

## Regulation

Selecting a transformer for industrial control circuit applications requires knowledge of the following terms:

**INRUSH VA** is the product of load voltage (V) multiplied by the current (A) that is required during circuit start-up. It is calculated by adding the inrush VA requirements of all devices (contactors, timers, relays, pilot lights, solenoids, etc.), which will be energized together. Inrush VA requirements are best obtained from the component manufacturer.

**SEALED VA** is the product of load voltage (V) multiplied by the current (A) that is required to operate the circuit after initial start-up or under normal operating conditions. It is calculated by adding the sealed VA requirements of all electrical components of the circuit that will be energized at any given time. Sealed VA requirements are best obtained from the component manufacturer. Sealed VA is also referred to as steady state VA.

**PRIMARY VOLTAGE** is the voltage available from the electrical distribution system and its operational frequency, which is connected to the transformer supply voltage terminals.

**SECONDARY VOLTAGE** is the voltage required for load operation which is connected to the transformer load voltage terminals.

Once the circuit variables have been determined, transformer selection is a simple 5-step process as follows:

1. Determine the application inrush VA by using the following industry accepted formula:

$$\text{Application inrush VA} = \sqrt{(\text{INRUSH VA})^2 + (\text{SEALED VA})^2}$$

2. Refer to the Regulation Data chart. If the primary voltage is basically stable and does not vary by more than 5% from nominal, the 90% secondary voltage column should be used. If the primary voltage varies between 5 and 10% of nominal, the 95% secondary voltage column should be used.

3. After determining the proper secondary voltage column, read down until a value equal to or greater than the application inrush VA is found. In no case should a figure less than the Application Inrush VA be used.

4. Read left to the Transformer VA rating column to determine the proper transformer for this application. As a final check, make sure that the Transformer VA rating is equal to or greater than the total sealed requirements. If not, select a transformer with a VA rating equal to or greater than the total sealed VA.

5. Refer to transformer selection pages to determine the proper catalog number based on the transformer VA, and primary and secondary voltage requirements.

## Inrush

Industrial control circuits and motor control loads typically require more current when they are initially energized than under normal operating conditions. This period of high current demand, referred to as inrush, may be as great as ten times the current required under steady state (normal) operation conditions and can last up to 40 milliseconds.

A transformer in a circuit subject to inrush will typically attempt to provide the load with the required current during the inrush period. However, it will be at the expense of the secondary voltage stability by allowing the voltage to the load to decrease as the current increases. This period of secondary voltage instability, resulting from increased current, can be of such a magnitude that the transformer is unable to supply sufficient voltage to energize the load.

This transformer must therefore be designed and constructed to accommodate the high inrush current, while maintaining secondary voltage stability. According to NEMA standards, the secondary voltage should typically be at 85% of the rated voltage.

Industrial Control Circuit Transformers by ABB Control Inc. are specifically designed and built to provide adequate voltage to the load while accommodating the high current levels present at inrush. These transformers deliver excellent secondary voltage regulation and meet or exceed the standards established by NEMA, ANSI, UL and CSA. Their hearty construction and excellent electrical characteristics assure reliable operation of electromagnetic devices and trouble-free performance.

① For units with class 105°C insulation systems.

② For units with class 180°C insulation systems.

## Regulation Data Chart

Transformer VA rating	Inrush VA at 20% power factor		
	95% secondary voltage	90% secondary voltage	85% secondary voltage
25	100	130	150
50	170	200	240
75	310	410	540
100	370	540	730
150	780	930	1150
200	810	1150	1450
250	1400	1900	2300
300	1900	2700	3850
350	3100	3650	4800
500	4000	5300	7000
750	8300	11000	14000
1000 ①	15000	21000	27000
1000 ②	9000	13000	18500
1500	10500	15000	205000
2000	17000	25500	34000
3000	24000	36000	47500
5000	55000	92500	115000

To comply with NEMA standards, which require all magnetic devices to operate successfully at 85% of rated voltage, the 90% secondary voltage column is most often used in selecting a transformer.

**NOTE**  
For UL overcurrent protection, see page 12.11