PM-PA/PM-PAC
POWER ANALYZER

1. INTRODUCTION

Power Analyzer is an ideal device to control measure and monitor all electrical parameters of a system. Thanks to its four display rows, all parameters can be read easily from the main screen. The device is applicable for mono, two and three phase systems. It can measure and display 123 electrical parameters. The device has three 5A internal secondary current transformer. PM-PAC is as same as of PM-PA but is enhanced with RS 485 Communication via Modbus Protocol (Scada Compatible).

2. USAGE OF PM-PA/PM-PAC

All connection must be done according to the connection diagram (Figure 1). When the device is energized for the first time, first three display will show phase – neutral voltage and total display (bottom display) will show average of phase – neutral voltage of the three phases. To read correct voltage values, primary and secondary voltage value of the voltage transformer must be entered correctly. The correct CT Ratio should be entered in order to obtain correct current readouts. In following to that, the device will start to display the accurate values of current and voltage. L1, L2, L3 points show there phases connection terminal and N point shows neutral connection terminal. External current transformer must be connected to $I1_1$. $I1_2$, $I2_1$-$I2_2$ and $I3_1$-$I3_2$ in a sequence row while K and l point of the external current transformer must be connected separately. In order to obtain the accurate Cosφ, Capacitor Power and Harmonic values, currents and voltages must be matched each other meaning that L1 and I1 must be on the same line.

2.1. Measured Parameters

Parameter	*Total*	*L1*	*L2*	*L3*
VLN	●	●	●	●
VLL	●	●	●	●
I	●	●	●	●
FRQ(Hz)		●		
PF	●	●	●	●
KW	●	●	●	●
KVar	●	●	●	●
KVA	●	●	●	●
KWH(Import)	●			
KWH(Export)	●			
KVarH IND	●			
KVarH CAP	●			
KVAH	●			
VTHD		●	●	●
V3 ÷ V13		●	●	●
ITHD		●	●	●
I3 ÷ I13		●	●	●

The device **PM-PA** measures and displays the following 123 parameters:

- Voltages (L1-N**;** L2-N; L3-N; L1-L2; L2-L3; L1-L3; average L-N; average L-L)
- Currents (L1**;** L2; L3; total)
- Active power (L1**;** L2; L3; total)
- Reactive power (L1**;** L2; L3; total)
- Apparent power (L1**;** L2; L3; total)

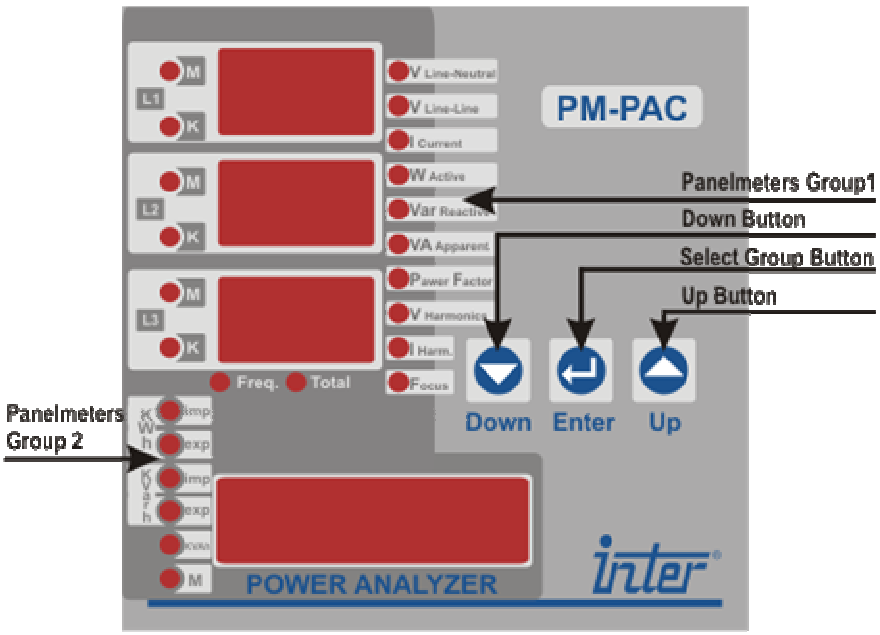
**** Min. and Max values of above parameters***

- Power factor (L1**;** L2; L3; average)
- Voltage harmonics (THD; odd harmonics up to 13-th of L1, L2, L3)
- Current harmonics (THD; odd harmonics up to 13-th of L1, L2, L3)
- Active energy
- Inductive energy
- Capacitive energy
- Apparent energy
- Frequency

3. Applications

- Factory energy control.
- Monitoring and detecting network problems.

4. Front Panel Description



5. View Parameters

Parameters group I – One of nine single LEDs shows the current selected parameter.

Parameters group II - One of six single LEDs shows the current selected parameter.

Select group button – Press to change current **Parameters group -**all single LEDs from new selected Parameters group blink shortly.

Up/Down button – Press any button to change current parameter view.

5.1. Parameter Menus of PM-PA

Menu entry – Press and hold **Set** button for 3 sec.

Appearance:

- L3 Screen – Parameter Name
- Total Screen – Parameter Value

List of Parameters:

Parameter	Description	Range	Default
USc	VT Secondary Voltage (Volt)	20-300	220
UPr	VT Primary Voltage (Volt)	20-120000	220
ctr	CT Ratio	1-2000	1
F.r1	Relay1 Function Type		-nonE-
L.r1*	Relay1 Threshold Value		
t.d1*	Relay1 Time Delay (seconds)	1-180	4
F.r2	Relay2 Function Type		-nonE-
L.r2*	Relay2 Threshold Value		
t.d2*	Relay2 Time Delay (seconds)	1-180	4
SL.A**	Slave Address of Device	1-247	1
Bdr**	Baud Rate (bps)	1200/115200	9600
St.b**	Stop Bits	1/2	1
Clr	Clear Energy Counters	Hold down to few sec. from Down button.	
Loc	Password	No / Yes	Must Be C.XX+XX=99 Example: C.25 + 74 =99
End	Exit From Menu		

*** :If F.rx value is set to nonE parameters are invisible.**

**** : Paremeters exist only in devices with optional RS485 communication interface**

Parameters Scrolling and Value Editing:

- Parameters Scrolling Mode – **Total LED** lights and **Up/Down** buttons scroll the parameters
- Value Editing Mode – **Total LED** doesn't light and **Up/Down** buttons change the value

Set button shifts between modes.

Exit from Parameters menu : Select End parameter and press Set button

Relay Function type:

Function Name	Description
-nonE-	Nothing is assigned to Relay
t.Hi.VLn	Average Line-Neutral Voltage is High
Hi.VLn	One of Line-Neautral Voltages is High
t.Lo.VLn	Average Line-Neutral Voltage is Low
Lo.VLn	One of Line-Neautral Voltages is Low
t.Hi.VLL	Average Line-Line Voltage is High
Hi.VLL	One of the Line-Line Voltages is High
t.Lo.VLL	Average Line-Line Voltage is Low
Lo.VLL	One of the Line-Line Voltages is Low
t.Hi. I	Total Current is High
Hi. I	One of Line Currents is High
t.Lo. I	Total Current is Low
Lo. I	One of Line Currents is Low
t.Hi.Ac.P	Total Active Power is High
Hi.Ac.P	One of Line's Active Power is High
t.Lo.Ac.P	Total of Active Power is Low
Lo.Ac.P	One of Line's Active Power is Low
t.Hi. r.P	Total Reactive Power is High
Hi. r.P	One of Line's Reactive Power is High
t.Lo. r.P	Total Reactive Power is Low
Lo. r.P	One of Lines Reactive Power is Low
t.Hi.AP.P	Total Apparent Power is High
Hi.AP.P	One of Lines Apparent Power is High
t.Lo.AP.P	Total Apparent Power is Low
Lo.AP.P	One of Lines Apparent Power is Low

Example 1:

F.r1 : t.Hi.Ac.P

L.r1 : 50000

Total Active Power < 50000 W : Relay 1 – OFF Total Active

Power > 50000 W : Relay 1 – ON

Example 2:

F.r1 : t.Lo.Ac.P L.r1 : 35000

Total Active Power < 35000 W : Relay 1 – ON Total Active

Power > 35000 W : Relay 1 – OFF

Example 3:

F.r2 : Hi.Ac.P

L.r2 : 20000

Active Power of each Line < 20000 W : Relay 2 – OFF Active

Power of one Line > 20000 W : Relay 2 – ON

Example 4:

F.r1 : -nonE-

L.r1 and t.d1 parameters are invisible

Relay 1 is Always OFF

Power Analyzer PM-PAC MODBUS Communication Description

The communication port of PM-PA is based on:

- Asynchronous serial transmission over 2 wire RS485 network (EIA/TIA-485 Standard)
- Modbus Protocol – RTU (Remote Terminal Unit) Mode

The format for each byte in RTU mode is:

Coding System: 8–bit binary, hexadecimal 0–9, A–F Two hexadecimal characters contained in each 8–bit field of the message

Bits per Byte: 1 start bit
8 data bits, least significant bit sent first
1 stop bit (dtb=8); 2 stop bits (dtb=9)

Error Check Field: Cyclical Redundancy Check (CRC)

The device supports 2 asynchronous serial transmission speeds: 4800bps and 9600bps

Each message must be transmitted in a continuous stream with the following stucture:

Slave Address *1 byte*	Function Code *1 byte*	Data *n bytes*	CRC *2 bytes*

Available Slave Addresses are from 1 to 247.

Broadcast messages (query with Slave Address 0) are not supported. The length of messages must be up to 64 bytes (including Slave Address and CRC). Supported MODBUS Functions:

03 (0x03) Read Holding Registers

06 (0x06) Write Single Register

08 (0x08) Diagnostics (Loopback Message)

16 (0x10) Write Multiple registers

17 (0x11) Report Slave ID Function 17 (0x11) reports as response the string "PM-PA_V*x*_MB*y*", where *x* and *y* are Firmware and Modbus Table versions respectively.

Supported MODBUS Exception Codes :

01 ILLEGAL FUNCTION

02 ILLEGAL DATA ADDRESS

03 ILLEGAL DATA VALUE

POWER ANALYZER PM-PAC

MODBUS TABLE VER.1

Register Address	Register Name	Data Format	Access	Comment
1	Relays Status	Word	R	0 – Both Relays OFF 1 – REL1-ON; REL2-OFF 2 – REL1-OFF; REL2-ON 3 – Both Relays ON
2	Switch ON Relay *n*	Word	W	1 - Switch ON REL1 2 - Switch ON REL2
3	Switch OFF Relay *n*	Word	W	1 - Switch OFF REL1 2 - Switch OFF REL2
4	Clear Counters	Word	W	Writting something clears all Energy Counters
5	Reset Min. Max. Values	Word	W	Writing: 0 – Resets all Min. and Max. Values 1 – Resets Min. and Max. Phase Voltages 2 – Resets Min. and Max. Line Voltages 3 – Resets Min. and Max. Currents 4 – Resets Min. and Max. Active Powers 5 – Resets Min. and Max. Reactive Powers 6 – Resets Min. and Max. Apparent Powers
6	Current Tranformer Ratio [ctr]	Word	R / W	1÷2000 Current Tranformer Ratio
7	Function of Relay 1 [F.r1]	Word	R / W	**24** – No function Value binary map: ***00000000000ppphht: 1*** – total ; ***0*** – any line ***h: 1*** – High Limit; ***0*** – Low Limit parameter index ***ppp***: **000** – Apparent Power **001** – Reactive Power **010** – Active Power **011** – Current **100** – Line Voltage **101** – Phase Voltage
8	Function of Relay 2 [F.r2]	Word	R / W	*Like Relay 1*
9	Time Delay of Relay 1 [t.d1]	Word	R / W	1÷180 sec Switching On/Off time delay of REL1
10	Time Delay of Relay 2 [t.d2]	Word	R / W	1÷180 sec Switching On/Off time delay of REL2
11	Device Slave Address [SL.A]	Word	R / W	1÷247 Modbus Slave Address of Device
12	Baud Rate [bdr]	Word	R / W	1 – 9600 bps; 0 – 4800 bps
13	Data Bits [dtb]	Word	R / W	1 – 9 bits; 0 – 8 bits
44	Limit of Relay 1 [L.r1]	LongInt	R / W	Limit of Relay 1 Function
46	Limit of Relay 2 [L.r2]	LongInt	R / W	Limit of Relay 2 Function

Register Address	Register Name	Data Format	Access	Comment
48	Frequency	Float	R	Frequency of Line 1
50	ULN1	Float	R	Phase Voltage of Line 1
52	ULN2	Float	R	Phase Voltage of Line 2
54	ULN3	Float	R	Phase Voltage of Line 3
56	ULNavrg	Float	R	Average of Phase Voltages
58	ULL1	Float	R	Line 1 to Line 2 Voltage
60	ULL2	Float	R	Line 2 to Line 3 Voltage
62	ULL3	Float	R	Line 3 to Line 1 Voltage
64	ULLavrg	Float	R	Average of Line Voltages
66	I1	Float	R	Current of Line 1
68	I2	Float	R	Current of Line 2
70	I3	Float	R	Current of Line 3
72	I-total	Float	R	Total Current
74	P1	Float	R	Active Power of Line 1
76	P2	Float	R	Active Power of Line 2
78	P3	Float	R	Active Power of Line 3
80	P-total	Float	R	Total Active Power
82	Q1	Float	R	Reactive Power of Line 1
84	Q2	Float	R	Reactive Power of Line 2
86	Q3	Float	R	Reactive Power of Line 3
88	Q-total	Float	R	Total Reactive Power
90	S1	Float	R	Apparent Power of Line 1
92	S2	Float	R	Apparent Power of Line 2
94	S3	Float	R	Apparent Power of Line 3
96	S-total	Float	R	Total Apparent Power
98	PF1	Float	R	Power Factor of Line 1
100	PF2	Float	R	Power Factor of Line 2
102	PF3	Float	R	Power Factor of Line 3
104	PF-total	Float	R	Total Power Factor
106	Active Energy	LongWord	R	Active Energy Counter
108	Inductive Energy	LongWord	R	Inductive Energy Counter
110	Capacitive Energy	LongWord	R	Capacitive Energy Counter
112	Apparent Energy	LongWord	R	Apparent Energy Counter
114	L1:VTHD	Float	R	THD of Line 1 Phase Voltage
116	L2:VTHD	Float	R	THD of Line 2 Phase Voltage
118	L3:VTHD	Float	R	THD of Line 3 Phase Voltage
120	L1:ITHD	Float	R	THD of Line 1 Current
122	L2:ITHD	Float	R	THD of Line 2 Current

Register Address	Register Name	Data Format	Access	Comment
124	L3:ITHD	Float	R	THD of Line 3 Current
126	L1:V3	Float	R	3-rd harmonic of Line 1 Phase Voltage
128	L2:V3	Float	R	3-rd harmonic of Line 2 Phase Voltage
130	L3:V3	Float	R	3-rd harmonic of Line 3 Phase Voltage
132	L1:I3	Float	R	3-rd harmonic of Line 1 Current
134	L2:I3	Float	R	3-rd harmonic of Line 2 Current
136	L3:I3	Float	R	3-rd harmonic of Line 3 Current
138	L1:V5	Float	R	5-th harmonic of Line 1 Phase Voltage
140	L2:V5	Float	R	5-th harmonic of Line 2 Phase Voltage
142	L3:V5	Float	R	5-th harmonic of Line 3 Phase Voltage
144	L1:I5	Float	R	5-th harmonic of Line 1 Current
146	L2:I5	Float	R	5-th harmonic of Line 2 Current
148	L3:I5	Float	R	5-th harmonic of Line 3 Current
150	L1:V7	Float	R	7-th harmonic of Line 1 Phase Voltage
152	L2:V7	Float	R	7-th harmonic of Line 2 Phase Voltage
154	L3:V7	Float	R	7-th harmonic of Line 3 Phase Voltage
156	L1:I7	Float	R	7-th harmonic of Line 1 Current
158	L2:I7	Float	R	7-th harmonic of Line 2 Current
160	L3:I7	Float	R	7-th harmonic of Line 3 Current
162	L1:V9	Float	R	9-th harmonic of Line 1 Phase Voltage
164	L2:V9	Float	R	9-th harmonic of Line 2 Phase Voltage
166	L3:V9	Float	R	9-th harmonic of Line 3 Phase Voltage
168	L1:I9	Float	R	9-th harmonic of Line 1 Current
170	L2:I9	Float	R	9-th harmonic of Line 2 Current
172	L3:I9	Float	R	9-th harmonic of Line 3 Current
174	L1:V11	Float	R	11-th harmonic of Line 1 Phase Voltage
176	L2:V11	Float	R	11-th harmonic of Line 2 Phase Voltage
178	L3:V11	Float	R	11-th harmonic of Line 3 Phase Voltage
180	L1:I11	Float	R	11-th harmonic of Line 1 Current
182	L2:I11	Float	R	11-th harmonic of Line 2 Current
184	L3:I11	Float	R	11-th harmonic of Line 3 Current
186	L1:V13	Float	R	13-th harmonic of Line 1 Phase Voltage
188	L2:V13	Float	R	13-th harmonic of Line 2 Phase Voltage
190	L3:V13	Float	R	13-th harmonic of Line 3 Phase Voltage
192	L1:I13	Float	R	13-th harmonic of Line 1 Current
194	L2:I13	Float	R	13-th harmonic of Line 2 Current
196	L3:I13	Float	R	13-th harmonic of Line 3 Current
198	minULN1	Float	R	Min. Phase Voltage of Line 1

Register Address	Register Name	Data Format	Access	Comment
200	minULN2	Float	R	Min. Phase Voltage of Line 2
202	minULN3	Float	R	Min. Phase Voltage of Line 3
204	minULNavrg	Float	R	Min. Average of Phase Voltages
206	minULL1	Float	R	Min. Line 1 to Line 2 Voltage
208	minULL2	Float	R	Min. Line 2 to Line 3 Voltage
210	minULL3	Float	R	Min. Line 3 to Line 1 Voltage
212	minULLavrg	Float	R	Min. Average of Line Voltages
214	minI1	Float	R	Min. Current of Line 1
216	minI2	Float	R	Min. Current of Line 2
218	minI3	Float	R	Min. Current of Line 3
220	minI-total	Float	R	Min. Total Current
222	minP1	Float	R	Min. Active Power of Line 1
224	minP2	Float	R	Min. Active Power of Line 2
226	minP3	Float	R	Min. Active Power of Line 3
228	minP-total	Float	R	Min. Total Active Power
230	minQ1	Float	R	Min. Reactive Power of Line 1
232	minQ2	Float	R	Min. Reactive Power of Line 2
234	minQ3	Float	R	Min. Reactive Power of Line 3
236	minQ-total	Float	R	Min. Total Reactive Power
238	minS1	Float	R	Min. Apparent Power of Line 1
240	minS2	Float	R	Min. Apparent Power of Line 2
242	minS3	Float	R	Min. Apparent Power of Line 3
244	minS-total	Float	R	Min. Total Apparent Power
246	maxULN1	Float	R	Max. Phase Voltage of Line 1
248	maxULN2	Float	R	Max. Phase Voltage of Line 2
250	maxULN3	Float	R	Max. Phase Voltage of Line 3
252	maxULNavrg	Float	R	Max. Average of Phase Voltages
254	maxULL1	Float	R	Max. Line 1 to Line 2 Voltage
256	maxULL2	Float	R	Max. Line 2 to Line 3 Voltage
258	maxULL3	Float	R	Max. Line 3 to Line 1 Voltage
260	maxULLavrg	Float	R	Max. Average of Line Voltages
262	maxI1	Float	R	Max. Current of Line 1
264	maxI2	Float	R	Max. Current of Line 2
266	maxI3	Float	R	Max. Current of Line 3
268	maxI-total	Float	R	Max. Total Current
270	maxP1	Float	R	Max. Active Power of Line 1
272	maxP2	Float	R	Max. Active Power of Line 2
274	maxP3	Float	R	Max. Active Power of Line 3

Register Address	Register Name	Data Format	Access	Comment
276	maxP-total	Float	R	Max. Total Active Power
278	maxQ1	Float	R	Max. Reactive Power of Line 1
280	maxQ2	Float	R	Max. Reactive Power of Line 2
282	maxQ3	Float	R	Max. Reactive Power of Line 3
284	maxQ-total	Float	R	Max. Total Reactive Power
286	maxS1	Float	R	Max. Apparent Power of Line 1
288	maxS2	Float	R	Max. Apparent Power of Line 2
290	maxS3	Float	R	Max. Apparent Power of Line 3
292	maxS-total	Float	R	Max. Total Apparent Power

Error Checking Method

Messages include an error–checking field that is based on a Cyclical Redundancy Check (CRC) method. The CRC field checks the contents of the entire message. It is applied regardless of any parity check method used for the individual characters of the message. The CRC field is two bytes, containing a 16–bit binary value.

CONNECTION DIAGRAMS

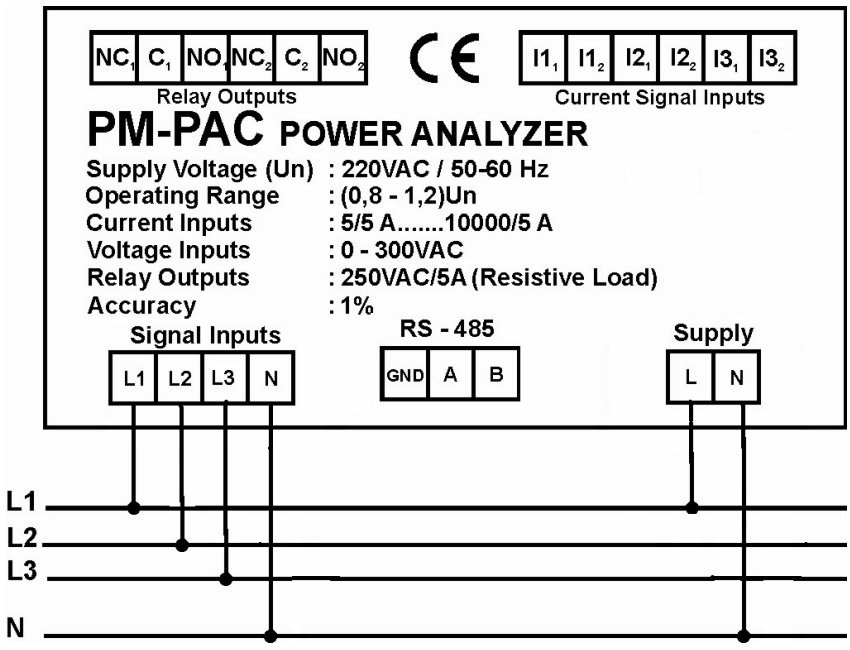


Figure-1 Connection Diagram (For PM-PAC)

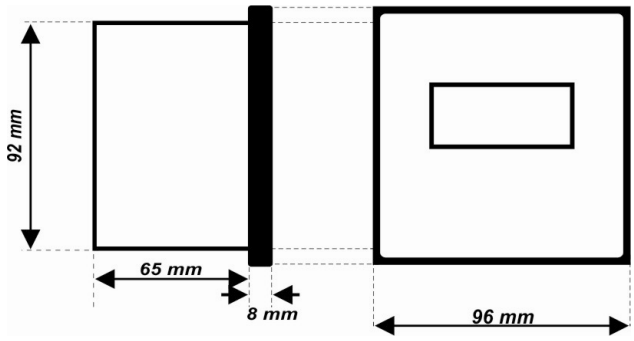
TECHNICAL SPECIFICATIONS

Operating Voltage (Un)	220VAC
Operating Range	(0.8-1.2)xUn
Operating Frequency	50/60 Hz
Display	Seven-segment 9 mm red LED's, 3 digit on 3 lines and 6 digits energy and total display
Voltmeter inputs	VL1, VL2, VL3, N : 0-300 V ~ phase-neutral, 0-500 V ~ phase-to-phase, 50-60 Hz.
Sampling rate	64 samples per period
Amperometric inputs	AL1, AL2, AL3, COM. Three /5A external current transformer required
Amper. input overload	max 7 A ~ permanent. 20A for 1 second.
Number of displays	Four rows 7 segment LED Display
Measurements	T.R.M.S, up to 13th harmonic (50 Hz), 9th (60 Hz)
Accuracy	1% reading per V and I; 2% for Power
Suitable for connection to	Single phase or Three phase systems.
Relative humidity range (R.H.)	from 20% to 80%, without condensation
Protection Class	device IP20, front panel IP30
Plastic Material	V0 Nonflammable
Operating Temperature	-25°C…. + 65°C
Weight	**PM-PA:** 475 gr., **PM-PAC:** 515 gr.

SAFETY & WARNING INSTRUCTIONS

- Turn off power during connection/wiring.
- Check correct mains voltage/wiring terminal.
- Installation shall only be performed by qualified personnel.
- Do not use any solvent or alike for cleaning.

MECHANICAL DIMENSIONS



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