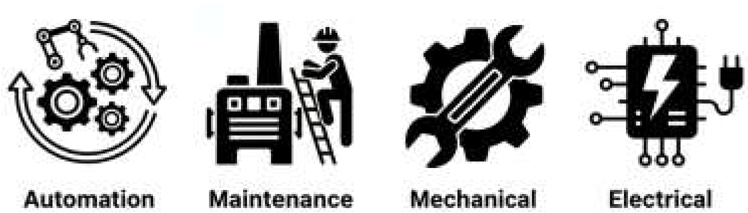
BIN95 Unit Conversion Charts Handout

Industrial Engineering Reference Manual



A comprehensive, printable reference of unit conversions and engineering charts used in automation, electrical, mechanical, and maintenance disciplines. These charts and references are from the free online Unit Conversion Chart App by BIN96. The app is highly interactive and includes additional commonly used unit-conversion calculators and charts.

Version: 1.0
Date: 12/26/2025

Publisher: BIN95 Industrial Training

Table of Contents

Automation Group

This section contains core automation reference charts used in PLC programming, motion control, instrumentation, and industrial automation diagnostics.

Motion & Kinematics

Acceleration Conversion Chart

Conversion factors for linear acceleration used in motion control and robotics.

From / To	**m/s²**	**ft/s²**	**g (gravity)**
m/s²	1	3.28084	0.1019716
ft/s²	0.3048	1	0.03108095
g	9.80665	32.17405	1

Speed Conversion Chart

Speed conversions are commonly used in conveyors, drives, and motion systems.

From / To	**m/s**	**ft/s**	**km/h**	**mph**
m/s	1	3.28084	3.6	2.23694
ft/s	0.3048	1	1.09728	0.681818
km/h	0.277778	0.911344	1	0.621371
mph	0.44704	1.46667	1.60934	1

Velocity Conversion Chart

Linear velocity conversions are used in drives, actuators, and motion tuning.

From / To	**m/s**	**ft/min**	**in/s**
m/s	1	196.8504	39.3701
ft/min	0.00508	1	0.2
in/s	0.0254	5	1

Magnetic & Electric Fields

Electric Field Strength Conversion Chart

Electric field intensity conversions used in sensors, EMC, and automation design.

From / To	**V/m**	**kV/m**	**V/cm**
V/m	1	0.001	0.01
kV/m	1000	1	10
V/cm	100	0.1	1

Magnetic Field Strength Conversion Chart

Magnetic field strength conversions used in inductive sensors and automation design.

From / To	**A/m**	**Oersted**
A/m	1	0.012566
Oersted	79.5775	1

Magnetic Flux Conversion Chart

Magnetic flux conversions are used in motors, transformers, and automation components.

From / To	**Weber (Wb)**	**Maxwell**
Wb	1	1e8
Maxwell	1e-8	1

Magnetic Flux Density Conversion Chart

Magnetic flux density conversions are used in sensors, motors, and automation systems.

From / To	**Tesla (T)**	**Gauss (G)**
Tesla	1	10000
Gauss	0.0001	1

Pressure & Force

Pressure Conversion Chart

Pressure conversions used in pneumatics, hydraulics, and instrumentation.

From / To	**psi**	**bar**	**kPa**	**atm**
psi	1	0.0689476	6.89476	0.068046
bar	14.5038	1	100	0.986923
kPa	0.145038	0.01	1	0.00986923
atm	14.6959	1.01325	101.325	1

Force Conversion Chart

Force conversions are used in mechanical systems, actuators, and load calculations.

From / To	**Newton (N)**	**lbf**	**kgf**
N	1	0.224809	0.101972
lbf	4.44822	1	0.453592
kgf	9.80665	2.20462	1

Torque Conversion Chart

Torque conversions are used in motors, gearboxes, and mechanical drives.

From / To	**N·m**	**ft·lb**	**in·lb**
N·m	1	0.737562	8.85075
ft·lb	1.35582	1	12
in·lb	0.112985	0.0833333	1

Torque Unit Conversion Chart

Unit	Symbol	Equivalent
Newton-meter	**Nm**	1 Nm = 0.737562 ft·lb
Kilogram-force meter	**kgfm**	1 kgfm = 9.80665 Nm
Foot-pound	**ft·lb**	1 ft·lb = 1.35582 Nm
Inch-pound	**in·lb**	1 in·lb = 0.112985 Nm

Automation Reference Tables

ASCII Control Characters Table

ASCII codes are used in serial communication, HMIs, barcode scanners, and PLC messaging.

Dec	Hex	Binary	ASCII	Description
0	00	00000000	NUL	Null
1	01	00000001	SOH	Start of Heading
2	02	00000010	STX	Start of Text
3	03	00000011	ETX	End of Text
4	04	00000100	EOT	End of Transmission
5	05	00000101	ENQ	Enquiry
6	06	00000110	ACK	Acknowledge
7	07	00000111	BEL	Bell
8	08	00001000	BS	Backspace
9	09	00001001	TAB	Horizontal Tab
10	0A	00001010	LF	Line Feed
11	0B	00001011	VT	Vertical Tab
12	0C	00001100	FF	Form Feed
13	0D	00001101	CR	Carriage Return
14	0E	00001110	SO	Shift Out
15	0F	00001111	SI	Shift In

Number System Conversion Chart

Binary, octal, decimal, and hexadecimal values are used in PLC addressing and diagnostics.

Decimal	Binary	Octal	Hex
0	0000	0	0
1	0001	1	1
2	0010	2	2
3	0011	3	3
4	0100	4	4
5	0101	5	5
6	0110	6	6
7	0111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F

PLC Data Types Reference Chart

Standard PLC data types, including BOOL, INT, DINT, REAL, and STRING, are used across Allen-Bradley, Siemens, and IEC-based controllers.

Data Type	Size	Range / Description	Common Uses
BOOL	1 bit	0 or 1	Discrete inputs/outputs, status flags, interlocks
SINT	8 bits (1 byte)	-128 to +127	Small counters, byte-level data, and ASCII characters
INT	16 bits (2 bytes)	-32,768 to +32,767	Timers, analog raw values, general-purpose integers
DINT	32 bits (4 bytes)	-2,147,483,648 to +2,147,483,647	High-resolution counters, math operations, timestamps
REAL	32 bits (4 bytes)	Floating point (approx. $\pm 3.4 \times 10^{38}$)	Scaled engineering units, PID loops, calculations
LREAL	64 bits (8 bytes)	Double-precision floating point	High-precision math, advanced control algorithms
STRING	Variable (typically	Length byte + characters	HMI messages, serial communication, recipe names
TIMER (TON/TOF/RTO)	Structure	PRE, ACC, DN, TT, EN bits	Delays, sequencing, and machine timing
COUNTER (CTU/CTD)	Structure	PRE, ACC, CU/CD, DN bits	Event counting, production tracking
UDT	User-defined	Custom structure	Standardizing machine modules, reusable code

Notes:

- PLC data types follow IEC 61131-3 standards but vary slightly by vendor.
- Allen-Bradley uses BOOL, SINT, INT, DINT, REAL, STRING, TIMER, COUNTER, and UDTs extensively.
- Siemens uses BOOL, BYTE, WORD, DWORD, INT, DINT, REAL, LREAL, and STRING.
- Choosing the correct data type improves scan time, memory usage, and program clarity.

IEC 61131-3 Programming Languages Chart

Overview of Ladder Diagram, Function Block Diagram, Structured Text, Sequential Function Chart, and Instruction List.

Language	Type	Description	Common Uses
Ladder Diagram (LD)	Graphical	Relay-style logic using contacts, coils, timers, and counters.	Discrete control, interlocks, machine logic, maintenance-friendly programming
Function Block Diagram (FBD)	Graphical	Blocks connected by signal lines representing functions and operations.	PIDs, analog processing, reusable logic blocks, process control
Structured Text (ST)	Text-based	High-level language similar to Pascal; supports loops, math, and complex logic.	Advanced algorithms, data handling, calculations, and modular programming
Sequential Function Chart (SFC)	Graphical	Step-and-transition model for sequencing operations.	Batch processes, multi-step machines, state-based control
Instruction List (IL)	Text-based	Low-level mnemonic instructions (deprecated in modern standards).	Legacy systems, compact logic, simple arithmetic

Notes:

- IEC 61131-3 defines the standard programming languages used in PLCs worldwide.
- Most modern platforms support LD, FBD, ST, and SFC; IL remains for legacy compatibility.
- Choosing the correct language improves readability, maintainability, and troubleshooting efficiency.

Ladder Logic Symbols Reference

Common ladder logic symbols, including XIC, XIO, OTE, timers, counters, and control instructions used in PLC programming.

Symbol / Instruction	Meaning	Description	Common Uses
XIC	Examine If Closed	True when the referenced bit is ON (1).	Start conditions, permissives, interlocks
XIO	Examine If Open	True when the referenced bit is OFF (0).	Fault conditions, stop logic, safety checks
OTE	Output Energize	Sets a bit ON when rung logic is true.	Coils, outputs, internal bits
OTL	Output Latch	Turns a bit ON and keeps it ON until unlatched.	Mode bits, machine states, latching circuits
OTU	Output Unlatch	Turns a latched bit OFF.	Resetting states, clearing latches
TON	Timer On Delay	Delays turning ON until the preset time elapses.	Start delays, sequencing, debounce logic
TOF	Timer Off Delay	Delays turning OFF after logic goes false.	Fan run-on, purge cycles, shutdown delays
RTO	Retentive Timer	Accumulates time across power cycles until reset.	Runtime tracking, maintenance counters
CTU	Count Up	Increments the accumulator on rising	Part counting, cycle counting, production totals
CTD	Count Down	Decrements the accumulator on rising	Batching, decrementing inventory, and step tracking
RES	Reset	Resets timers, counters, and control structures.	Clearing faults, restarting sequences
MOV	Move	Copies a value from source to destination.	Scaling, data transfer, and initializing values
ADD	Add	Adds two values and stores the result.	Math operations, counters, calculations

Symbol / Instruction	**Meaning**	**Description**	**Common Uses**
SUB	Subtract	Subtracts one value from another.	Offsets, adjustments, calculations
MUL	Multiply	Multiplies two values.	Scaling, engineering unit conversions
DIV	Divide	Divides one value by another.	Scaling, ratios, and engineering calculations
EQU	Equal	True when two values match.	Comparisons, mode selection, validation
NEQ	Not Equal	True when two values differ.	Error detection, mismatch checks
GRT	Greater Than	True when A > B.	Thresholds, limits, process control
LES	Less Than	True when A < B.	Low limits, safety checks

Notes:

- Instruction names follow Allen-Bradley conventions but map cleanly to IEC 61131-3 concepts.
- Ladder logic is widely used because it is intuitive for technicians and easy to troubleshoot.
- These symbols form the core of most industrial automation programs.

Analog Signal Scaling Chart

Scaling formulas and lookup tables for converting 4–20 mA and 0–10 V signals into engineering units for instrumentation and PLC inputs.

Signal Type	Raw Input	Engineering Units Formula	Description
4–20 mA	Typically 0–32767 (PLC), 0–4095 (12-bit)	$EU = ((mA - 4) \div 16) \times (EU_{max} - EU_{min}) + EU_{min}$	The most common industrial analog signal for sensors and transmitters.
0–10 V	Typically 0–32767 (PLC), 0–4095 (12-bit)	$EU = (V \div 10) \times (EU_{max} - EU_{min}) + EU_{min}$	Used for short-distance analog inputs, HMIs, and drives.
Raw Count → EU	Raw_{min} to Raw_{max}	$EU = ((Raw - Raw_{min}) \div (Raw_{max} - Raw_{min})) \times (EU_{max} - EU_{min}) + EU_{min}$	Generic scaling formula for PLC analog modules.
EU → Raw Count	EU_{min} to EU_{max}	$Raw = ((EU - EU_{min}) \div (EU_{max} - EU_{min})) \times (Raw_{max} - Raw_{min}) + Raw_{min}$	Used when writing analog outputs or simulating signals.

mA	% of Span	Example EU (0–100%)
4.00	0%	0%
8.00	25%	25%
12.00	50%	50%
16.00	75%	75%
20.00	100%	100%

Notes:

- 4–20 mA is preferred for long cable runs and noise immunity.
- 0–10 V is more sensitive to voltage drop and electrical noise.
- Raw count ranges vary by PLC: 0–4095 (12-bit), 0–16383 (14-bit), 0–32767 (15-bit).
- Scaling is essential for converting sensor signals into engineering units such as PSI, °C, GPM, or % level.

Communication Pinout Diagrams

Wiring pinouts for RS-232, RS-485, and Ethernet/IP connectors used in industrial automation networks.

RS-232 (DB9) Pinout		
Pin	**Signal**	**Description**
1	DCD	Data Carrier Detect
2	RXD	Receive Data
3	TXD	Transmit Data
4	DTR	Data Terminal Ready
5	GND	Signal Ground
6	DSR	Data Set Ready
7	RTS	Request to Send
8	CTS	Clear to Send
9	RI	Ring Indicator

RS-485 Pinout (2-Wire & 4-Wire)		
Signal	**Label**	**Description**
Data +	A / D+	Non-inverting line
Data −	B / D−	Inverting line
Ground	GND	Reference ground (optional)
4-Wire RS-485 (Full Duplex)		
TX+	A-TX	Transmit positive
TX−	B-TX	Transmit negative
RX+	A-RX	Receive positive
RX−	B-RX	Receive negative

Ethernet/IP (RJ45) Pinout — T568B		
Pin	**Color**	**Signal**
1	White/Orange	TX+
2	Orange	TX−
3	White/Green	RX+
4	Blue	Unused / PoE+
5	White/Blue	Unused / PoE+
6	Green	RX−
7	White/Brown	Unused / PoE−
8	Brown	Unused / PoE−

Notes:

- RS-232 is point-to-point and used for HMIs, barcode scanners, and legacy PLC ports.
- RS-485 supports long distances and multi-drop networks such as Modbus RTU.
- Ethernet/IP uses standard RJ45 wiring (T568B) for PLCs, drives, and industrial switches.
- Always verify polarity on RS-485 A/B lines — vendors sometimes reverse labels.

Maintenance Group

This section contains charts commonly used in industrial maintenance, reliability, troubleshooting, lubrication, HVAC, and fluid systems.

Temperature & Energy

Temperature Conversion Chart

Temperature conversions are used in HVAC, refrigeration, thermal diagnostics, and process control.

Scale	Formula
Celsius (°C) → Fahrenheit (°F)	(°C × 9/5) + 32
Fahrenheit (°F) → Celsius (°C)	(°F − 32) × 5/9
Celsius (°C) → Kelvin (K)	°C + 273.15
Kelvin (K) → Celsius (°C)	K − 273.15
Fahrenheit (°F) → Kelvin (K)	(°F − 32) × 5/9 + 273.15
Kelvin (K) → Fahrenheit (°F)	(K − 273.15) × 9/5 + 32

Energy Conversion Chart

Energy conversions are used in heating, cooling, mechanical work, and electrical systems.

From / To	Joule (J)	kJ	BTU	kWh
J	1	0.001	0.000947817	2.77778e-7
kJ	1000	1	0.947817	0.000277778
BTU	1055.06	1.05506	1	0.000293071
kWh	3.6e6	3600	3412.14	1

Power Conversion Chart

Power conversions are used in motors, HVAC systems, compressors, and electrical loads.

From / To	**Watt (W)**	**kW**	**HP**	**BTU/hr**
W	1	0.001	0.00134102	3.41214
kW	1000	1	1.34102	3412.14
HP	745.7	0.7457	1	2544.43
BTU/hr	0.293071	0.000293071	0.000393014	1

Flow & Fluids

Volumetric Liquid Flow Conversion Chart

Liquid flow conversions are used in pumps, chillers, cooling towers, and process systems.

From / To	**GPM**	**L/min**	**m^3/hr**
GPM	1	3.78541	0.227124
L/min	0.264172	1	0.06
m^3/hr	4.403	16.6667	1

Volumetric Gas Flow Conversion Chart

Gas flow conversions are used in compressed air systems, burners, and HVAC.

From / To	SCFM	Nm³/hr	L/min
SCFM	1	1.699	28.3168
Nm³/hr	0.588	1	16.67
L/min	0.0353147	0.06	1

Volumetric Gas Flow Unit Conversion Chart

Unit	Symbol	Equivalent
Normal cubic meter per hour	**Nm³/hr**	1 Nm³/hr = 35.31073 scfh
Standard cubic foot per hour	**scfh**	1 scfh = 0.02832 Nm³/hr
Standard cubic foot per minute	**scfm**	1 scfm = 1.699 Nm³/hr

Mass Flow Conversion Chart

Mass flow conversions are used in chemical processes, combustion, and industrial metering.

From / To	kg/hr	lb/hr	kg/min
kg/hr	1	2.20462	0.0166667
lb/hr	0.453592	1	0.00755987
kg/min	60	132.277	1

Material Properties

Density Conversion Chart

Density conversions are used in lubrication, material handling, and fluid analysis.

From / To	kg/m³	g/cm³	lb/ft³
kg/m³	1	0.001	0.0624279
g/cm³	1000	1	62.4279
lb/ft³	16.0185	0.0160185	1

Dynamic Viscosity Conversion Chart

Dynamic viscosity conversions are used in lubrication, hydraulics, and fluid diagnostics.

From / To	Pa·s	cP	lb·s/ft²
Pa·s	1	1000	0.0208854
cP	0.001	1	2.08854e-5
lb·s/ft²	47.8803	47880.3	1

Kinematic Viscosity Conversion Chart

Kinematic viscosity conversions are used in lubrication and fluid flow analysis.

From / To	m²/s	cSt	ft²/s
m²/s	1	1e6	10.7639
cSt	1e-6	1	1.07639e-5
ft²/s	0.092903	92890.3	1

Electrical Group

This section contains electrical property conversions, magnetics, radiation charts, and wiring/protection reference tables used in industrial electrical work, instrumentation, and automation systems.

Electrical Properties

Resistance Conversion Chart

Resistance conversions are used in electrical troubleshooting, sensors, and circuit analysis.

From / To	**Ω**	**kΩ**	**MΩ**
Ω	1	0.001	0.000001
kΩ	1000	1	0.001
MΩ	1e6	1000	1

Conductivity Conversion Chart

Conductivity conversions are used in water quality, chemical processes, and instrumentation.

From / To	**S/m**	**mS/cm**	**µS/cm**
S/m	1	10	10000
mS/cm	0.1	1	1000
µS/cm	0.0001	0.001	1

Resistivity Conversion Chart

Resistivity conversions are used in grounding, soil testing, and material analysis.

From / To	**Ω·m**	**Ω·cm**	**Ω·ft**
Ω·m	1	100	3.28084
Ω·cm	0.01	1	0.0328084
Ω·ft	0.3048	30.48	1

Magnetics

Magnetic Field Strength Conversion Chart

Magnetic field strength conversions are used in motors, inductive sensors, and transformers.

From / To	**A/m**	**Oersted**
A/m	1	0.012566
Oersted	79.5775	1

Magnetic Flux Conversion Chart

Magnetic flux conversions are used in motor windings, inductors, and transformer design.

From / To	**Weber (Wb)**	**Maxwell**
Wb	1	1e8
Maxwell	1e-8	1

Magnetic Flux Density Conversion Chart

Magnetic flux density conversions are used in sensors, motors, and automation systems.

From / To	**Tesla (T)**	**Gauss (G)**
Tesla	1	10000
Gauss	0.0001	1

Radiation

Radiation Dose Conversion Chart

Radiation dose conversions are used in safety, medical imaging, and industrial radiography.

From / To	**Gray (Gy)**	**Rad**
Gy	1	100
Rad	0.01	1

Radiation Exposure Conversion Chart

Radiation exposure conversions used in industrial X-ray, NDT, and safety monitoring.

From / To	**Roentgen (R)**	**C/kg**
R	1	2.58e-4
C/kg	3876	1

Wiring & Protection

Wire Gauge & Ampacity Table

AWG wire sizes and ampacity ratings are used in electrical installations and panel design.

AWG	Diameter (mm)	Area (mm^2)	Ampacity (A)
14	1.63	2.08	15
12	2.05	3.31	20
10	2.59	5.26	30
8	3.26	8.37	40
6	4.11	13.3	55
4	5.19	21.2	70
2	6.54	33.6	95
1/0	8.25	53.5	125
2/0	9.27	67.4	145

IP Ratings Table

Ingress Protection (IP) ratings are used for enclosures, sensors, and industrial equipment.

IP Code	Solid Protection	Liquid Protection
IP20	Fingers	None
IP54	Dust Protected	Water Spray
IP65	Dust Tight	Water Jets
IP66	Dust Tight	Powerful Water Jets
IP67	Dust Tight	Immersion (1m)
IP68	Dust Tight	Continuous Immersion

Mechanical Group

This section contains reference charts for mechanical forces, motion, fluids, and materials used in machine design, hydraulics, pneumatics, and mechanical maintenance.

Mechanical Forces

Force Conversion Chart

Force conversions are used in mechanical systems, actuators, load calculations, and torque analysis.

From / To	**Newton (N)**	**lbf**	**kgf**
N	1	0.224809	0.101972
lbf	4.44822	1	0.453592
kgf	9.80665	2.20462	1

Torque Conversion Chart

Torque conversions are used in motors, gearboxes, mechanical drives, and fastening systems.

From / To	**N·m**	**ft·lb**	**in·lb**
N·m	1	0.737562	8.85075
ft·lb	1.35582	1	12
in·lb	0.112985	0.0833333	1

Pressure Conversion Chart

Pressure conversions used in pneumatics, hydraulics, and mechanical system diagnostics.

From / To	psi	bar	kPa	atm
psi	1	0.0689476	6.89476	0.068046
bar	14.5038	1	100	0.986923
kPa	0.145038	0.01	1	0.00986923
atm	14.6959	1.01325	101.325	1

Motion

Speed Conversion Chart

Speed conversions are used in conveyors, rotating equipment, and mechanical drives.

From / To	m/s	ft/s	km/h	mph
m/s	1	3.28084	3.6	2.23694
ft/s	0.3048	1	1.09728	0.681818
km/h	0.277778	0.911344	1	0.621371
mph	0.44704	1.46667	1.60934	1

Velocity Conversion Chart

Velocity conversions are used in actuators, cylinders, and mechanical motion systems.

From / To	m/s	ft/min	in/s
m/s	1	196.8504	39.3701
ft/min	0.00508	1	0.2
in/s	0.0254	5	1

Acceleration Conversion Chart (Mech)

Acceleration conversions used in vibration analysis, motion control, and mechanical design.

From / To	m/s²	ft/s²	g (gravity)
m/s²	1	3.28084	0.1019716
ft/s²	0.3048	1	0.03108095
g (gravity)	9.80665	32.17405	1

Acceleration Unit Conversion Chart

Unit	Symbol	Equivalent
Meter per second squared	**m/s²**	Base SI unit
Foot per second squared	**ft/s²**	1 ft/s² = 0.3048 m/s²
Gal (centimeter per second squared)	**Gal**	1 Gal = 0.01 m/s²
Standard gravity	**g**	1 g = 9.80665 m/s²
Inch per second squared	**in/s²**	1 in/s² = 0.0254 m/s²

Fluids

Density Conversion Chart

Density conversions are used in lubrication, hydraulic fluids, and material analysis.

From / To	kg/m³	g/cm³	lb/ft³
kg/m³	1	0.001	0.0624279
g/cm³	1000	1	62.4279
lb/ft³	16.0185	0.0160185	1

Viscosity Conversion Chart

Viscosity conversions are used in lubrication, hydraulic systems, and fluid diagnostics.

From / To	Pa·s	cP	lb·s/ft²
Pa·s	1	1000	0.0208854
cP	0.001	1	2.08854e-5
lb·s/ft²	47.8803	47880.3	1

Dynamic Viscosity Unit Conversion Chart

Unit	Symbol	Equivalent
Centipoise	**cP**	1 cP = 0.01 poise
Poise	**P**	1 P = 100 cP
Pound per foot-second	**lb/(ft·s)**	1 lb/(ft·s) = 1488.16 cP

A–Z Index

This alphabetical index provides quick navigation to every chart in this handout. Click any entry to jump directly to the corresponding chart.

A

C

D

E

F

I

K

L

M

N

P

R

S

T

V

W

This student handout is part of the free online BIN95 Unit Conversion Chart App. An app for engineers, technicians, maintenance pros, and students. It provides quick, accurate conversions across a wide range of industrial measurement units. See https://bin95.com/charts/