart and a tripod for easy mounting of the Rotational Function Generator.

\*Registered Trademark, Polaroid Corporation

## VIBRATION MEASUREMENTS

Vibration measurements are useful in detecting leaking valves, destructive detonation, excessive cylinder wear, blowby, worn bearings, broken compression rings, valve flutter and many other signs of wear and malfunction. The vibration pickup is a piezoelectric crystal mounted in a magnetic head that can be placed anywhere on the engine or compressor.

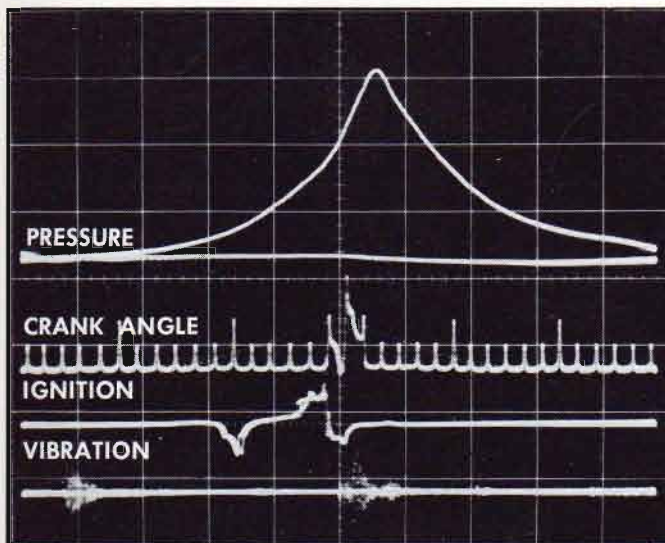
## IGNITION MEASUREMENTS

Ignition measurements are used for proper timing of the engine and can detect bad spark plugs, pulse generator problems, point problems, bad condensers and coil condition. Ignition measurements can also be used to calculate RPM. Ignition measurements are made using a 1000X capacitive attenuator that clamps on the secondary coil and spark-plug wire.

## PRESSURE MEASUREMENTS

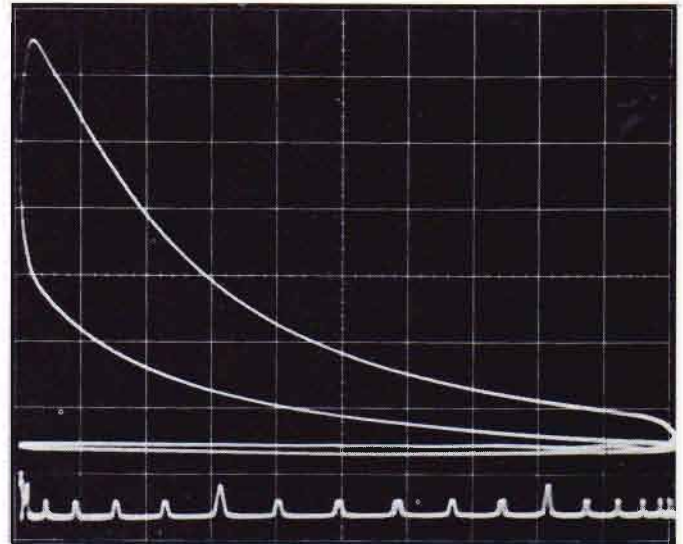
Pressure measurements detect peak firing pressures, compression, early and late cylinder firing, and pre-ignition of the engine under test. Three displays of cylinder pressure are easily and quickly obtained: pressure vs crank angle, pressure vs cylinder volume and pressure vs time.

## FOUR SIMULTANEOUS DISPLAYS



Simultaneous displays of four engine parameters provide the operator with one comprehensive picture of the total engine performance and make identification of malfunctions easy. The top waveform is engine pressure; waveform 2 shows crank-angle markers with the larger marker in the center indicating the top dead center; waveform 3 is engine ignition; waveform 4 is engine vibration showing valves opening and closing and vibration due to combustion.

## PRESSURE VS VOLUME



Pressure vs cylinder volume displays are used to determine the indicated engine horsepower and detect over-all problems in engines and compressors. The area within the loop is the mean effective pressure and is used to determine indicated horsepower of the engine.

$$hp = \frac{PLAN}{33,000}$$

hp = Horsepower

P = Mean Effective Pressure

L = Piston Stroke (ft)

A = Piston Area (in<sup>2</sup>)

N = Engine RPM

## ENGINE ANALYZER CHARACTERISTICS

### TYPE 561A OSCILLOSCOPE

The Type 561A Oscilloscope accepts the Type 2B67 Engine Analyzer Time-Base Plug-In and the Type 3A74 Engine Analyzer Amplifier Plug-In plus all two-series and three-series Tektronix plug-in units. The Type 561A uses an 8 x 10-cm cathode-ray tube that features an internal, illuminated graticule. An amplitude and time calibrator provides accurate squarewave voltages from 0.2 mV to 100 V P-P at a line-frequency rate. See page 151 of Tektronix Catalog 27 for further information.

### TYPE 564 STORAGE OSCILLOSCOPE

The Type 564 Storage Oscilloscope uses the same plug-in units as the Type 561A and offers the added advantage of split-screen storage. Split-screen storage permits using either half of the display for storage and/or conventional displays. Storage is especially useful when making pressure measurements. 10 or 20 engine cycles can be stored on the display to detect changes of pressure, or the display can be continuously stored for up to one hour to detect pre-ignition problems. See page 155 of Tektronix Catalog 27 for further information.

# ENGINE ANALYZER

## TYPE 2B67 ENGINE ANALYZER TIME BASE

### TIME BASE

1  $\mu$ s/div to 5 s/div and 21 calibrated steps, 1-2-5 sequence; accurate within 3%. 5X magnifier operates over full time base, accurate within 5%.

### SINGLE SWEEP

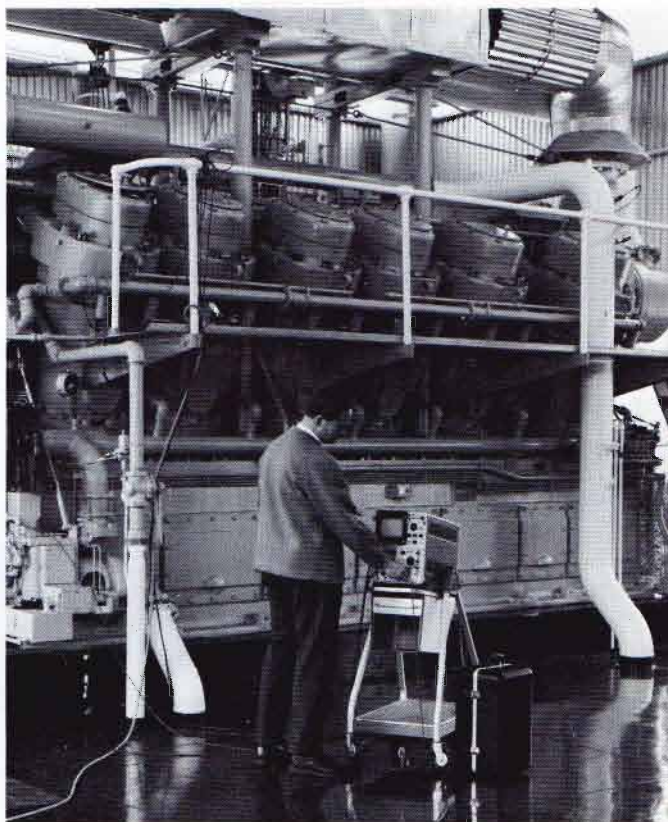
Provides single display for one-shot waveform photography and storage applications. In the Rotational Function Generator mode of operation, single displays of either 360° (2 cycle) or 720° (4 cycle) are possible.

### TRIGGER

Automatic, manual, or free-run operation; triggering on + or - slope from an internal, line frequency or external source. In external trigger, a signal from the Rotational Function Generator is available for triggering.

### ROTATIONAL FUNCTION AMPLIFIER

Accepts inputs from the Rotational Function Generator providing horizontal displays of piston volume or crank angle. Crank-angle degree markers are internally coupled to Channel 2 of the Type 3A74 Engine Analyzer Amplifier.



## TYPE 3A74 ENGINE ANALYZER AMPLIFIER

The Type 3A74 Engine Analyzer Amplifier is a four-channel plug-in unit featuring simultaneous displays of pressure, crank-angle markers, engine vibration, and ignition. Channel 1 is a charge amplifier designed for use with the pressure transducer; Channel 2 provides a crank-angle marker display from the Rotational Function Generator plus the magnetic pickup display of top dead center; Channel 3 and Channel 4 are identical amplifiers used for vibration and ignition displays.

### CHARGE AMPLIFIER, CHANNEL 1

1 psi/div to 500 psi/div in 1-2-5 sequence; accurate within 3%. Frequency response: Restore Time — Long is from 0.05 Hz to 10 kHz, Short is from 0.5 Hz to 10 kHz. Maximum charge signal is 0.6  $\mu$ C (micro coulomb) at 10 kHz, increasing to 2  $\mu$ C at 2.75 kHz. Restore Time is at least 3 s in the Long position, at least 0.3 s in the Short position. Display noise is less than 0.15 pC (pico coulomb) per 1000 pF of source capacitance, with 1 psi/div and gain set to 100 pC/psi.

### CHANNELS 2, 3 and 4

0.02 V/div to 10 V/div in 9 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div. Bandwidth is DC to 2 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz. Input characteristics are 1 M $\Omega$  paralleled by approx 47 pF. Maximum input voltage is 600 V (combined DC plus AC).

## ENGINE ANALYZER ACCESSORIES

### PRESSURE TRANSDUCER

The Pressure Transducer and cooling adapter with Bacharach fittings are connected to the cylinder pressure cock and are designed for use at engine speeds up to 1000 RPM. The piezoelectric Pressure Transducer, when used with the charge amplifier of the Type 3A74 Engine Analyzer Amplifier and the included 50-ft low-noise cable, has the following characteristics.

**PRESSURE RANGE** is 0 to 3000 psi.

**DEFLECTION FACTOR** is 1 psi/div to 500 psi/div in 1-2-5 sequence, accurate within 5% throughout calibrated range. Maximum overload pressure is 300%.

**BANDWIDTH** in the Long Restore Time position is from 0.05 Hz or less to at least 10 kHz; in the Short Restore Time position, from 0.5 Hz or less to at least 10 kHz.

**RESTORE TIME** in the Long position is at least 3 seconds; in the Short position is at least 0.3 seconds.

**NOISE** is not discernible with the 50-ft low-noise cable supplied.

**TEMPERATURE RANGE** is from -40°C to +150°C. A cooling adapter is supplied for environmental conditions above +150°C.

### VIBRATION TRANSDUCER

The piezoelectric Vibration Transducer has a magnetic mount and is used with Channel 2, 3 or 4 of the Type 3A74 Engine Analyzer Amplifier with the included 50-ft low-noise cable.

## ENGINE ANALYZER

**TRANSDUCER SENSITIVITY** is nominally 6 mV/g (4.5 mV/g with the included cable). Exact value is shown with the calibration chart supplied with the transducer.

**BANDWIDTH** is from 40 Hz to 15 kHz with a resonant frequency at approx 10 kHz.

**MAXIMUM ACCELERATION** is 1000 g's.

**TEMPERATURE RANGE** is from  $-40^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$ .

### IGNITION PICKOFF

The Ignition Pickoff, when used with Channel 2, 3 or 4 with the Type 3A74 Engine Analyzer Amplifier and the included 50-ft low-noise cable, has the following characteristics.

**ATTENUATION** is nominally 1000X. Exact attenuation is determined by the capacitance between the pickoff and the secondary lead under test. The oscilloscope calibrator and a piece of ignition cable can be used to calibrate the ignition pickoff and the vertical amplifier.

**TIME CONSTANT** is at least 6.5 ms.

### MAGNETIC PICKUP

The Magnetic Pickup, when used with Channel 2 of the Type 3A74 Engine Analyzer Amplifier and the included 20-ft or 50-ft low-noise cable, has the following characteristics.

**OUTPUT VOLTAGE** is at least 15 V P-P at 1000 inch/s and a clearance gap of 0.005 inch using a 20-pitch, 30-tooth ferrous metal gear.

**COIL RESISTANCE** is 90  $\Omega$  to 110  $\Omega$ .

**COIL INDUCTANCE** is 26 mH to 40 mH.

**TEMPERATURE RANGE** is from  $-54^{\circ}\text{C}$  to  $+107^{\circ}\text{C}$ .

### ROTATIONAL FUNCTION GENERATOR

The Rotational Function Generator is mechanically coupled to the engine under test and generates  $10^{\circ}$ ,  $60^{\circ}$  and  $360^{\circ}$  markers. Crank-Angle Markers are displayed on Channel 2 of the Type 3A74 Engine Analyzer. The Rotational Function Generator is mechanically timed to an engine reference point by comparing the display of the top dead center mark of the magnetic pickup from the fly wheel with the  $0^{\circ}/360^{\circ}$  pulse generated by the function generator. The Rotational Function Generator also generates a sawtooth ramp for displays related to crank angle, and a sinewave that is equivalent to piston volume for P-V curves. The Rotational Function Generator, when used with the Type 2B67 Engine Analyzer Time Base and the included 20-ft cable supplied, has the following characteristics.

**MAXIMUM RPM** is 20,000 revolutions per minute.

**DEGREE MARKER** angular accuracy is within  $1^{\circ}$ .

**SHAFT LOAD** actual and radial is 10 lb maximum.

**CRANK-ANGLE MARKERS** are generated every  $10^{\circ}$ , a pulse of larger amplitude every  $60^{\circ}$ , and a pulse riding on a pedestal every  $360^{\circ}$ . The markers are internally coupled to Channel 2 and have an amplitude of at least a division of the display. The magnetic pickup signal can be superimposed on Channel 2 to permit timing of the function generator markers to the engine under test.

**CRANK ANGLE** displays provide  $350^{\circ}$  of useable display related directly to crank angle and incremental accuracy is within 3% of full scale display.

**PISTON VOLUME** displays have an incremental accuracy within 3% of full scale display. The phase shift is  $0.5^{\circ}$  or less at 20,000 RPM.

**TEMPERATURE RANGE** is from  $-15^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$ .

### ORDERING INFORMATION

**TYPE 561A P7 OSCILLOSCOPE**, without plug-in units

OR

**TYPE 564 STORAGE OSCILLOSCOPE**, without plug-in units

**TYPE 2B67 ENGINE ANALYZER TIME BASE**, order Type 2B67 MOD 730A

Includes: Engine Analyzer instruction manual (070-0890-00).

**TYPE 3A74 ENGINE ANALYZER AMPLIFIER**, order Type 3A74 MOD 730A

Includes: Engine Analyzer instruction manual (070-0890-00).

### ENGINE ANALYZER ACCESSORIES

Order 015-0126-00

Includes: rotational function generator (015-0108-00); pressure transducer (015-0117-00); vibration transducer (015-0116-00); magnetic transducer (015-0119-00); capacitive ignition pickup (012-0139-00); 20-ft function generator cable (012-0140-00); adapter plate (386-1453-00); extension shaft kit (015-0124-00); cooling adapter (015-0118-00); 3 50-ft low-noise coax cables (012-0137-00); 20-ft low-noise coax cable (012-0136-00); clip marker cable kit (016-0127-00); 18-inch coax cable (012-0076-00); Type 3A74 charge amplitude calibrator (011-0095-00); carrying case/trays (202-0170-01); instruction manual (070-0890-00).

For price and availability information on specific items included in the Engine Analyzer accessory package, contact your nearby Tektronix Field Office.

### RECOMMENDED OPTIONAL ACCESSORIES

#### CAMERAS

C-12 with beam-splitting mirror for straight-on viewing and use of optional projected graticule,  $f/1.9-1:0.85$  lens, Polaroid Land\* Pack Film back, order C-12

Type 561A or Type 564 to C-12 Camera adapter, order 016-0217-00

Projected Graticule for 115 V, order 016-0204-00

Projected Graticule for 230 V, order 016-0234-00

Camera carrying case, order 016-0208-01

#### SCOPE-MOBILE® CART

Model 201-1 for Type 561A: 9-position tilt-lock oscilloscope tray, order 201-1

#### TRIPOD

For easy mounting and positioning of the Rotational Function Generator, order 016-0253-00

#### ROTATIONAL FUNCTION GENERATOR

Rotational Function Generators can be permanently attached to a number of engines for use with the Engine Analyzer when needed, order 015-0108-00