

# EMS

## Engine Management Services

PrimeServ Academy Copenhagen

**MAN PrimeServ**



# Learning objectives

## Upon completion of this module you ...

- will be able to interpret and apply data from the EMS-PMI system.
- will be able to recognize the different components in the EMS-PMI system.
- will be able to apply data from the PMI system into the Auto-tuning system.



# EMS – Engine Management Services

Agenda

- 1 EMS – Engine Management Services**
- 2 PMI – Pressure Measurement Instrument**

# EMS – Engine Management Services

## Description

Engine Management Services – EMS manages software, data and applications for engine operation and includes the existing PMI and CoCoS-EDS as “EMS applications”.



# EMS – Engine Management Services

PMI and CoCoS - EDS included in EMS

## EMS software:

- **PMI Auto - tuning**
- **CoCoS - EDS ME Basic**
- **Hardened Windows image (Win8.1 / Win10)**
- **EMS manager**
  - User Interface for installation & supervision of EMS applications & network
  - ECS and EMS data & configuration backup
  - Data exchange service with third party (AMS)



# EMS – Engine Management Services

PMI and CoCoS - EDS included in EMS

## EMS hardware:

- **Industrial type dedicated EMS MOP PC (replaces current PMI / CoCoS-EDS PC)**
- **Network components**
  - Managed switch
  - Firewall / VPN router (same as current)
- **PMI hardware (same as current)**



# EMS – Engine Management Services

Display

Sub-menus

Navigation bar

Main menus

Main display

^ EMS Div1611

Status

- Network
- EDS
- PMI
- ECS
- ERCS
- AMS

Status

- Maintenance
- Documents

PMI Application Status

PMI running

PMI Communication Status

Key Values I/F: 09-03-2017 16:20:39 OK

Key Values

Engine

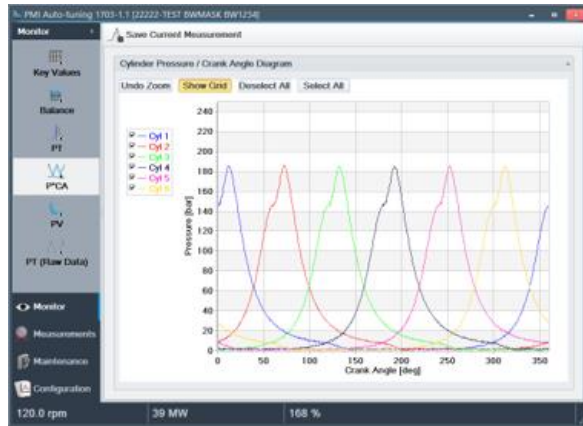
Time Stamp	Engine Speed [rpm]	p(scav) [bar]	Estimated Effective Power [MW]	Estimated Load [%]
09-03-2017 16:20:34	120.0	2.00	59	168

Cylinder

Cylinder Number	p(i) [bar]	p(comp) [bar]	p(max) [bar]	p(comp)/p(scav) [abs/abs]
1	21.1	144.0	184.3	48.3
2	21.1	144.1	184.6	48.4
3	21.1	144.3	184.8	48.4
4	21.0	143.8	185.1	48.3
5	21.0	143.5	183.3	48.2
6	21.1	144.2	184.0	48.4
7	21.1	144.6	184.6	48.5
8	21.0	144.0	184.7	48.3
9	21.0	143.7	184.3	48.2
Mean	21.0	144.0	184.4	48.4

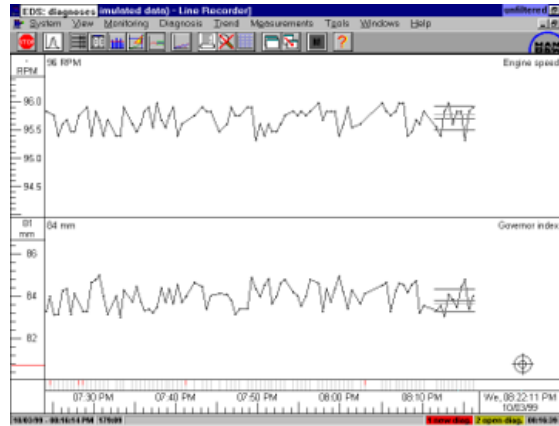
# EMS – Engine Management Services

All – in - one



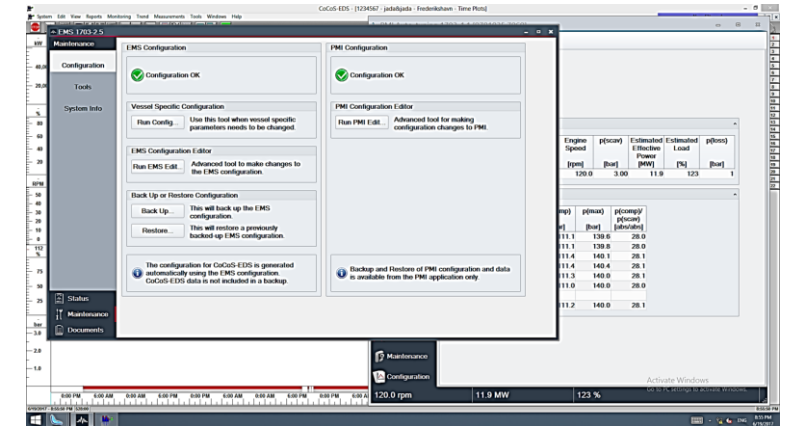
## PMI Auto-tuning

(online cylinder pressure measuring)



## CoCoS-EDS

(Trend view and performance-rapport)



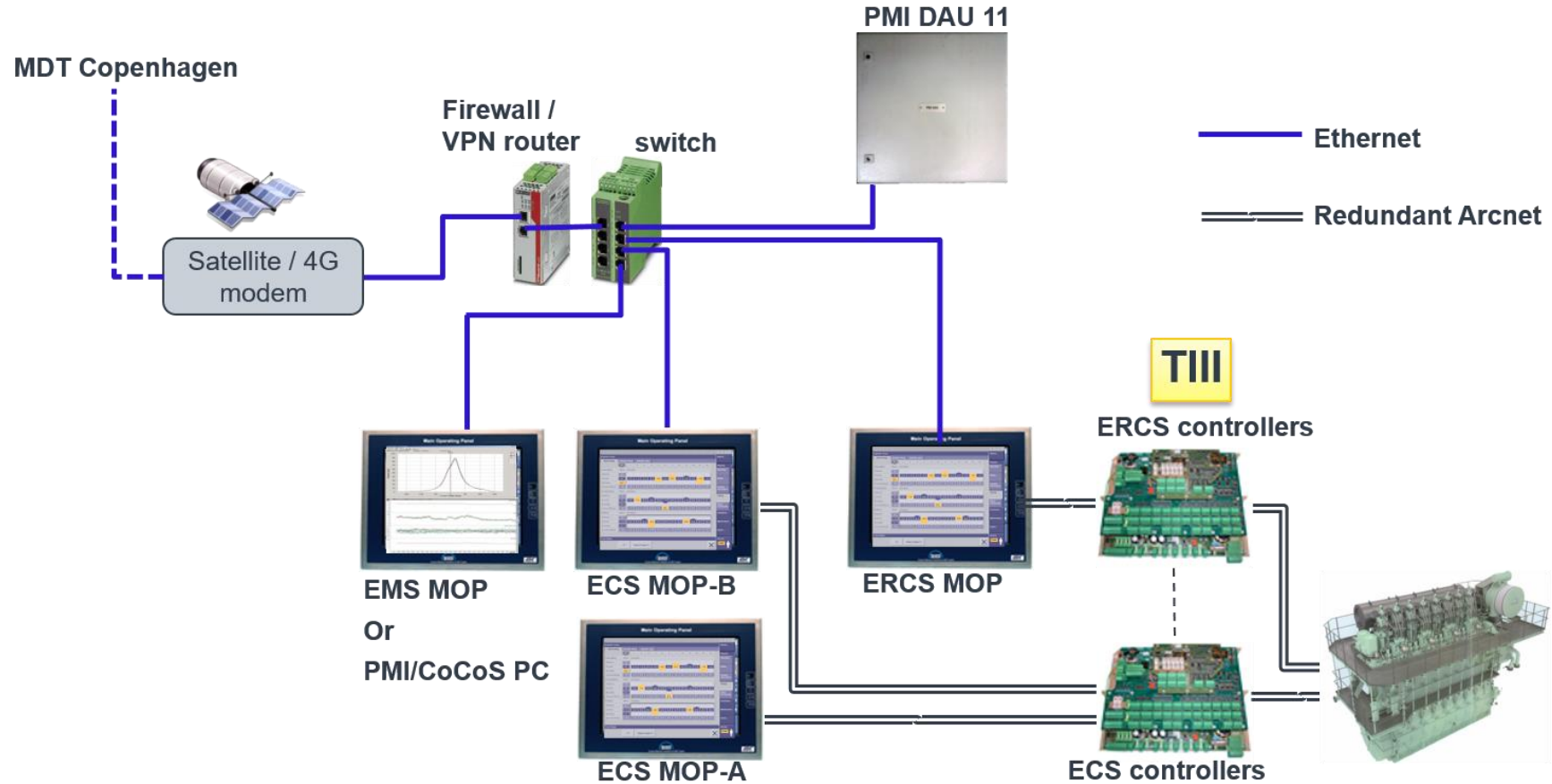
## EMS user interface

- User interface for on-site configuration and trouble shooting - Handles (auto) configuration of CoCoS - EDS
- Integrated DatGat - to retrieve EMS data and ECS - spaf



# EMS – Engine Management Services

## Connections



# EMS – Engine Management Services

Screen set - up



# EMS – Engine Management Services

Data in EMS hard disk

## Liner recorder:

- AI manual dumps
- Two hours average data of 30 days up to 200 lines

## Trend:

- Seven days average data of five minutes
- 30 years long trend data of 24 hours



# EMS – Engine Management Services

## ECS software versions

EMS can currently be configured to exchange data with the following ECS versions:

ME-ECS-SW-1304-2  
ME-ECS-SW-1312-1  
ME-ECS-SW-1312-2  
ME-ECS-SW-1312-3  
ME-ECS-SW-1312-4  
ME-ECS-SW-1312-5  
ME-ECS-SW-1312-7  
ME-ECS-SW-1506-1  
ME-ECS-SW-1601-2  
ME-ECS-SW-1601-3  
ME-ECS-SW-1603-1  
ME-ECS-SW-1603-2  
ME-ECS-SW-1603-3  
ME-ECS-SW-1609-1  
ME-ECS-SW-1609-2  
ME-ECS-SW-1609-3  
ME-ECS-SW-1609-4  
ME-B-ECS-SW-1403-1  
ME-B-ECS-SW-1403-2  
ME-B-ECS-SW-1403-3  
ME-B-ECS-SW-1403-4

# EMS – Engine Management Services

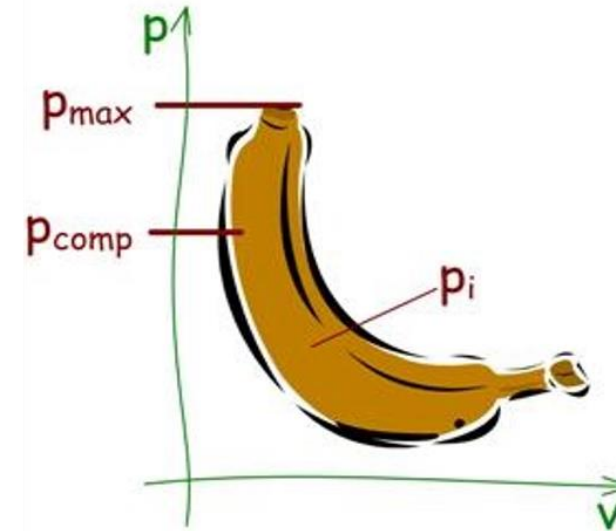
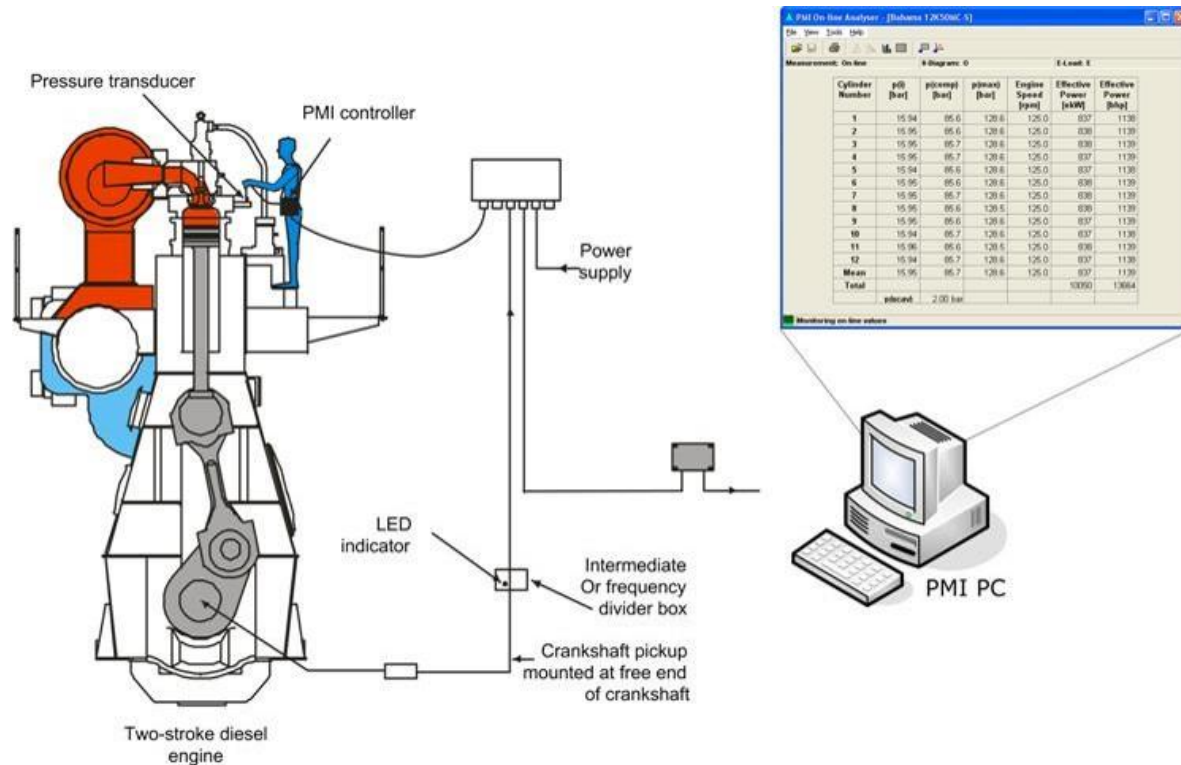
Agenda

**1 EMS – Engine Management Services**

**2 PMI – Pressure Measurement Instrument**

# EMS – Engine Management Services

## PMI - Pressure Measurement Instrument




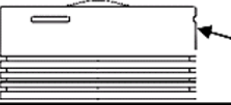




PMI is measuring cylinder pressures to determine a set of key values:

**$P_i$ ,  $P_{comp}$ ,  $P_{max}$ .**

These key values for optimizing engine performance by adjusting parameters in the engine control system.

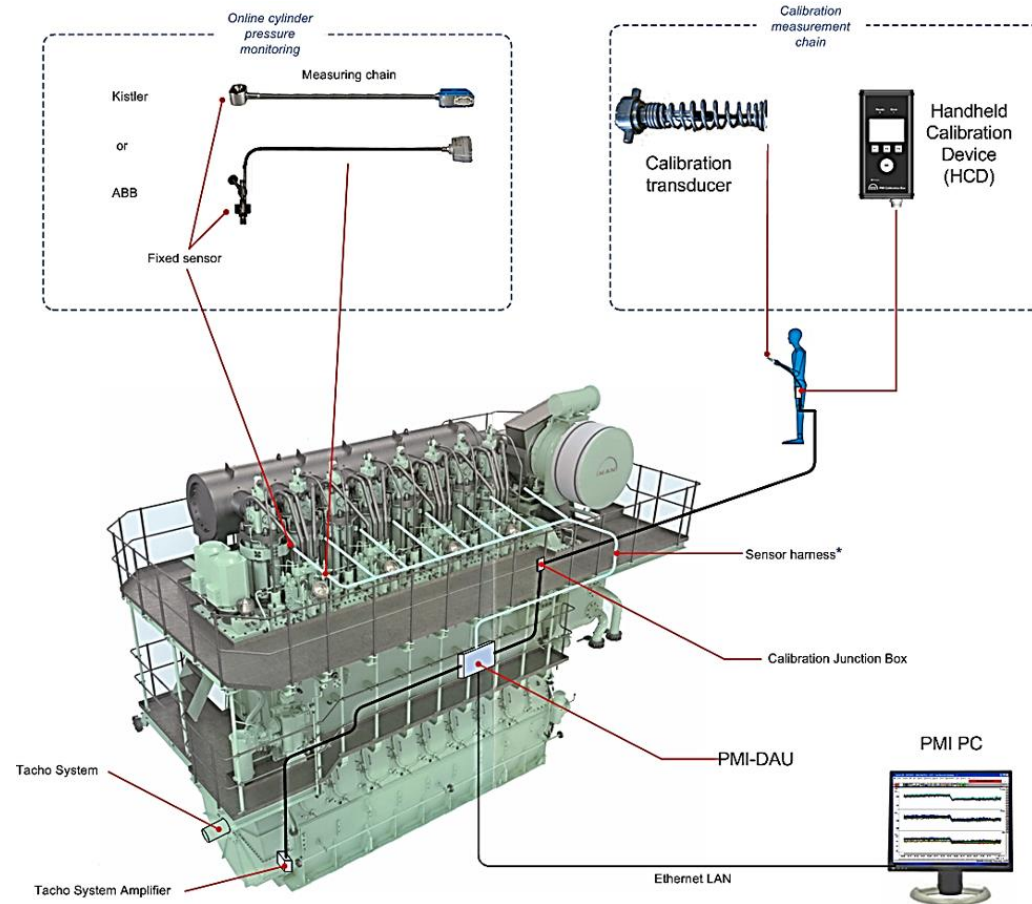
# EMS – Engine Management Services

Technical file - NOx components

4. NOx Components marking	
Example	Component and marking instruction Actual marking field for use during survey
	Component: <b>Cylinder liner</b>
	Marking instruction: 0742637-8
	Actual marking: _____
	Component: <b>Piston crown</b>
	Marking instruction: 0742392-0
	Actual marking: _____
	Component: <b>Cylinder cover</b>
	Marking instruction: 0742634-2
	Actual marking: _____
	Component: <b>Compressor wheel</b>
	Marking instruction: From turbocharger manufacturer
	Actual marking: _____ (2 manufacturer dependent locations)
	Component: <b>Diffuser</b>
	Marking instruction: From turbocharger manufacturer
	Actual marking: _____
	Component: <b>Nozzle ring</b>
	Marking instruction: From turbocharger manufacturer
	Actual marking: _____

# EMS – Engine Management Services

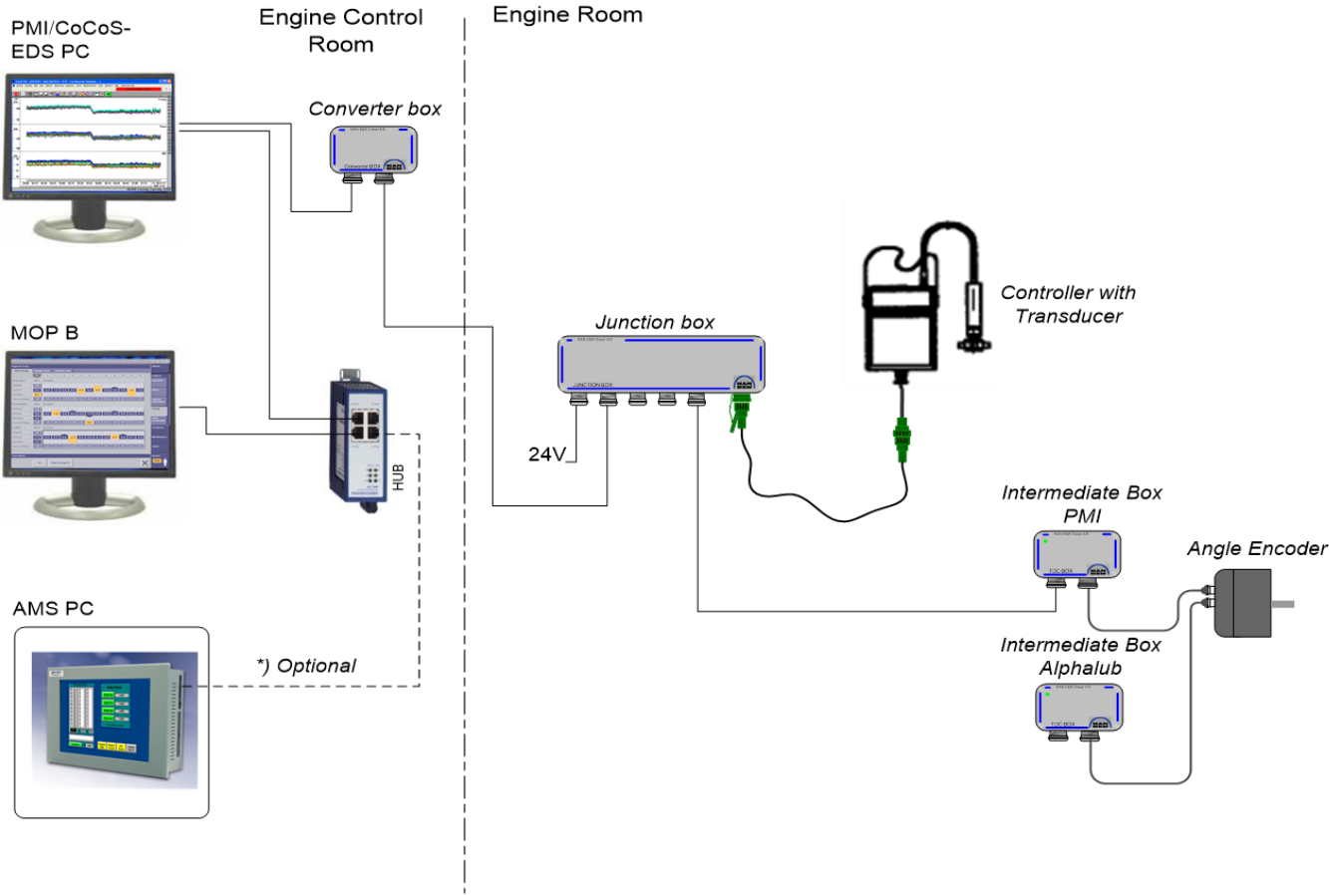
## PMI - System design





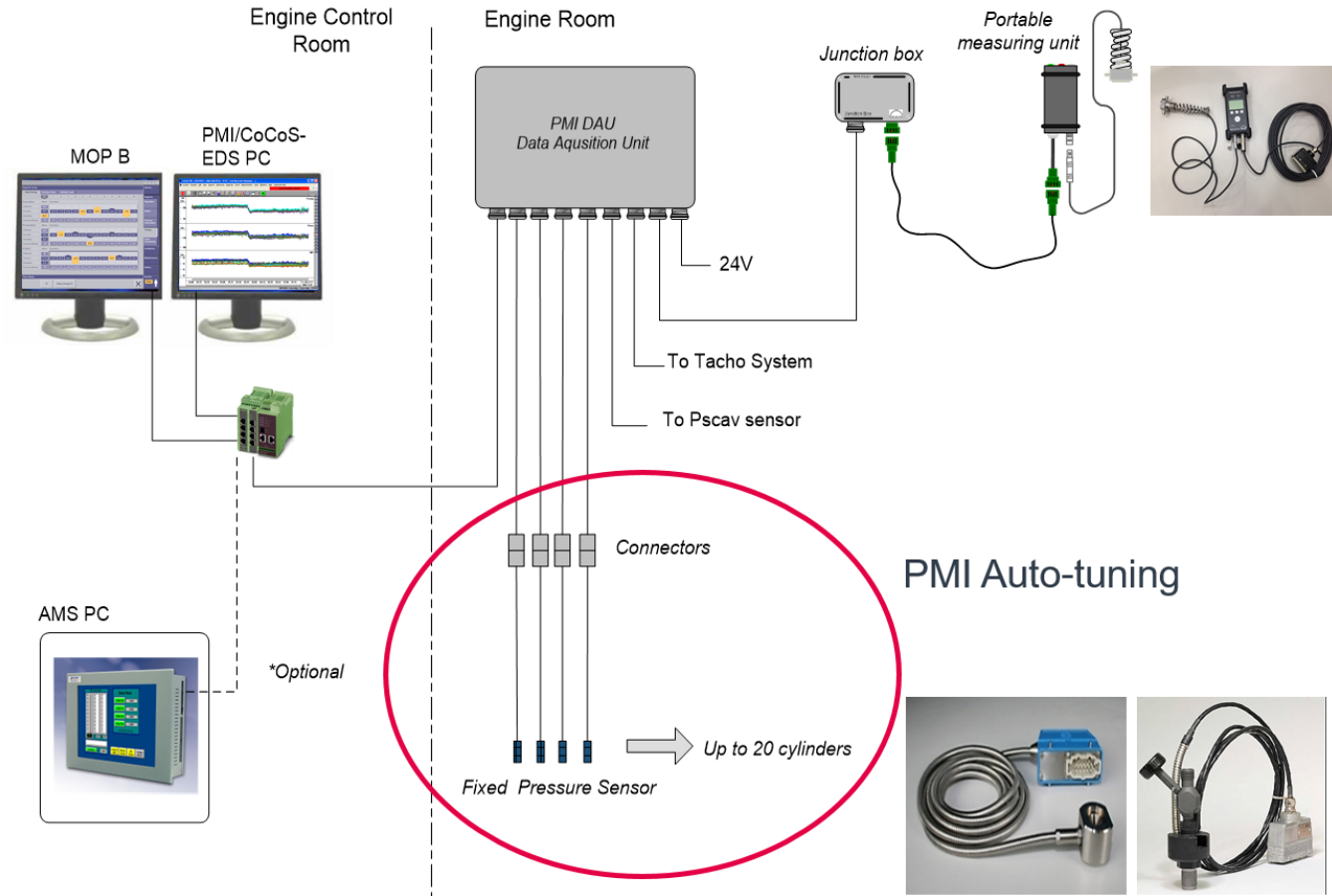
# EMS – Engine Management Services

PMI offline



# EMS – Engine Management Services

PMI online



# EMS – Engine Management Services

PMI - Portable transducer



# EMS – Engine Management Services

PMI - System & DAU

## DAU:

Data Acquisition Unit based on FPGA technology

## PMI Auto - tuning application:

- Support for up to 12 cylinders
- Support for ABB & Kistler sensors
- Angle and time triggered data sampling
- Real time data logging & transfer
- On - unit status indication



# EMS – Engine Management Services

PMI - Pressure sensors



# EMS – Engine Management Services

PMI - Pressure sensors

Kistler



ABB

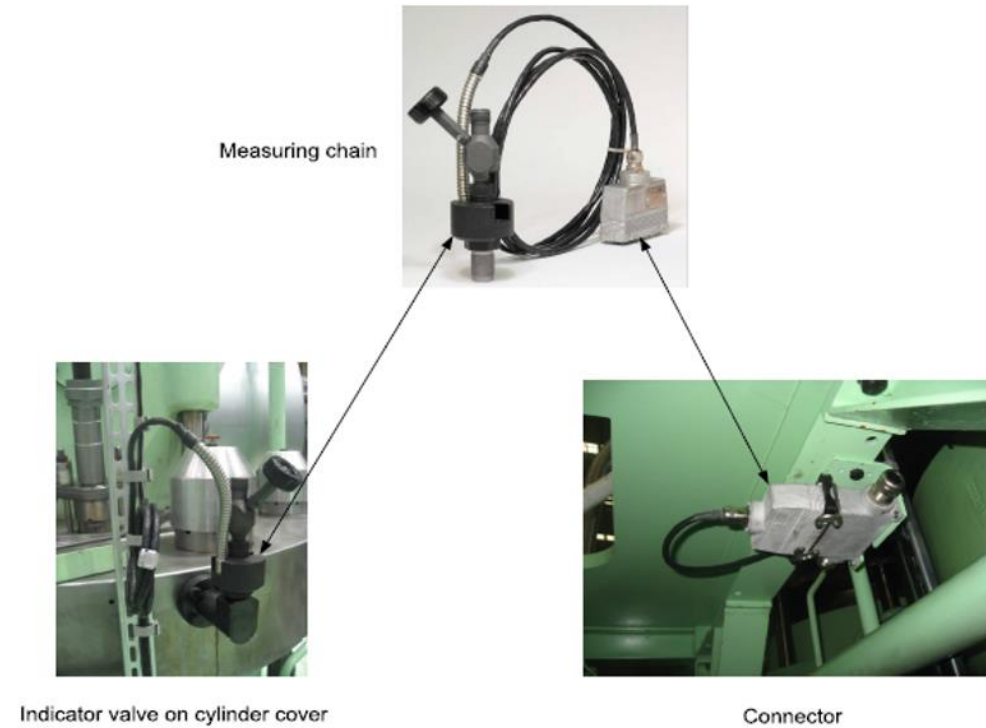


Estimated life time	+4 years	+10 years
Retail price	1	2
Sensor mounting	Between cyl cover & indicator cock	Outer end of indicator cock
Sensor technology	Piezoelectric based	Magnetoelastic based
Calibration / sensitivity (makers recommendation)	Sensitivity check on regular basis	Calibration not required
Indicator cock valve	Re-using existing	New valve included

# EMS – Engine Management Services

PMI - ABB sensors

Online Pressure Sensor – ABB series (PMI Auto-tuning only)



# EMS – Engine Management Services

PMI - Kistler sensors



Measuring chain



Connector



Indicator valve on cylinder cover



# EMS – Engine Management Services

## PMI - Displays

The screenshot shows the 'Monitor' window of the EMS software. The left sidebar contains navigation icons for 'Key Values', 'Balance', 'PT', 'P\*CA', 'PV', and 'PT (Raw Data)'. At the bottom of the sidebar are 'Monitor', 'Measurements', 'Maintenance', and 'Configuration'. The main area displays two data tables: 'Engine' and 'Cylinder'. The 'Engine' table shows a single row of data for a timestamp of 30-09-2016 10:40:39, with values for Engine Speed (60.0 rpm), p(scav) (2.00 bar), Estimated Effective Power (39 MW), and Estimated Load (84%). The 'Cylinder' table shows 12 rows of data for individual cylinders, with a 'Mean' row at the bottom. The status bar at the bottom of the window displays '60.0 rpm', '39 MW', and '84 %'. Two red annotations are present: a circle with '1' and the word 'Select' pointing to the 'Monitor' icon in the sidebar, and a circle with '2' and the text 'Select view' pointing to the 'Key Values' icon in the sidebar.

Time Stamp	Engine Speed [rpm]	p(scav) [bar]	Estimated Effective Power [MW]	Estimated Load [%]
30-09-2016 10:40:39	60.0	2.00	39	84

Cylinder Number	p(i) [bar]	p(comp) [bar]	p(max) [bar]	p(comp)/p(scav) [abs/abs]
1	21.0	145.9	184.2	49.0
2	21.1	146.3	184.7	49.1
3	21.1	146.7	185.2	49.2
4	21.1	146.3	184.7	49.1
5	21.1	146.3	184.6	49.1
6	21.0	146.1	184.5	49.0
7	21.1	146.4	184.8	49.1
8	21.0	146.1	184.4	49.0
9	21.1	146.8	185.3	49.3
10	21.0	146.2	184.5	49.1
11	21.1	146.4	184.9	49.1
12	21.1	146.2	184.6	49.1
Mean	21.1	146.3	184.7	49.1

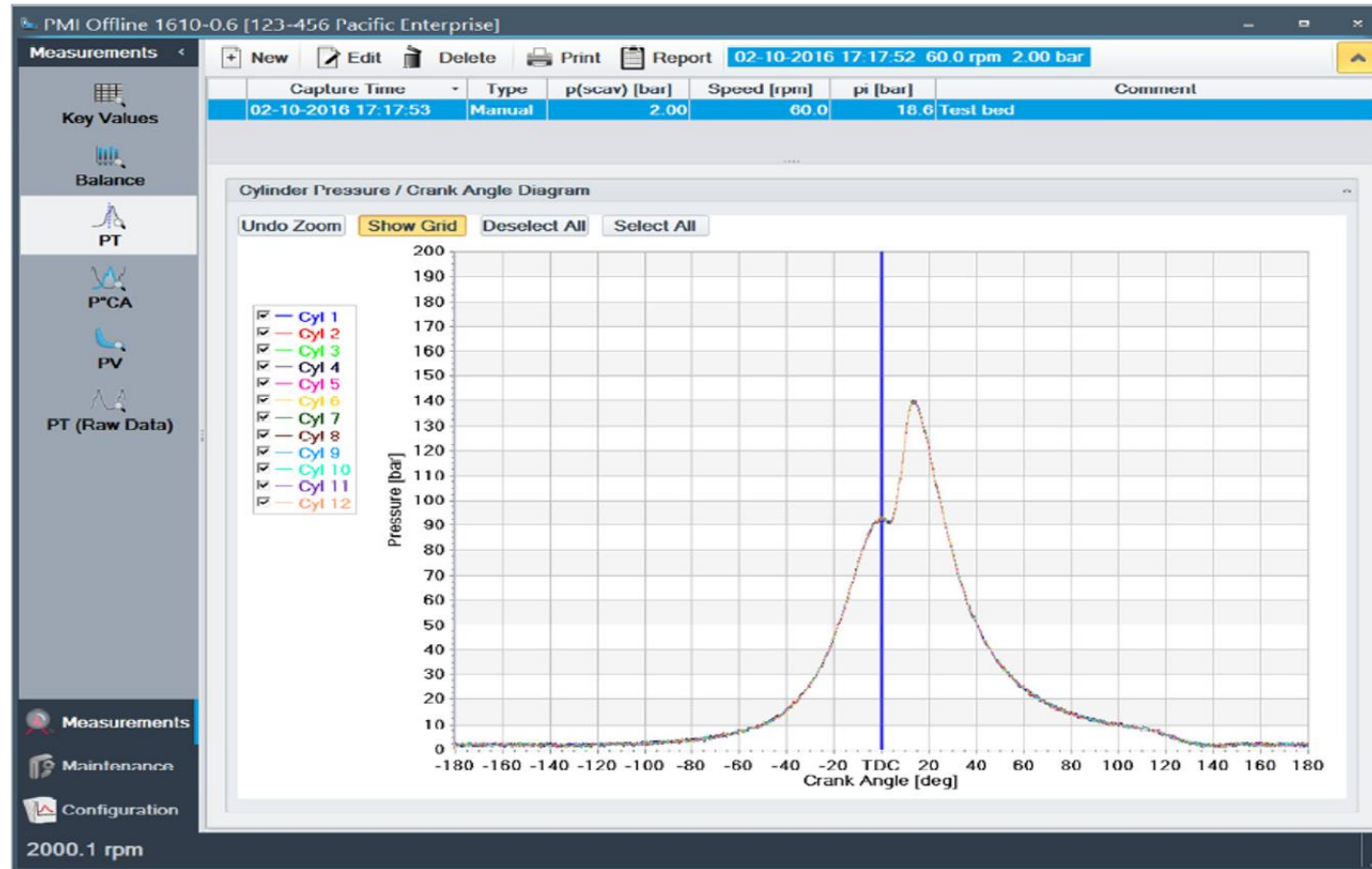
# EMS – Engine Management Services

## PMI - Displays



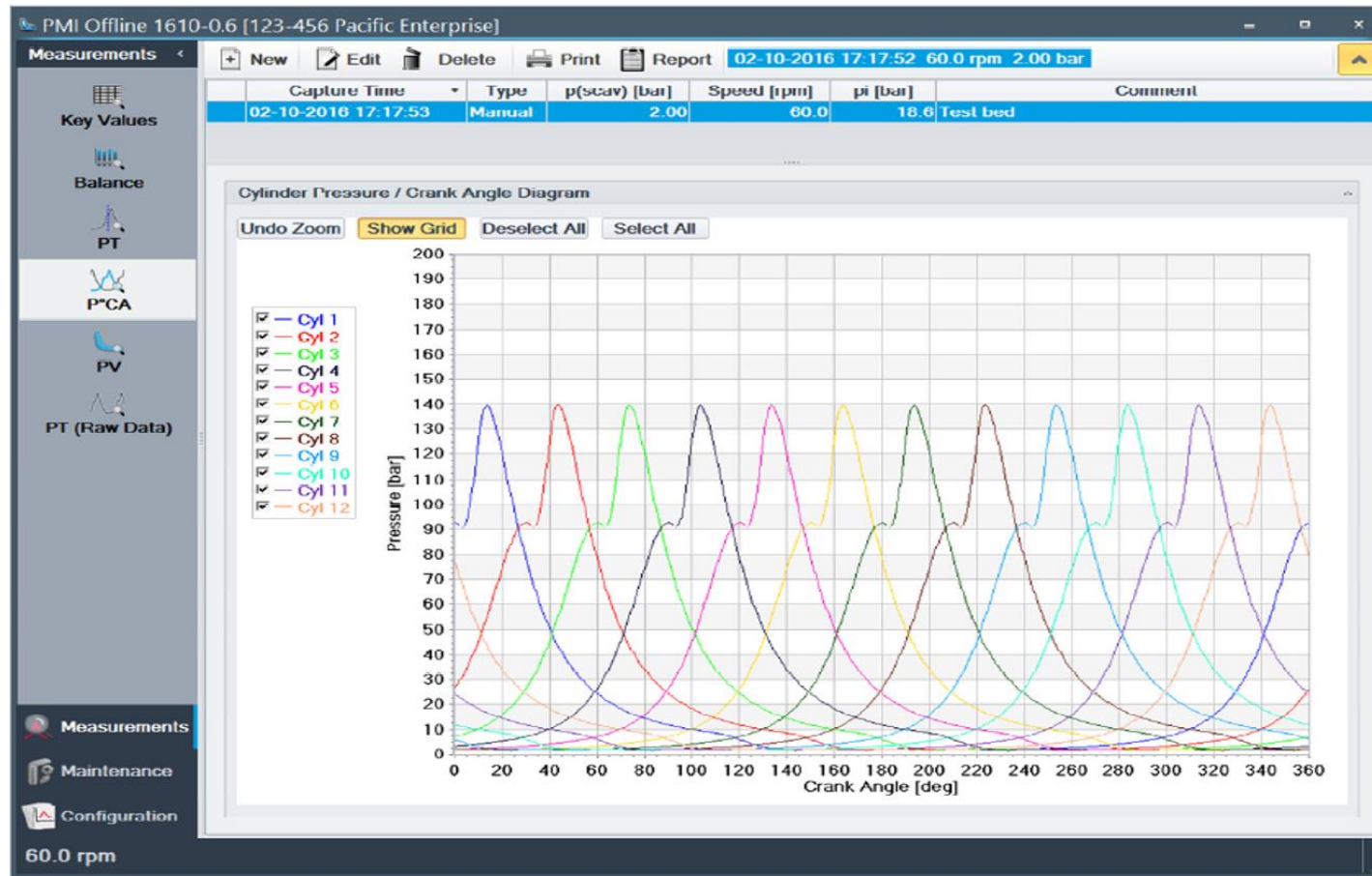
# EMS – Engine Management Services

## PMI - Displays



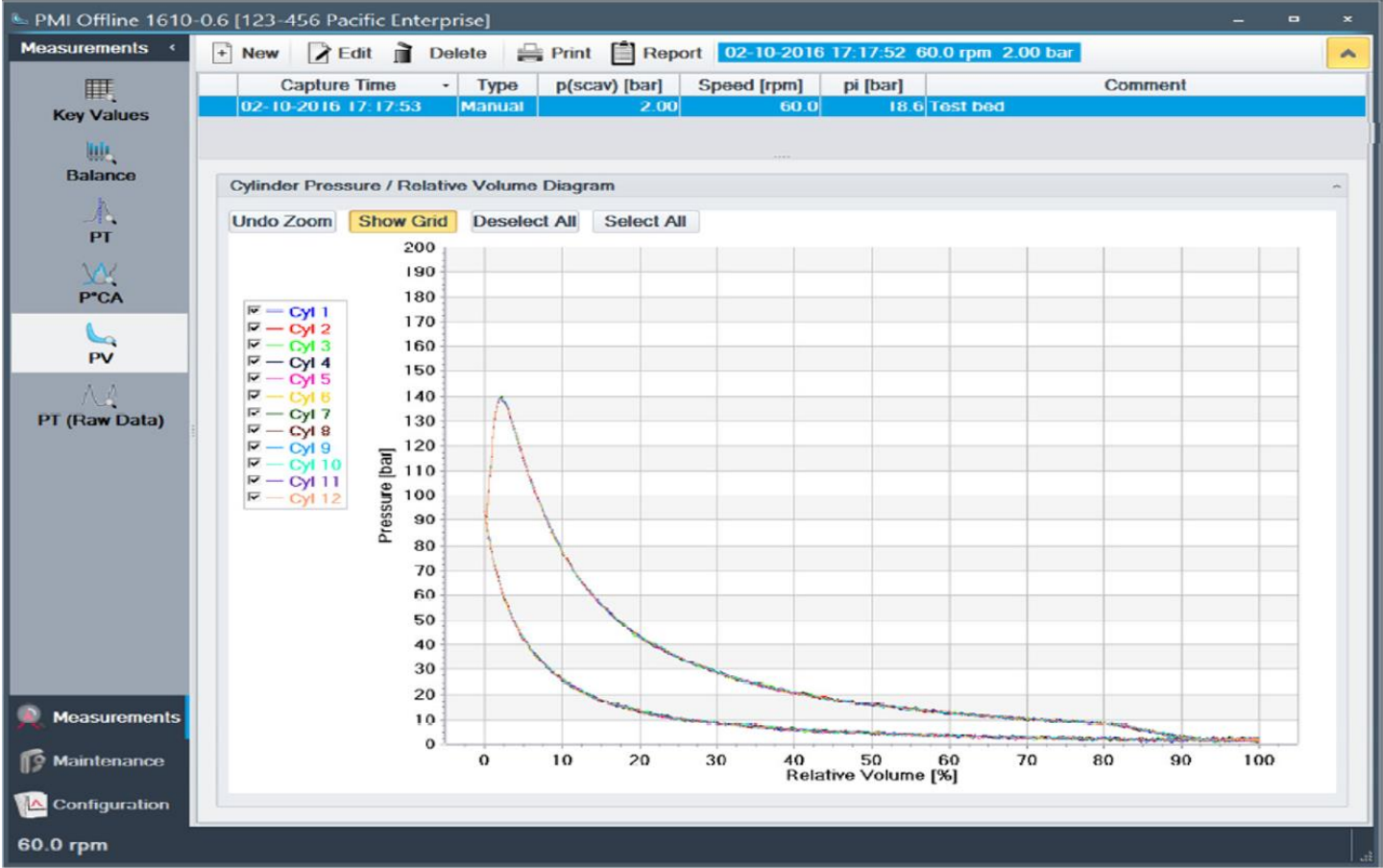
# EMS – Engine Management Services

PMI - Displays



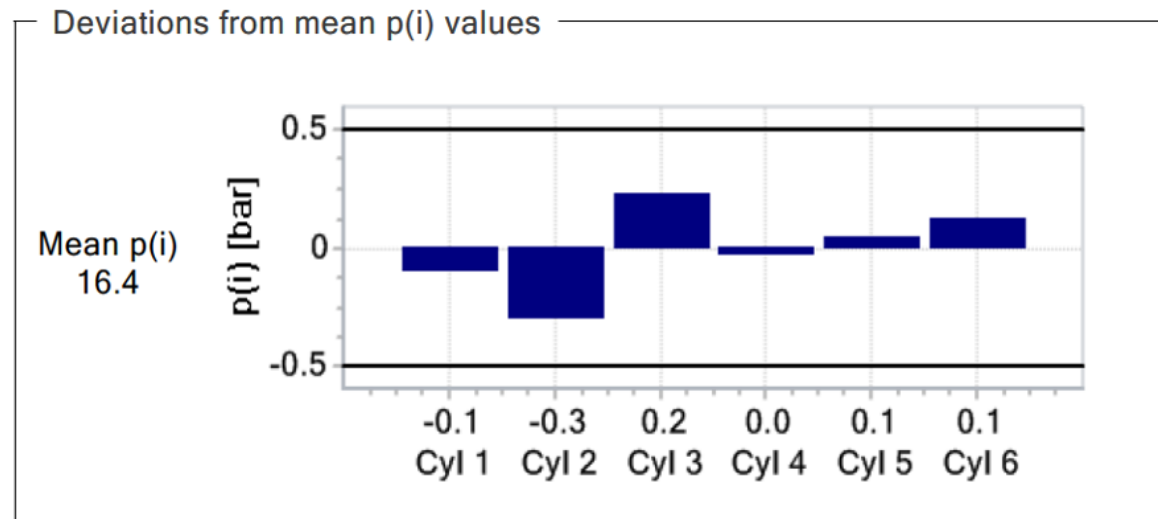
# EMS – Engine Management Services

## PMI - Displays



# EMS – Engine Management Services

PMI - Balanced plot, Pi



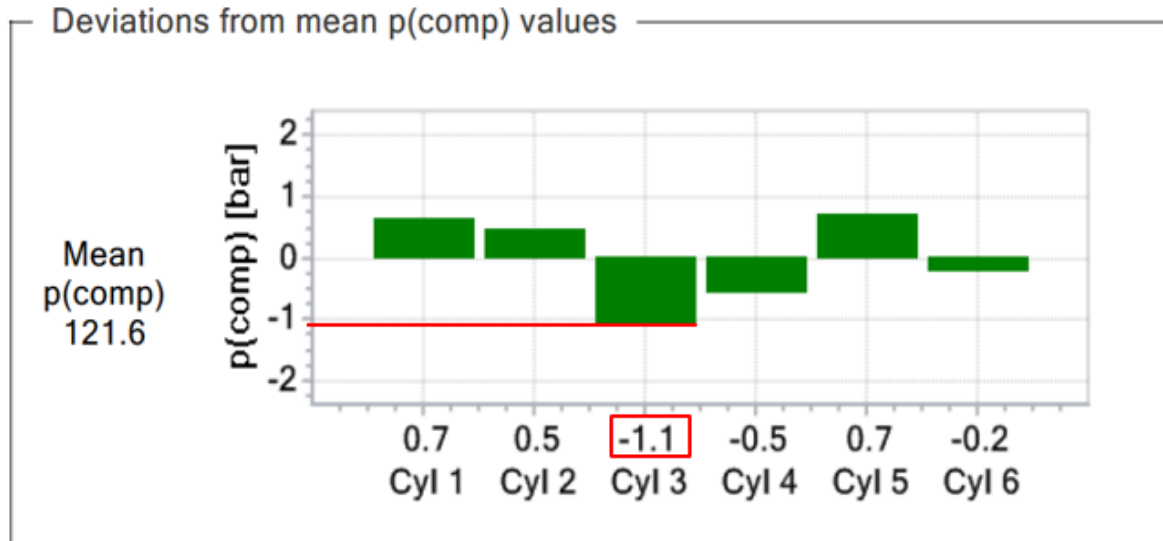
\* Pi tuning:

Offset (high) load

$$(0,3 / 16.4) \times 100\% = 1.8 \%$$

# EMS – Engine Management Services

PMI - Balanced plot, Pcomp



\* **Pcomp tuning** is done by entering a compression ratio offset:

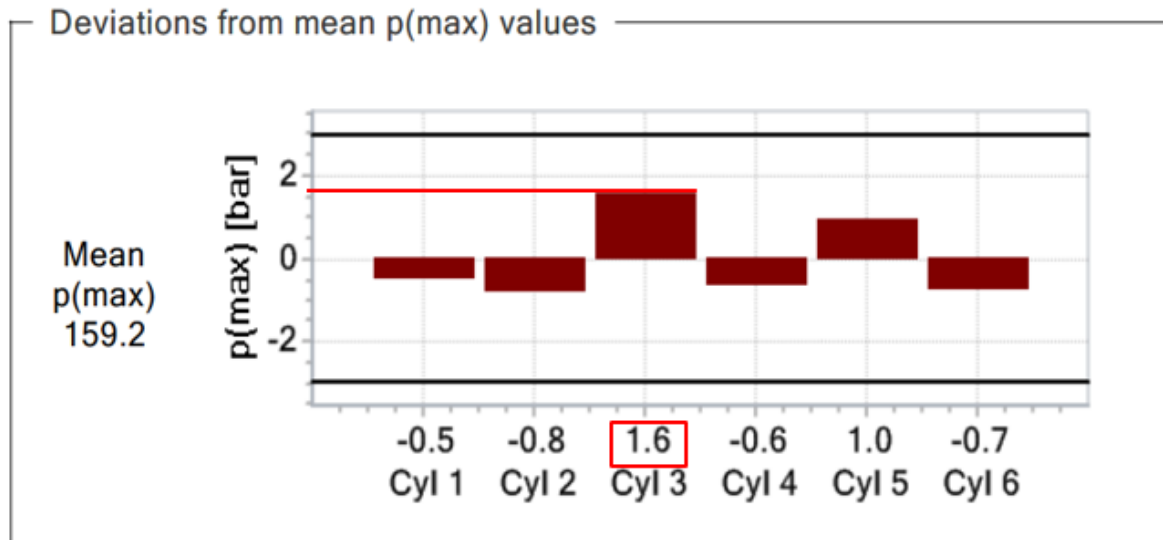
$$\text{Cratio} = \text{Pcomp} / \text{Pscav}$$

$$\text{Cratio} = 1,1 / 3,52 = 0.31$$

(Reading from Pscav sensor is corrected to Absolute value by adding atmospheric pressure, one bar)

# EMS – Engine Management Services

PMI - Balanced plot, Pmax



\* Pmax tuning is done by entering an offset directly in bar

Pmax offset = - 1.6



# EMS – Engine Management Services

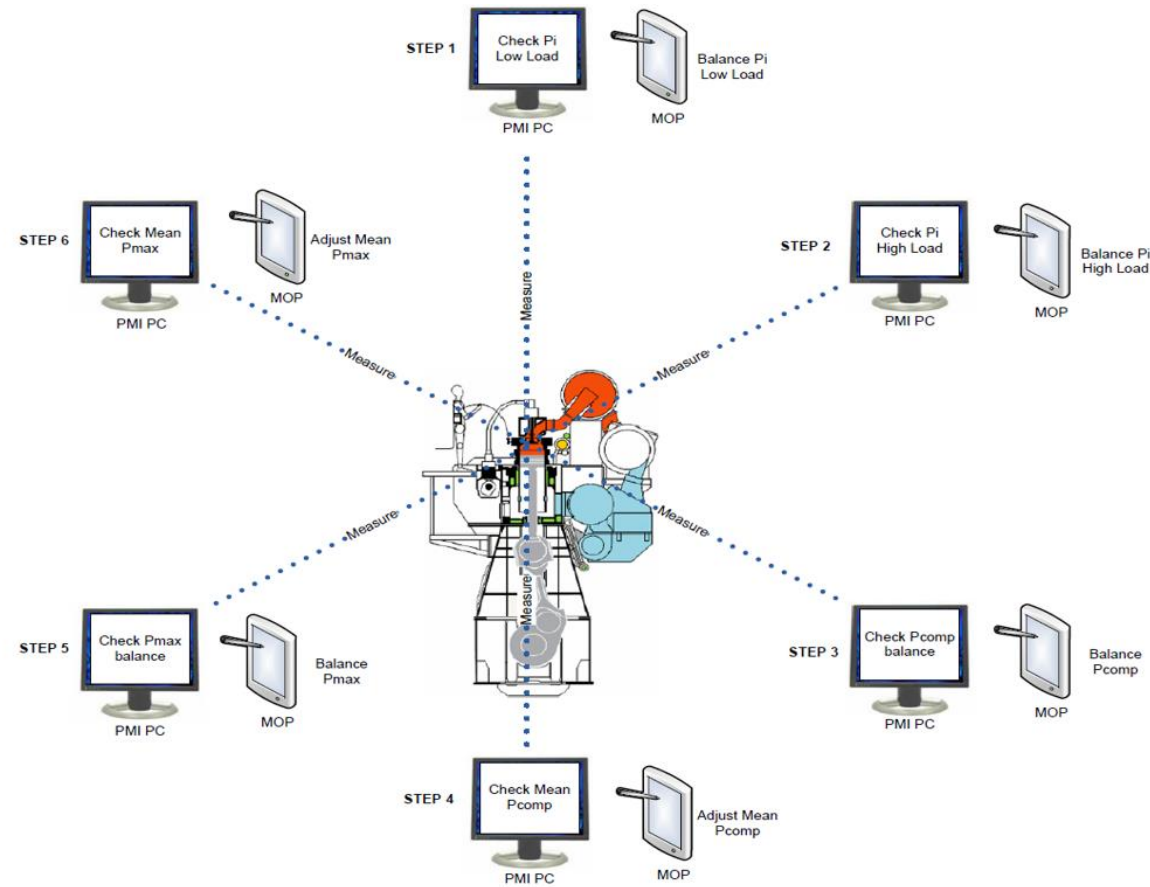
PMI - Manual adjustments

The screenshot shows the 'Engine Process Adjustment' screen at 12:48:47. The 'Cylinder Load' tab is selected, and the 'Process Adjustment' button is highlighted in the right-hand menu. The interface displays two rows of 12 sliders each, representing cylinders 1 through 12. The top row is labeled 'High Load Offset [%]' and the bottom row is labeled 'Low Load Offset [%]'. All sliders are currently set to 0. The right-hand menu includes buttons for Alarms..., Engine, Operation, Status, Process Information, Process Adjustment, Chief Limiters, Auxiliaries..., Maintenance..., Admin..., Power Off, and Access.

The screenshot shows the 'Engine Process Adjustment' screen at 12:51:11. The 'Cylinder Press.' tab is selected, and the 'Process Adjustment' button is highlighted in the right-hand menu. The interface displays three rows of 12 sliders each, representing cylinders 1 through 12. The top row is labeled 'Pmax Offset [Bar]' with values ranging from -20 to 20. The middle row is labeled 'Pcomp/Pscav Offset [-]' with values ranging from -2 to 2. The bottom row is labeled 'Exhaust Valve Open Timing Offset [DEG]' with values ranging from -2 to 0. Sliders for cylinders 2 through 12 are currently set to '---'. The right-hand menu includes buttons for Alarms..., Engine, Operation, Status, Process Information, Process Adjustment, Chief Limiters, Auxiliaries..., Maintenance..., Admin..., Power Off, and Access. The 'Access' button is highlighted with a 'Chief' label.

# EMS – Engine Management Services

## PMI - Auto tuning



# EMS – Engine Management Services

PMI - Auto tuning

Based on estimated engine load

Measured by PMI online

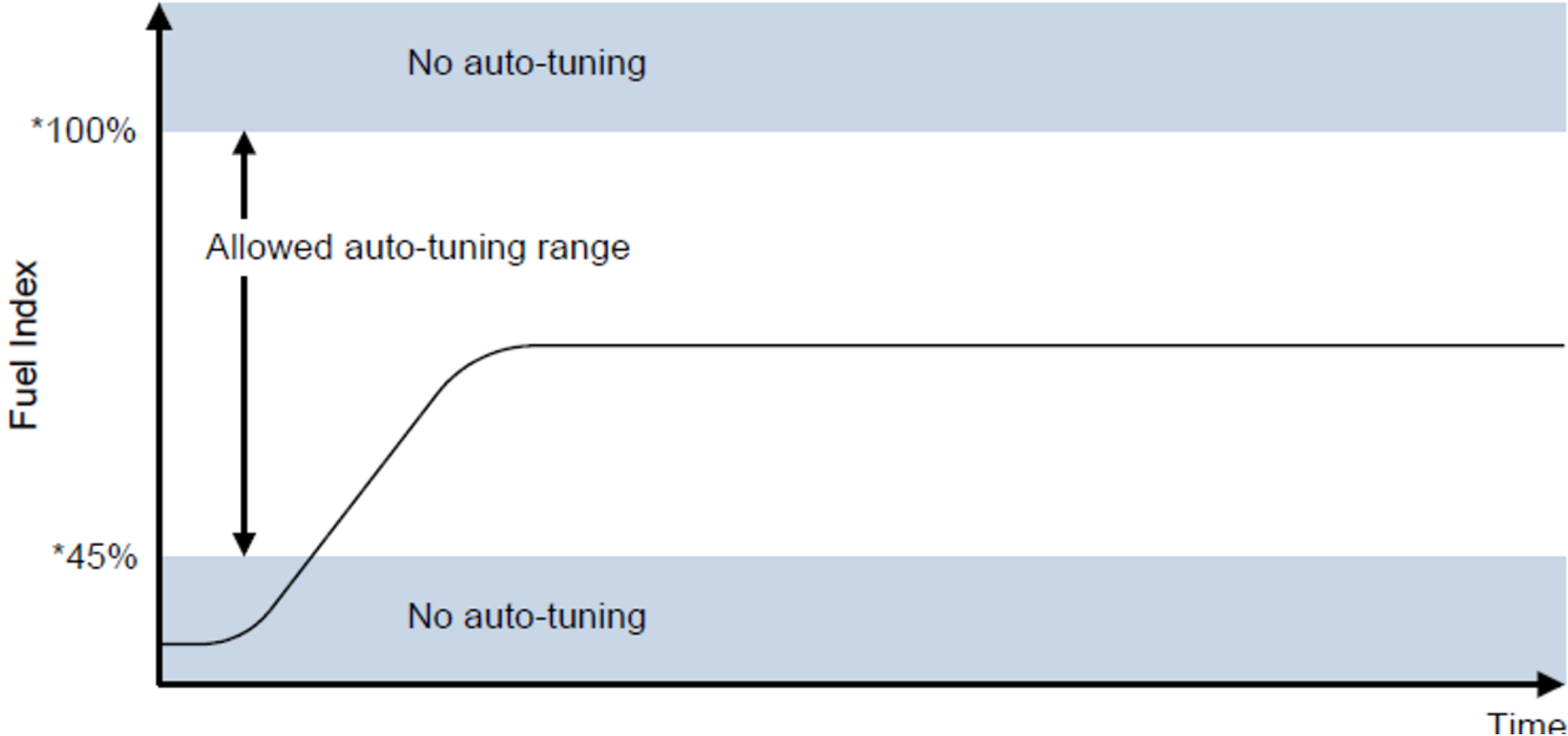
Manually adjusted values

The screenshot displays the 'Engine Process Adjustment' interface. It features a top navigation bar with 'Auto Tuning', 'Cylinder Load', 'Cylinder Press.', and 'Fuel Quality' tabs. Below this, there are three main data sections: Pmax [Bar], Pcomp [Bar], and Pi [Bar]. Each section shows 'Ordered', 'Current', 'Deviation', and 'Offset Auto/Cont.' values. A grid of 12 columns represents individual cylinders. The status bar at the bottom indicates 'STATUS: Tuning allowed' and 'REPORT: Last tuning successful'.

Parameter	Mean	Deviation	1	2	3	4	5	6	7	8	9	10	11	12
Pmax [Bar]														
Ordered	103													
Current	139	-0.1	0.1	-0.1	0.2	0.1	0.0	-0.1	-0.3	0.0	0.2	-0.1	0.1	
Deviation	36.1													
Offset Auto/Cont.	0	-4.3	0	0	0	-6	-6	6	3	-2	-7	-1	2	-3
Pcomp [Bar]														
Ordered	68													
Current	109	-0.3	0.1	0.0	-0.1	0.4	-0.1	-0.1	0.0	0.0	0.1	-0.2	0.2	
Deviation	41.0													
Offset Auto/Cont.	0.0	---	0.0	0.0	0.0	0.5	0.7	0.7	1.3	0.0	0.2	0.0	2.0	0.2
Pi [Bar]														
Ordered	15.0													
Current	15.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Deviation	0.8													
Offset	---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0








# EMS – Engine Management Services

PMI - Auto tuning range



# EMS – Engine Management Services

## PMI - Thresholds

Threshold icon	$P_{\max}$ (bar)	$P_{\text{comp}}$ (bar)	$P_i$ (bar)
	>20	>20	>2
	3 to 20	3 to 20	0.5 to 2
	1 to 3	1 to 3	0.2 to 0.5
	-1 to 1	-1 to 1	-0.2 to 0.2
	-1 to -3	-1 to -3	-0.2 to -0.5
	-3 to -20	-3 to -20	-0.5 to -2
	< -20	< -20	<-2

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This data serves informational purposes only and is especially not guaranteed in any way.

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