

Transformer Wound Cores

ISO-9001



同成電機股份有限公司
MAXWELL ELECTRIC CO., LTD.



配電用捲鐵心型變壓器簡介 Wound Core Transformer Description

◆ 以纏繞電磁鋼板(俗稱矽鋼片或矽鋼帶)做鐵心的變壓器，可以有效利用方向性矽鋼片之壓延方向特性，較適合於中小容量配電用變壓器者，如桿上型變壓器，地下系統變壓器。由於纏繞、剪切、成型的過程會使矽鋼片產生磁性惡化，因此必須經過退火處理過程。

◆ 傳統之捲鐵心係以連續沒有切斷之矽鋼片纏繞而成，再把線圈直接繞製於捲鐵心之柱鐵上，稱為“無接縫型鐵心 NO-CUT CORE”。為了鐵心和線圈能分開同時生產製造，為了鐵心能插入線圈，則鐵心的每一圈都必須切斷，再把切斷鐵心穿過線圈疊積而成的稱為“有接縫型鐵心 CUT CORE”依切斷部份疊積方式之不同，可分為好幾種，而目前最普遍廣為採用的是“有接縫階段式捲鐵心 STEP-LAP CORE”，矽鋼片的每一圈都切斷，並作定數量為一群的規則性階段式接縫排列。於退火固形後可以由接縫處掀開插入線圈再一組群一組群的組合，作業方便且效率高。由於該方式當鐵心和線圈組合時，鐵心之人為破壞減至最低，而且接縫與接縫間的距離拉長，在所有有接縫捲鐵心中磁路分佈最好，鐵心損失最低，噪音最小，可靠度最高。

◆ 就無接縫捲鐵心(NO-CUT CORE)與有接縫階段式捲鐵心(STEP-LAP CORE)二種做簡單的比較：

(1) 鐵心構造

無接縫捲鐵心之構造，在鐵心纏繞方向沒有剪切痕跡，而有接縫階段式捲鐵心則每一圈都有切斷口，而每一切斷口都分群以階段式按照順序錯開著。

(2) 鐵心素材

無接縫捲鐵心為了使鐵心切斷面形狀成分段形(擬似圓形)，而須要多種寬度的素材，備料較困難。而相對的有接縫階段式捲鐵心之素材寬度只要1~2種便可。

◆ When electrical steel is wound into a core, parallel to the material processed rolling direction, we will be able to utilize its excellent magnetic properties. It is very suitable for small and medium distribution transformers, such as for pole type and underground transformers. Wound cores require stress relief annealing to restore the magnetic damage from core processing, including: winding, cutting, and core shaping.

◆ A traditional core is made by continuously winding the steel strip into a loop without cutting. Coils are then wound through the core(s) window around the core legs. This is called a No-Cut core. In order to process cores and coils at the same time and be able to insert cores through coils, it is necessary to cut every layer of core laminations. Every layer of cut core laminations is then looped through the coil window to complete a core/coil assembly. The complete core is called a Cut core. There are many configurations for a group of laminations to close both cut ends to complete the magnetic pass. Currently, the most widely used configuration is a step lap pattern and its core is called a step lap core.

The technique of making a step lap core is by cutting a group of laminations in an incremental length and wrapping them into a concentric ring from the inner layers to the outer layers. Both ends of each lamination form a butt configuration in a circular ring and lap configuration with adjacent layers. The butt lap configuration creates a step lap pattern in a specified area in a plurality of groups. Each group repeats the same pattern of the step lap configuration with others. The processed ring core is then shaped into a rectangle for compactness of the core/coil assembly. Cores are then wrapped with steel band and stacked on a tray for stress relief annealing in a furnace. The annealed cores are tested for the core loss and then dismantled into a plurality of lamination groups. The laminations are then looped through the pre-wound coils to complete the core/coil assembly.

Since these cores are processed using automatic equipment and require less labor handling, the reliability of core quality is very high. The core loss and the noise level are low.

◆ COMPARISON OF NO CUT CORE TO STEP LAP CORE:

(1) Core structure

There is no physical interruption at each layer for the no-cut core. However, there is a cut to form butt at each layer and lap with adjacent layers in a step lap pattern for the cut core.

(2) Core material

In order to have a compact core/coil assembly, it is necessary to continuously wind coils tightly around the core legs of the no-cut core. This means that it is necessary to minimize the cross section of the core legs for the compactness. A no-cut core has to be wound from multiple width laminations to form a cross section close to a circular shape. A cut core can be wound with one or two width materials to obtain a compactness of the assembly.

(3) 鐵心、線圈之使用空間佔積率

無接縫型在線圈與鐵心柱鐵間及鐵心窗部都有無效空間(DEAD SPACE)但有接縫階段式則較少這個無效空間，所以鐵心空間佔積率較小，線圈使用率較高。

(4) 鐵心、線圈之處理

無接縫型之線圈必須以特殊捲線機設備，才能把線圈導線繞於鐵心柱鐵上，無法分開個別生產。而有接縫階段式之線圈可以獨立生產，待鐵心退火後由接縫處掀開插入線圈內依序組合。而線圈之機械強度比有接縫階段式者較高，主要為可預先完善的處理線圈的始、末端引線。

(5) 外殼

無接縫型鐵心變壓器需橢圓型外殼而且鐵心高度較高，所以外殼高度也較高。而有接縫階段型變壓器則外鐵型(SHELL TYPE)可使用圓形或方型外殼，內鐵型(CORE TYPE)則以橢圓形或方形外殼較合適，其外殼高度較低，而有利於小型化。

(6) 變壓器總重量

就變壓器總重量而言，有接縫階段型鐵心者較無接縫型鐵心者稍輕。

(7) 生產性

生產所須之準備時間和生產作業，由於線圈可以與鐵心同步生產，所以有接縫階段型鐵心者可較無接縫型鐵心者之時間較短而有利。

(8) 特性

同一鐵心形狀，在斷面積方面以無接縫型(NO-CUT)的特性較好，在這樣情況下，有接縫階段型(STEP-LAP)鐵損雖會增加數%，但實際上無接縫型(NO-CUT)與有接縫階段型(STEP-LAP)因鐵心形狀不同後者較小型，平均磁路長度較短，所以特性大致可視為相同。

(3) Space Occupancy Of Core And Coils

There are many opening spaces, called a dead space, between coils and core legs for the no-cut core. However, the cut core occupies less percentage of dead space and a high percentage of coil occupancy.

(4) Core Coil Handling

It is necessary to use a coil winding machine to wind coils tightly around core legs for a no-cut core. It is not possible to separate the core and coil for this assembling operation. The core and coils processing can be separated for a cut core. The core coil assembling is made by inserting a group of annealed core laminations into a coil window. Since core and coils are treated separately, the mechanical strength of the coil will be stronger for a cut core because it will be able to pre-treat the front and the end of coil lead wires.

(5) Transformer Tank

A no-cut core transformer needs an ellipse shape tank. Since the height of the no-cut core is higher, the transformer tank will be higher. A shell type step lap core transformer can use a circular shape or a rectangular type tank, while a core type step lap core transformer uses an ellipse or a rectangular shape tank. The height of these tanks is shorter. It is suitable for the smaller transformer.

(6) Transformer Total Weight

The weight of the cut core transformer is slightly lighter than that of a no-cut core transformer.

(7) Production Line

The time required for the product preparation and product operation will be less and favorable for a cut core transformer than the no-cut core transformer because the coils and cores can be processed simultaneously.

(8) Performance Characteristics

Under the same core shape, a no-cut core should perform better than a cut core because the cut core has a magnetic interruption at each lamination layer. However, a step lap cut core has been designed to distribute the magnetic field (flux) at the interruption (joint) from one layer to adjacent layers. Therefore, the performance of a core should perform as well as the no-cut core in watts per kilogram. Experimentally, it has showed that the ampere-volts per kilograms of the cut core were higher than that of a no-cut core due to the existence of magnetic interruption in each lamination layer.



同成牌配電變壓器用捲鐵心 Maxwell Transformer Wound Cores

- ◆ 素材採用全球各大鋼鐵廠生產的方向性電磁鋼板 (矽鋼片)，如：

美 國 AK STEEL

韓 國 POSCO

俄羅斯 VIZ-STEEL

中 國 WISCO 、 BAOSTEEL

本公司擁有各種高規格素材，充分供應客戶須求

Process with electrical steel manufactured from major makers:

AK Steel (USA)

POSCO (S. Korea)

VIZ-STEEL (Russia)

WISCO, BAOSTEEL (China)

For customers' urgent requirement, we stock various Grade of oriented electrical steel.

- ◆ 本公司備有性能優越的矽鋼片分條機，以超硬鎢鋼刀分條出近乎無毛邊的高品質素材，供捲鐵心加工用。

Our high efficient slitting machine equipped with tungsten blade can slit oriented electrical steel coils (almost burr free) for wound core processing.



- ◆ 以最優良的捲鐵心自動纏繞設備，以性能最佳的鐘罩型光輝退火爐，再加上累積40年的技術經驗製造出來的高品質有接縫階段式捲鐵心。

- ◆ Use the best automatic core winding machine to process cores and the most efficient Bell type furnace to anneal cores. Implement accumulated 40 years technical experience to manufacture high quality step lap cores.

- ◆ 捲鐵心成品具有以下之特點：

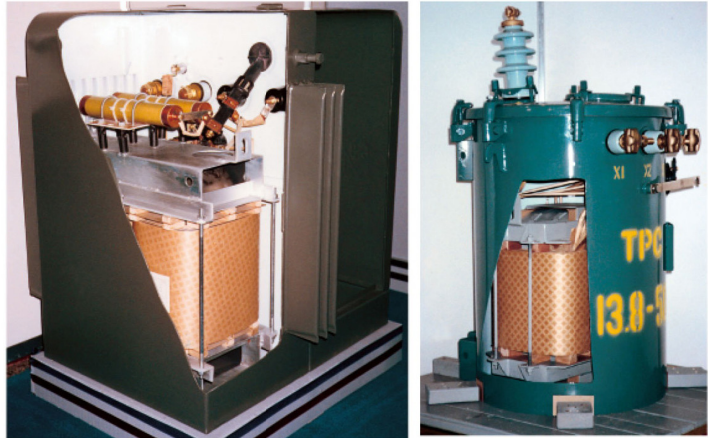
- (1)優良的磁性，鐵損低／激磁電流低。
- (2)噪音低。
- (3)與線圈的組合作業性良好，效率高。
- (4)尺寸、重量精準可靠。

- ◆ Characteristics of cores are as follows:

- (1) Excellent magnetic properties, low core loss and low exciting power
- (2) Low noise level
- (3) Easy of core/coil assembling, high efficiency
- (4) Reliable in dimensions & weight accuracy

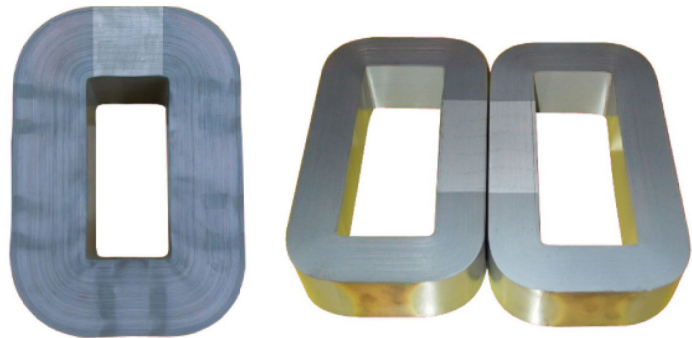
- ◆ 本公司所生產之有接縫階段式捲鐵心適用於比壓器，大小容量之單相、三相內鐵型／外鐵型油浸式、乾式、模鑄式配電變壓器，如桿上型、亭置式等地下系統變壓器。

Step lap cores manufactured by our company are suitable for large and small capacity single phase, three phases, core form and shell form, oil immersed, dry type, cast resin molded distribution transformers, and such as pole type, pad mounted and underground transformers.



- ◆ 鐵心接縫之排列採分組階段式，而接縫在成品鐵心上之位置則依鐵心尺寸大小、內鐵型或外鐵型由客戶指定排列於鐵心之柱鐵上或軛鐵上。

Core joints are assembled from a plurality of groups. Each group repeats the same pattern of the step lap configuration with others. The location of the joints, which depends upon the size of the core (either core form or shell form), can be at the top of the core or at the core leg. The customer can specify the joint location.



- ◆ 標準型之捲鐵心，其矽鋼片寬度均相同，如須於疊積鐵心的內側或外側縮小分段時，亦可依指定製造。

A standard core width is identical from inside to outside, the same width. However, if there is a need in changing the widths, (either inside wraps or outer wraps of the core), the customer can specify width dimensions.



承蒙訂購時請提供：

When placing an order, please provide the following information below:

- ◆ 鐵心設計圖面 (尺寸、重量、積厚、接縫位置)
Core design drawing (dimensions, weight, built up thickness and joint location)
- ◆ 鐵心電氣特性值
Magnetic characteristic
- ◆ 電氣特性試驗條件 (試驗電壓、激磁線圈匝數、週率)
Test conditions (Test voltage per turn and Frequency)
- ◆ 請使用本公司的“捲鐵心訂購須求單”
Please use our “Step-Lap Wound Core Inquiry Sheet”

捲鐵心製程 Wound Cores Processing

1. 矽鋼片自動纏繞作業
Automatic Core Winding



2. 鐵心成型作業
Core Forming



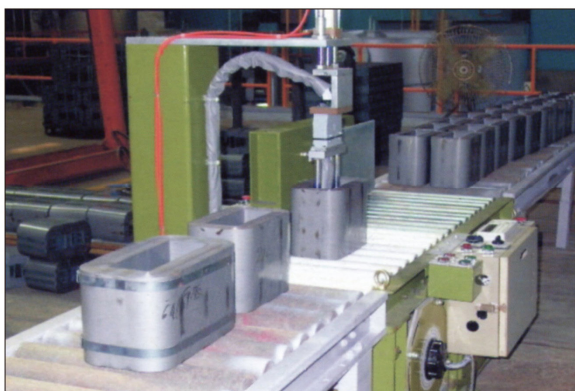
3. 堆積排列 (退火用)
Piles of Core (For Annealing)



6. 包裝出貨
Packing



5. 電氣特性檢驗
Electrical Testing



4. 退火處理作業
Core Annealing





主要設備規格 Main Equipment Specifications

◆ MXM自動鐵心纏繞機設備規格適用表 Automatic Core Winding Machine

設 備 型 式 Core Winding Machine		壹 號 機 MXM #1		貳 號 機 MXM #2	
適用變壓器機種 Transformer Capacity		三相油浸式變壓器最大容量參考值 3-Phase Oil-Immersed Capacity (max.)			
		內 鐵 型 Core Type	外 鐵 型 Shell Type	內 鐵 型 Core Type	外 鐵 型 Shell Type
		500kVA	1600kVA	2000kVA	5000kVA
捲鐵心最大外徑 Max. Outside Diameter		915 mm ϕ		1320 mm ϕ	
捲鐵心最小內徑 Min. Inside Diameter		114 mm ϕ		165 mm ϕ	
矽鋼片寬度 Steel Strip Width	最 大 Max.	266 mm		356 mm	
	最 小 Min.	40 mm		101 mm	
鐵心最大重量 Max. Core Weight		385 kg		680 kg	
適用矽鋼片厚度 Steel Strip Thickness		0.177 mm ~ 0.356 mm			

◆ 鐘罩型光輝退火爐

- (1) 本公司擁有國內性能最佳的鐘罩型光輝退火爐，係瓦斯燃燒熱循環、水冷／風冷強制冷卻系統，退火溫升曲線準確，爐內溫度分佈均勻，於800℃時誤差值在 $\pm 7.5^\circ\text{C}$ 以內，使鐵心於退火後恢復到最佳磁性。
- (2) 每爐的處理量達7,500Kgs。
- (3) 正常出爐量：每日3爐～4爐，交貨迅速。

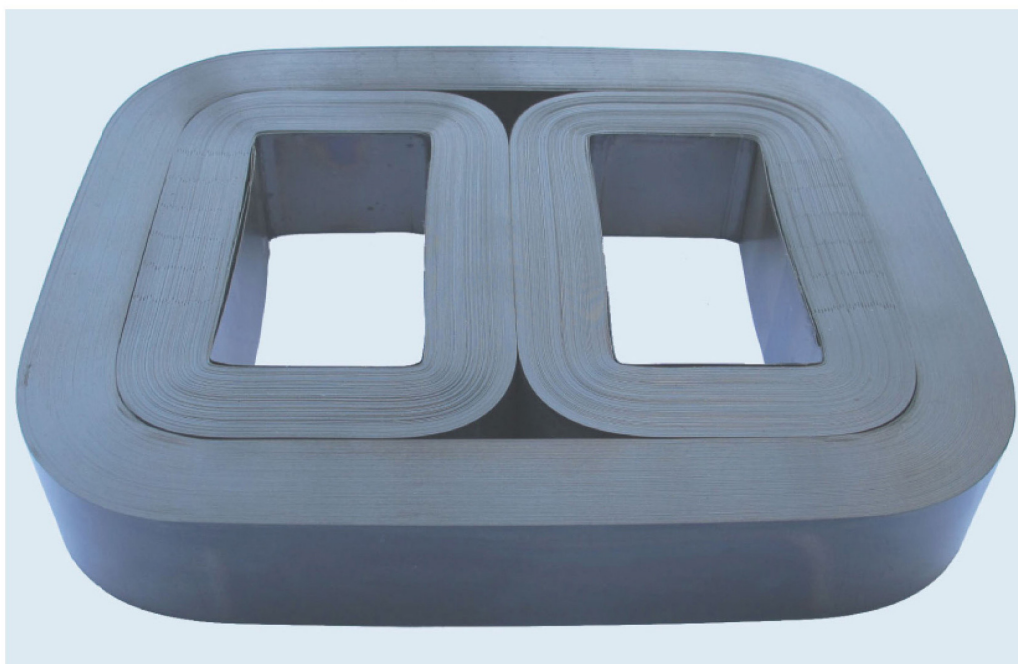
◆ Bell Type Annealing Furnace

- (1) Our company possesses a best Bell Type Annealing Furnace. It is heated by hot gas circulating in the chamber and cooled by water and forced air. We control the furnace rising temperatures accurately, and the distribution of heat at 800°C evenly within 7.5°C variation in the chamber to recover the best magnetic characteristics.
- (2) We are able to handle up to 7,500 kgs for each batch.
- (3) The normal harvest batches are 3 to 4 per day, fast delivery.

三相捲鐵心 Three Phase Wound Core

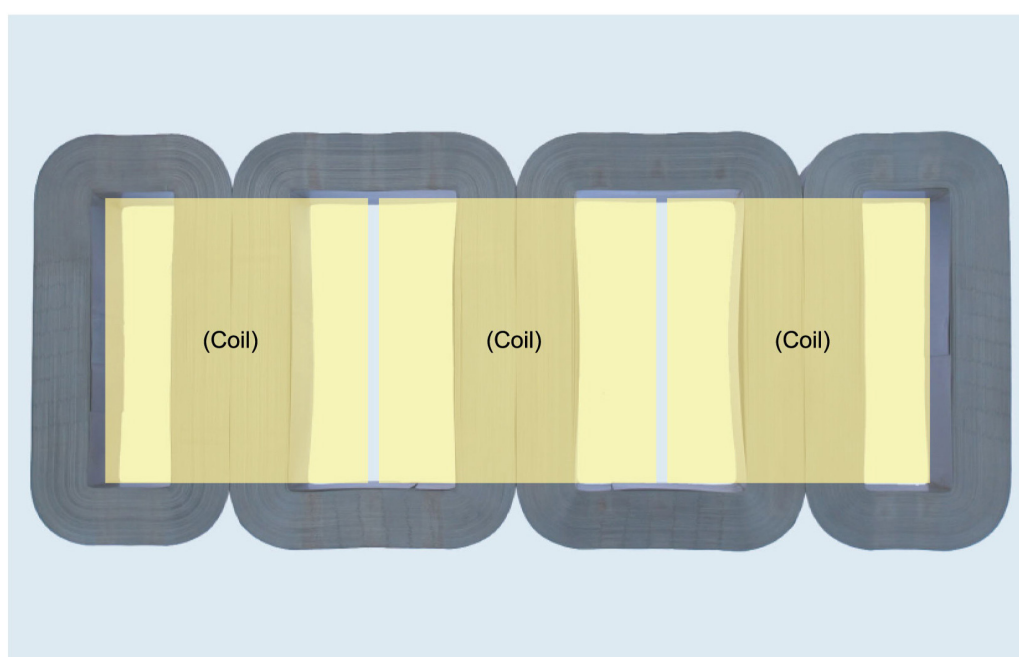
◆ 內鐵型三相捲鐵心

Three Phase Wound Core (Core Type)



◆ 外鐵型三相捲鐵心

Three Phase Wound Core (Shell Type)





捲鐵心變壓器產品 Wound Core Transformers

桿上型變壓器
Pole-Type Transformer



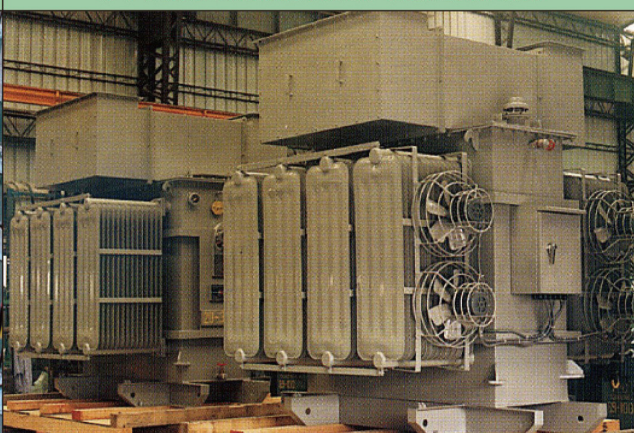
亭置式變壓器
Pad-Mounted Transformer



地下式變壓器
Submersible Transformer



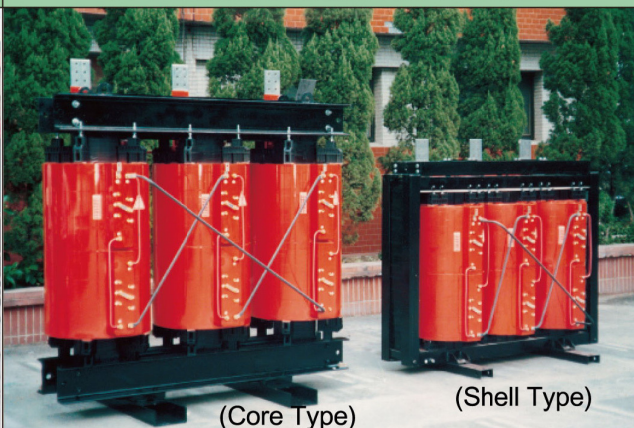
三相配電用變壓器
3 Phase Distribution Transformer



三相亭置式變壓器
3 Phase Pad-Mounted Transformer



三相樹脂模鑄式變壓器
3 Phase Cast Resin Transformer



本公司捲鐵心發展歷程 History of Maxwell's Transformer Wound Cores

1973年本公司創立之初，始鑑於國內之經濟型態，由農業社會轉向工業社會之趨勢，而從事重電機配電變壓器之開發與製造，迄今已超過40年。

1975年開始製交 No-Cut 捲鐵心變壓器，1980年起積極開發 Cut-Core 捲鐵心變壓器，提高生產效率及技術水準。並從1983年起逐年完成 TPC 各型變壓器之定型試驗（均為 Cut-Core 捲鐵心），且開始製造交貨。

1989年起配合 TPC 開發完成各型低損失變壓器之定型試驗。並開始引進多套加拿大 TRANCO 公司之 Cut-Core 自動鐵心纏繞機，生產特性較佳的 Step-Lap Core 捲鐵心。且同時從日本引進性能最佳的鐘罩式光輝退火爐，大大的提昇捲鐵心品質和生產效率。

2000年起榮獲 ISO-9001 國際品質認證合格，充分提昇產品品質水準。

本公司除自給自足外，為了更廣範的服務同業，40年來除積極改善及擴充設備外，並於2002年爭取到美國 AK-STEEL 公司之電磁鋼板的臺灣區總代理權，充分供應高品質，且交貨迅速的 Step-Lap Core 捲鐵心給客戶。

2006年起，積極拓展國際市場，特別是亞洲區：如中國、日本、泰國、印尼、越南、菲律賓、馬來西亞等，將捲鐵心國際化。且配合產業落地生根，將捲鐵心生產技術以合作方式整廠輸出，使其更具國際競爭力。

Maxwell Electric was founded in 1973. Due to the economical transition from the agriculture society to the industrial trend, we have devoted our effort in distribution transformer development and manufacturing segment more than 40 years.

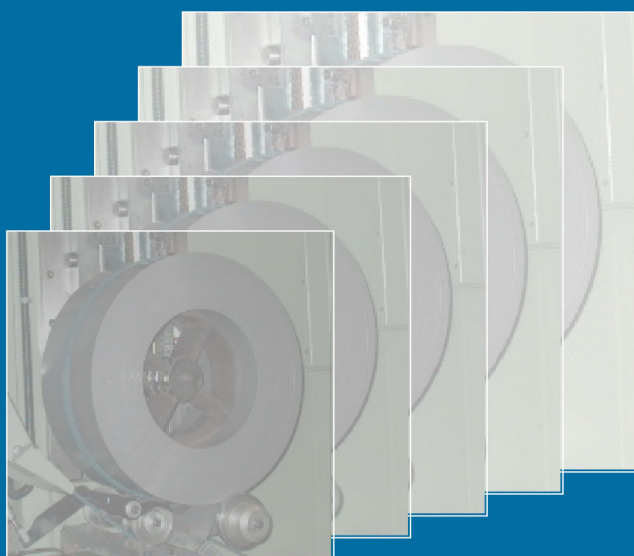
In 1975, we commenced the manufacture of the no-cut core transformers, and in 1980 initiated the manufacture of the cut core transformers. We gradually improved our productivity and the level of technical standards. After 1983 and thereafter, we gradually completed the type tests (for cut cores) required by Taiwan Power Company (TPC) and started to manufacture and delivered the products.

In 1989 and thereafter, we worked with TPC to complete the type tests for various types of low loss transformers. The automatic core winding machines were imported from the Tranco, Canada and then started to produce high efficiency step-lap cut cores. At the same time, we imported the first unit in Taiwan, a high efficiency bell type annealing furnace from Japan. We substantially improved our core quality and quantity.

Since 2000, we were certified by the International Quality Assurance for ISO-9001. We further improved our quality standard.

We could supply not only for our own needs, but also provide to other transformer makers. In order to improve quality and fast delivery to customers, we have actively expanded our facilities in the last 40 years. We were also authorized by AK Steel (USA) as exclusive distributor of oriented electrical steel for Taiwan market in 2002.

Since 2006, we are expanding business globally especially to Asia markets: China, Japan, Thailand, Indonesia, Vietnam, Philippines and Malaysia. To be competitive, we also cooperate and supply step lap wound core turnkey projects to local customers.



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