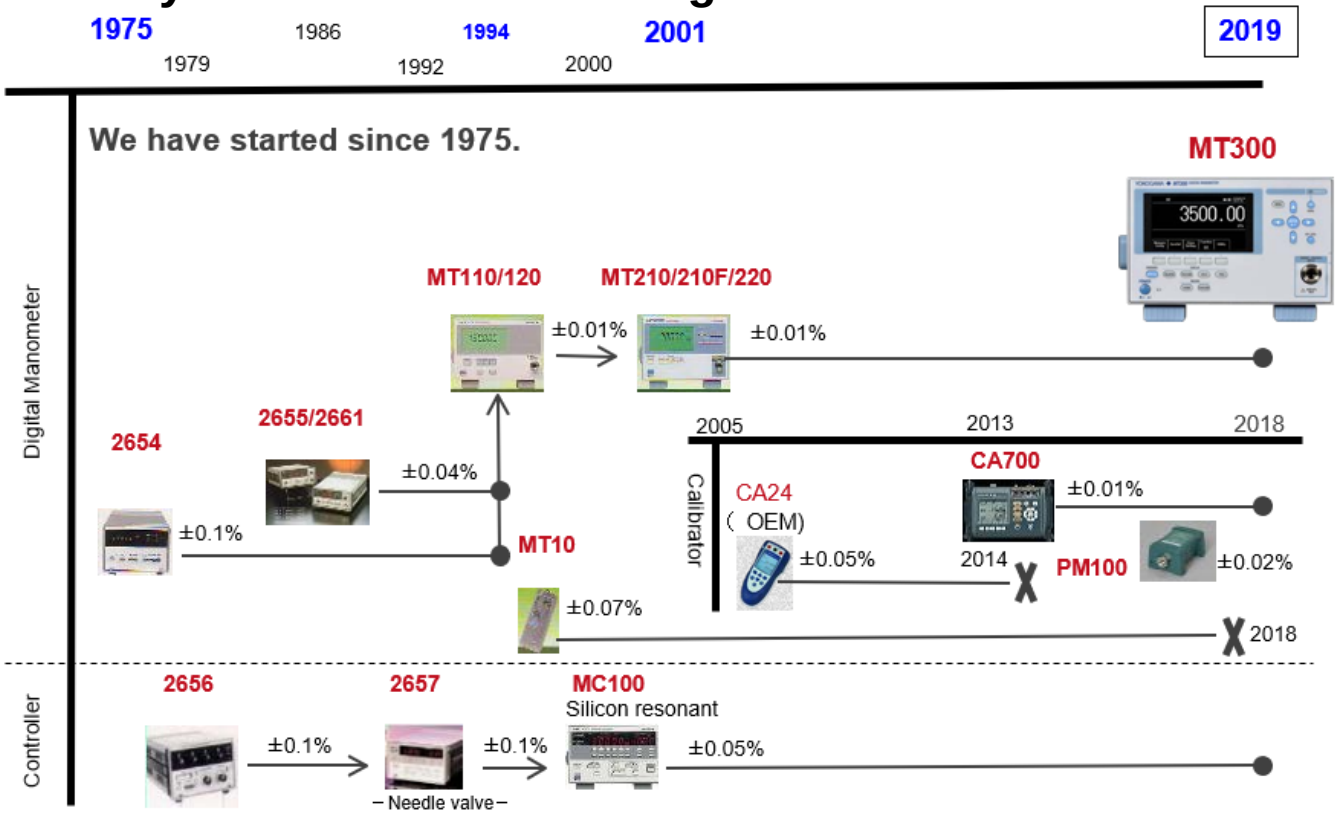
Yokogawa Ventilator Application

3 GOOD HEALTH AND WELL-BEING

17 PARTNERSHIPS FOR THE GOALS

Contents

History of Pressure Measuring Instruments

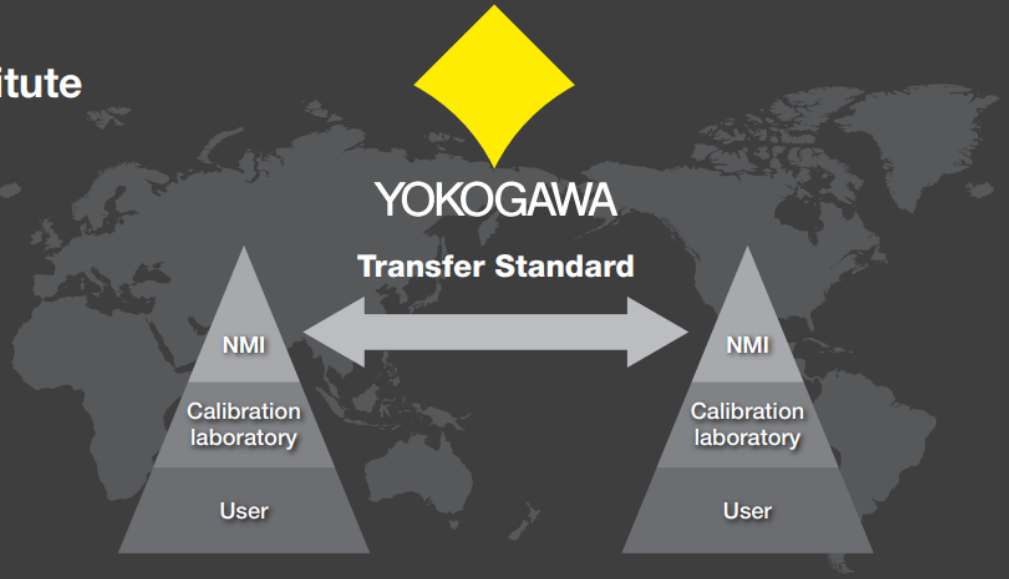


Efforts for National Metrology Institute

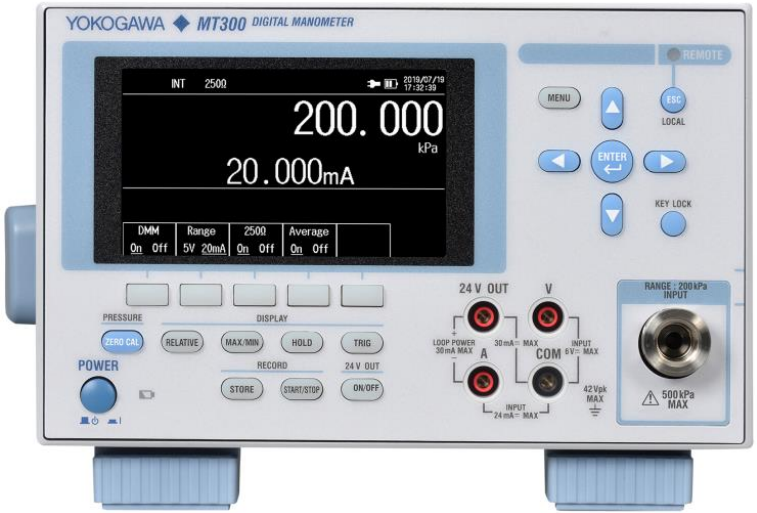
International Comparison

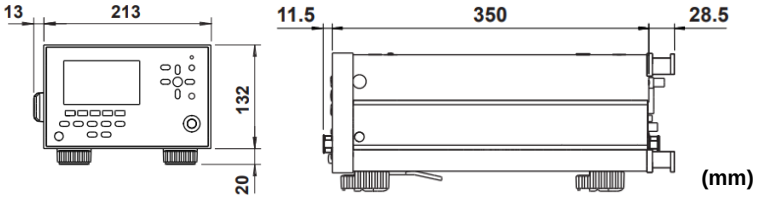
The Yokogawa's pressure sensor and the MT series are adopted as a Transfer Standard for many CC-level and the regional-level (for example APMP) international comparison of pressure standards based on the enhanced performance of digital pressure gauges and the evaluation result of long-term stability.

*Transfer Standard:
A standard used as a transfer equipment to compare standards.



Modern Day Pressure Products





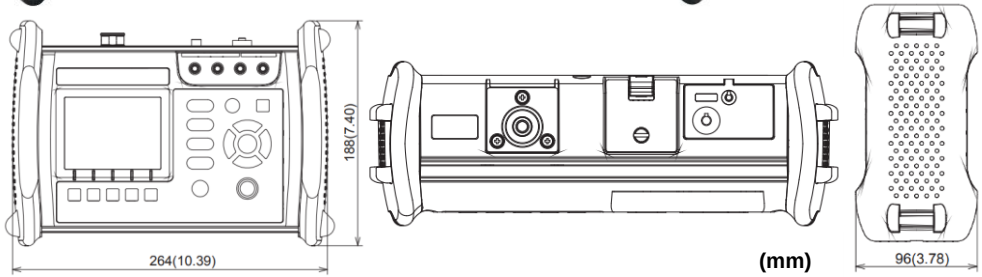
The MT300 delivers high speed, high resolution, and synchronous measurements for high measurement accuracy and long term stability. It offers various functions for field device calibration, including 24 VDC transmitter output, built-in communication resistance, and Li-ion battery operation. The D/A output makes it easy to output data to a recorder or other instrument, and external I/O terminals allow users to output control signals.

Engineered with Yokogawa's silicon-based resonant sensor, the MT300 achieves:

- A high measurement accuracy of 0.01% as absolute accuracy

- Long-term stability performance guaranteed with a measurement accuracy of 12 months

Modern Day Pressure Products



The CA700 Pressure Calibrator has a basic accuracy of 0.01% of reading on pressure measurement and 0.015% of reading on Current/Voltage source/measurement, which makes it the most accurate calibrator in the portable calibrator class. It also has the highest resolution and widest range of any portable instrument, with a resolution of 0.001 kpa (200.00 kpa range) and a resolution of 0.0001 psi (at the 29 psi range).

A high pressure module, the PM100, is now available, that effectively increases the pressure range of the CA700 to 2300 PSI, all the while maintaining the same basic accuracy of 0.01%.

Precision Making

- **Positioning:** Yokogawa Test & Measurement is the world's most trusted measurement partner

- **Purpose:** Yokogawa Test & Measurement gives businesses the confidence to fine-tune their critical R&D decision – and the means to preserve the continuing integrity of those decisions

- **Mission:** Yokogawa Test & Measurement defines measurement as the key driver in delivering sustainable innovation

- **Composition:** Yokogawa Test & Measurement works closely with its customers worldwide to understand their business needs and deliver measurement strategies based on its unique range of premium quality measurement technology

- **Culture:** Yokogawa Test & Measurement takes pride in over 100 years of being inquisitive, loyal and committed to its customers

- **Character:** Yokogawa Test & Measurement is quietly confident, honest, precise and dependable

Precision Making

We are proud of our business, our products and the level of quality we achieve in everything that we do.

We are experts – and people rely on us to help them make decision about life-changing innovations.

Building on over a century of knowledge and experience, measurement is at the heart of everything that we deliver.

We are a community of scientists serving a community of scientists. Pioneers serving pioneers.

We make things happen – accurately, confidently, seamlessly, precisely. And… Every. Detail. Matters.

We are the Precision Makers.

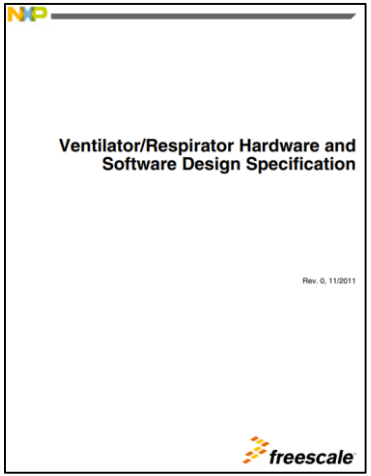
Precision Making

As Precision Makers, we work together to deliver products and services of the very highest standard.

We deliver quality. We delivery accuracy.
We deliver precision.

As individuals – and collectively – Precision Making is our business. **Precision Making is what we do.**

Application



https://www.nxp.com/docs/en/application-note/DRM127.pdf

1.1 Introduction

The ventilator (also known as a respirator) is a pneumatic and electronics system designed to monitor, assist, or control pulmonary ventilation, and respiration intermittently or continuously. It can also be used to control human body oxygen levels, for example during surgery where blood loss can result in hypoxia, or lack of sufficient oxygen in the patient´s body; it is best to have less human interaction. Mechanical ventilation is designed to maintain an adequate exchange of gases, even through diminished breathing rates and reduced myocardial use. However, it can also be used to provide adequate lung expansion, the correct combination of anesthetic sedation for muscle relaxing, and stabilize the thoracic wall.

The respirator is made of a compressed air reservoir, air and oxygen supplies, a set of valves and tubes, and a disposable or reusable patient circuit. The air reservoir is pneumatically compressed several times a minute to deliver room-air or in most cases an air/oxygen mixture. The lungs elasticity allows releasing the overpressure, this is called passive exhalation, and the exhaled air is released usually through a one-way valve within the patient circuit. The oxygen content of the inspired gas can be set from 21 percent (ambient air) to 100 percent (pure oxygen).

This reference design simulates basic human lung behavior. It is easy to test different pulmonary therapies without connecting a lung to the device. The objective of this development platform is to showcase Freescale product capability while developing a ventilator or respirator. it represents a complex application where accurate measurement, correct instrumentation, power manager, and signal integrity are a critical factor for correct operation of a machine which a human life may depend on.

2.1 Features

Main components:

- MCF51MM256 32-bit Coldfire Freescale MCU with analog modules (DAC, internal Op Amps) ideal for medical and instrumentation appliances.
- MPXV5050GP (0 to 50 KPa single pressure) and MPX7002DP (-2 to +2 KPa differential pressure) compensated Freescale sensors.
- MHP1-M4H (14 lts/min, at 5 V, 1 W, 250 Hz, 2/2, M3) electro valves.
- 12 V at 10 A i300 Good Year automotive Air compressor 15 lts/min.
- 500 mA transistors power stage (TIP31C) for valves and buzzer, and a 15 A relay (JSM1A-12V-5) for the air compressor.
- Aluminum air mixture chamber (30 PSI max) 4 outputs (M3).
- Multi-gain analog temperature sensor 0-3 V output voltage.
- 20 X 4 character 5 V LCD display (C-51847NFJ-SLW-ADN).
- Alarm buzzer MAG 2.0 KHZ 3 V
- Tactile buttons and LED indicators.
- USB device connector.
- 1 L anaesthetic bag to simulate human lungs
- Medical Venturi pipe to measure the flow from the pressure difference

Functions:

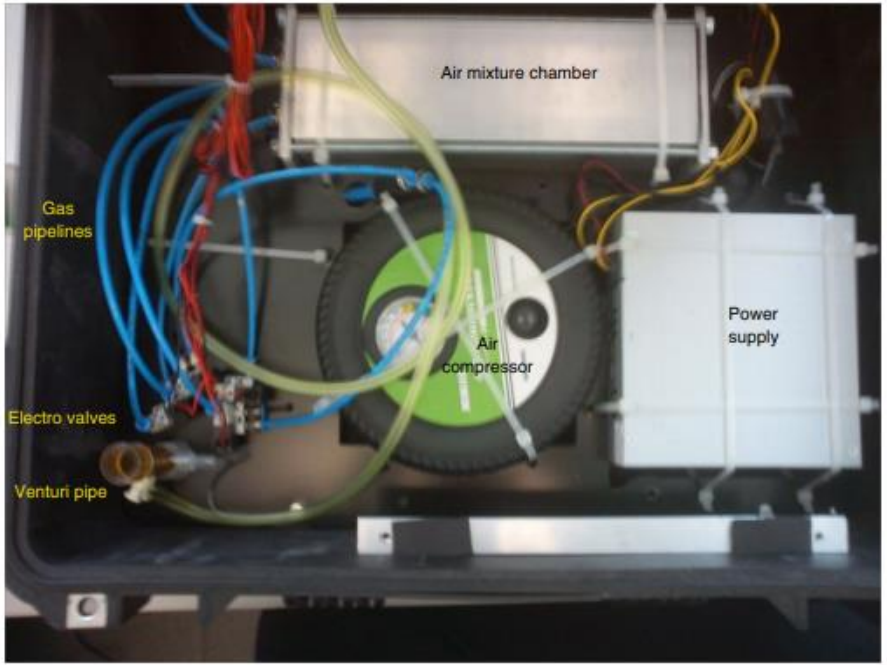
- Moves air in and out of the air container to assist, monitor, or control ventilation
- Control air mixture percentage by pressure.
- Human interface to monitor and control main parameters as respiration frequency, pressure, measure units and control mode.
- Lungs basic behavior simulation (air container bag).
- Three control modes (Pressure, Frequency, and Assisted)
- Control of one air compressor, and supportable PID functions for four valves

Resources:

This system uses the following resources from the MCF51MM256:

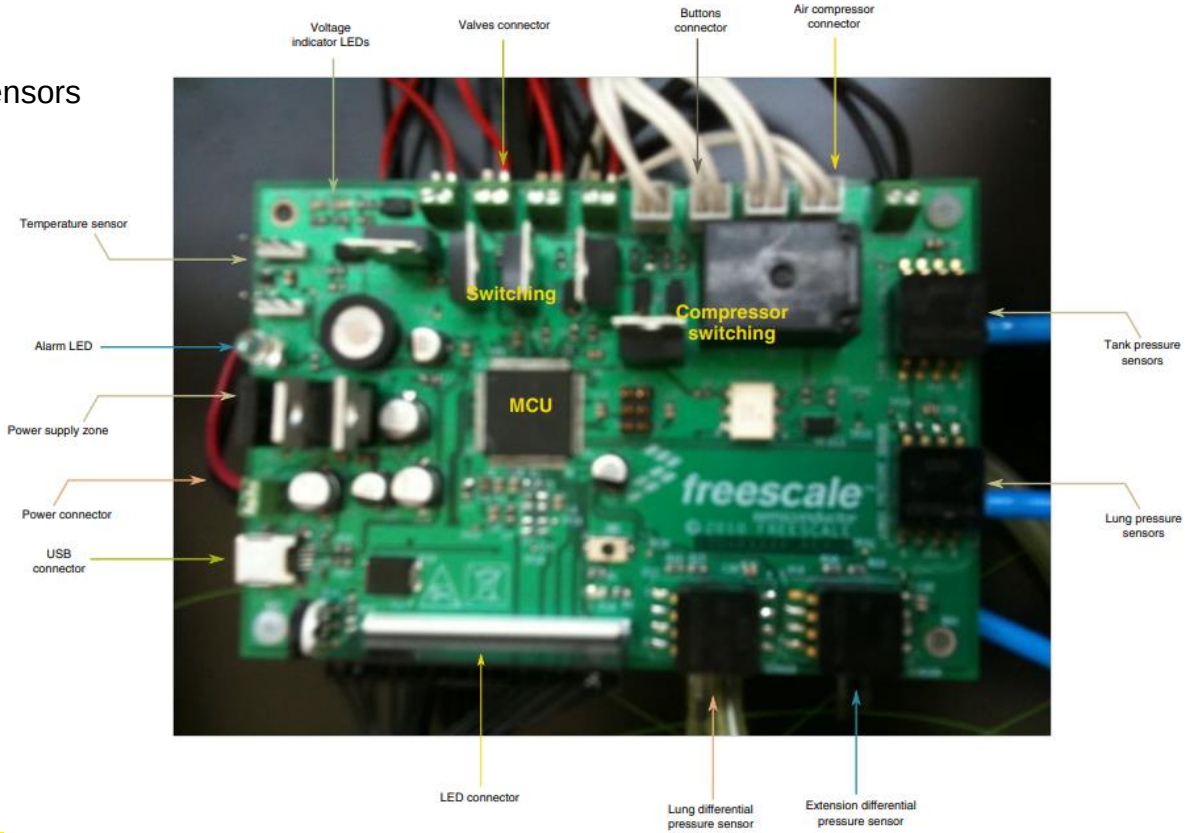
Application

Top layer + Pipes + Valves



Application

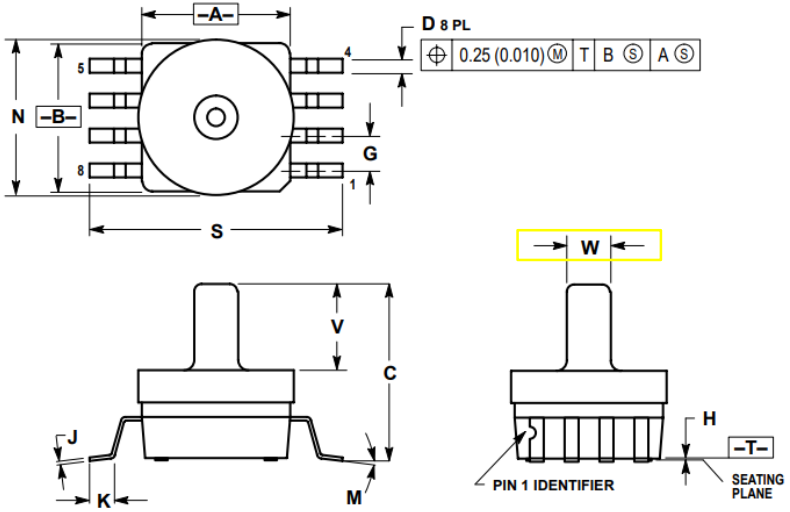
Electronics and Sensors



Application

Pressure

PACKAGE DIMENSIONS



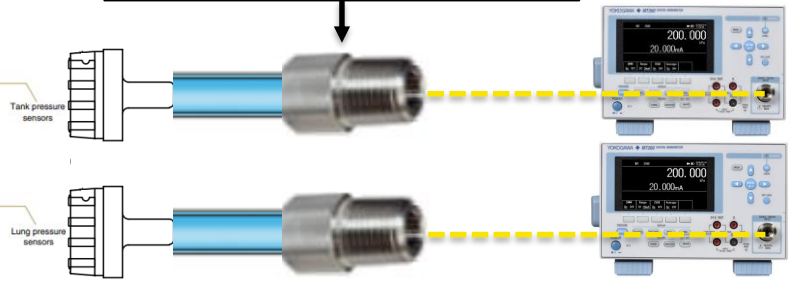
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.415	0.425	10.54	10.79
B	0.415	0.425	10.54	10.79
C	0.500	0.520	12.70	13.21
D	0.038	0.042	0.96	1.07
G	0.100 BSC		2.54 BSC	
H	0.002	0.010	0.05	0.25
J	0.009	0.011	0.23	0.28
K	0.061	0.071	1.55	1.80
M	0°	7°	0°	7°
N	0.444	0.448	11.28	11.38
S	0.709	0.725	18.01	18.41
V	0.245	0.255	6.22	6.48
W	0.115	0.125	2.92	3.17

CASE 482A-01
ISSUE A
UNIBODY PACKAGE

Application

R 1/4” NPT male thread to
1/8” NPT female thread



Yokogawa MT300 Manometer

- Range -80kPa to 3500kPA
- Resolution 0.01kPA to 0.00001kPA
- Accuracy 0.2% to 0.01%
- Measured Update Rate 0.25S to 0.1S

Leak test

The Leak-test feature can be used to measure pressure change or leak rate within the measurement period. It can be used to check the tightness or integrity of a pressure measurement system.

Start: Pressure value and time when started
Stop: Pressure value and time when stopped
Time: Measurement time
Delta: Difference of pressure value between started and stopped
Rate: Deffence of pressure value per minute

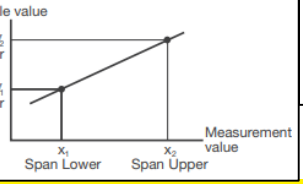
$$\text{Leak rate} = \frac{\text{(Started value)} - \text{(stopped value)}}{\text{Leak test period (minute)}}$$

Scaling

The scaling function can be used to assign customer specific coefficients to the measured values. Depending on the application, you can display your own conversion value. Scaling coefficient A and offset B are determined according to the following equation. Set the scale values for the upper and lower span limits.

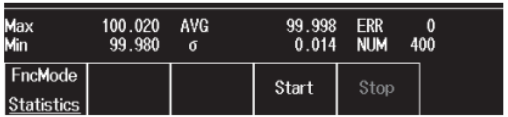
$y = Ax + B$

$$A = \frac{y_2 - y_1}{x_2 - x_1}, \quad B = \frac{x_2 y_1 - x_1 y_2}{x_2 - x_1}$$



Statistical processing

You can apply statistical processing to the data acquired. Find and display the maximum value, minimum value, average value, and standard deviation for the measured data. When error data is detected, the number of error data within the measurement range can be recorded and displayed.



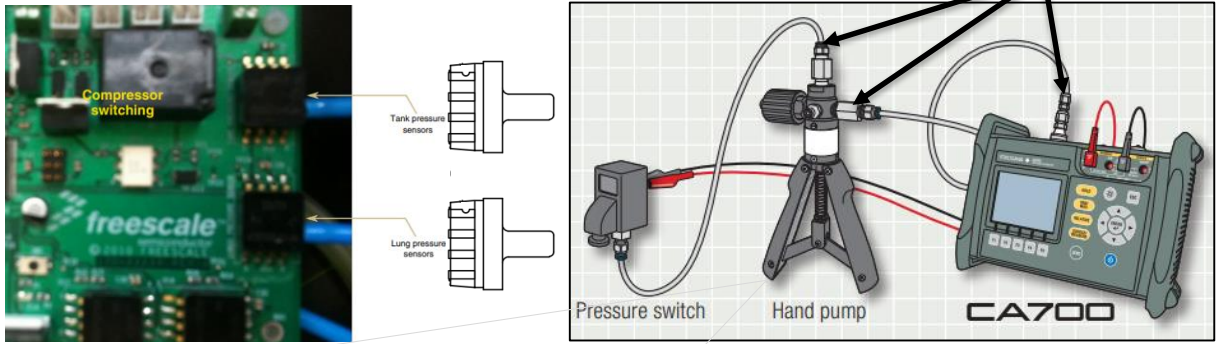
Max: Maximum value
Min: Minimum value
AVG: Average value
σ: Standard deviation
ERR: Number of error data

[Click for Datasheet]

PDF
Data
Sheet

Application

R 1/4” NPT male thread to 1/8” NPT female thread



A pressure switch test measures the pressure at the time when the contact opens and closes and the resistance at the time when the dead band contact closes. A test procedure is embedded to enable users to carry out a test following the prescribed procedure.

Pneumatic Hand Pump
- High-performance small hand pump with a wide range of pressure generation
- Pressure generation range: -83 to 4000 kPa
- Pressure generation ranging from low to medium pressures
- Fine adjustment and pressure reduction possible with one hand
- Smooth pressurization with less internal leaking
- Strainer preventing debris from entering the pump included

Yokogawa CA700 Pressure Calibrator

- Measurement Range -80kPa to 3500kPA
- Measurement Resolution 0.01kPA to 0.001kPA
- Accuracy 0.015%
- Measured Update Rate 0.3

Click for Datasheet

PDF Data Sheet

Application

Medicines & Healthcare products Regulatory Agency

MHRA

Acceptable Performance

- Under steady-state conditions, the indicated airway pressure shall be accurate to within ±(2 +(4 % of the actual reading)) cmH2O.
- The accuracy of measurement of expired volumes greater than 50 ml shall be within ±(4,0 +(15 % of the actual volume expired through the patient-connection port)) ml.
- Oxygen concentrations will be ± 5 % of the set value.
- Disconnect alarm will sound within 3 seconds of disconnection

Pressure Relief Tests

- Set ventilator to 250 – 300 mls tidal volume or 30 cmH2O Inspiratory pressure with 10 cmH2O PEEP at a rate of 10 min -1.
- Set maximum pressure level and alarm to 35 cmH20.
- Compress test lung until pressure alarms and ventilator stoops inflating and alarms
- Record maximum pressure reached.
- Set pressure to maximum value or 70 cmH20, whichever is lower.
- Detach test lung and occlude patient end of breathing system.
- Confirm that pressure in system does not exceed 80 cmH2O and that alarm is activated.

Closed Suctioning Test

- Set ventilator to 250 – 300 mls tidal volume or 30 cmH2O Inspiratory pressure with 10 cmH2O PEEP at a rate of 10 min -1.
- Attach intended breathing system to ventilator.
- Set maximum vacuum to -200 cmH20 when inlet occluded.
- Open suction flow control to a free suction flow of 30 lpm.
- Attach a closed suction system with a 14 Fr catheter fully retracted (important in some systems to produce a gas tight seal)
- Attach a test lung with a compliance of 10ml / cmH2O (+/- 10%) to the patient connection port of the closed suction system
- Advance suction catheter into test lung
- Operate suction control on closed suction system for 3 seconds whilst withdrawing
- Confirm PEEP does not drop below 5 cmH2O
- Retract suction catheter fully. Repeat 5 times
- Repeat but increase suction time to 30 seconds, (PEEP will be lost, and alarms may sound)
- Confirm ventilator returns to default settings when suction is stopped

EMC Testing (TBC)

- Must comply with IEC 60601-1-2:2014, Medical electrical equipment — Part 1-2: General requirements for basic safety and essential performance — Collateral Standard: Electromagnetic disturbances — Requirements and tests

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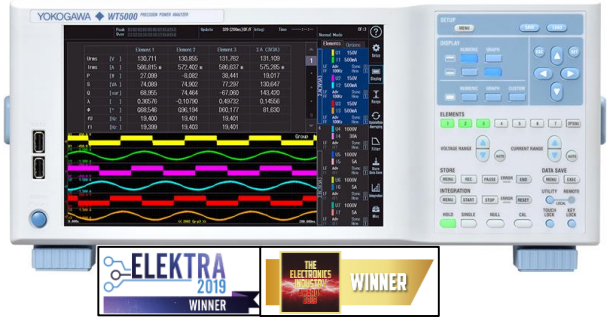
Part of IEC 60601-1-1-2:2014 is the need to test
IEC 61000-3-2 Harmonics and IEC 61000-3-3 Voltage Fluctuations

Application

IEC 61000-3-2 Harmonics and IEC 61000-3-3 Voltage Fluctuations

Yokogawa WT5000 Precision Power Analyser



ISO 17025 ACCREDITED

Power and Harmonics calibrated at International Standards to 100kHz

Yokogawa's European Calibration Laboratory is the world's first non-governmental facility to offer full ISO17025 Accreditation for power measurements at up to 100 kHz. This is in addition to its established capability for providing high-accuracy calibration at 50 Hz, especially at very low power factors (down to 0.0001) and at high currents.

When testing to IEC61000-3-2, the requirement for full frequency range calibration is essential.

Application

IEC 61000-3-2 Harmonics and IEC 61000-3-3 Voltage Fluctuations

Yokogawa WT5000 Precision Power Analyser

Voltage Fluctuation/Flicker Measurement Software for WT5000 (IEC 61000-3-3 Compliant

This free version of harmonic/flicker measurement software*1 allows you to load data measured by the WT5000 onto a PC and perform harmonic measurements conforming to IEC61000-3-2 Ed 4.0. The WT5000 supports the 50/60 Hz (10/12 cycles) of interharmonic measurement required by IEC61000-4-7 Ed 2.0 Am1.

Support of the IEC 61000-4-15 Ed1.1 /Ed2.0.
The flicker meter standard that defines the requirements of the measurement equipment and test method of voltage fluctuation and flicker measurement.

Support of the IEC61000-3-3 Ed2.0 and Ed3.0
The measurement and judgment procedure of the Voltage fluctuation and Flicker requires above international standards as well.

If large current (larger than 16A/phase) equipment test is required, please contact us including current sensors.
***1 This software supports the following standards:**

•Harmonic

- **IEC 61000-3-2: Ed3.0 (2005), Ed3.0 A2 (2009), Ed4.0 (2014)**
- **EN61000-3-2: 2006, 2009, 2014**
- **IEC 61000-3-12: Ed1.0 (2004), Ed2.0 (2011)**
- **EN 61000-3-12: 2005, 2011**
- **IEC 61000-4-7: Ed1.0 (1991), Ed2.0 (2002), Ed2.0 A1 (2008)**
- **EN 61000-4-7: 1993, 2002, 2009**
- **JIS C61000-3-2: 2011**
- **JIS C61000-4-7: 2007**

•Voltage fluctuation/flicker

- **IEC 61000-3-3: Ed2.0 (2008), Ed3.0 (2013)**
- **EN 61000-3-3: 2008, 2013**
- **IEC 61000-3-11: Ed 1.0 (2000)**
- **EN 61000-3-11: 2000**
- **IEC 61000-4-15: Ed1.1 (2003), Ed2.0 (2010)**
- **EN 61000-4-15: 1998, 2003, 2011**

Contact

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Thank you

Precision
Making