Cetronic Power Products Ltd.

REGUVOLT

CONSTANT VOLTAGE TRANSFORMERS

Technical Information

Sinusoidal Output Voltage

If the CVT is to be used as an AC voltage stabiliserthe sinusoid must be restored by a filter winding. the stability can also be improved by adding a compensation winding. An AC voltage stabiliser on this principle is therefore designed as shown in fig. 3. The equivalent diagram for such CVT is shown in fig. 4.

Filter Winding

In the third window of the **Reguvolt** core a winding has been added called L_F, and it is connected in series with the capacitor Cp. This winding is cut by a large proportion of the principle flux, some of which is taken by the magentic shunts. L_F and Cp establish a filter link which is tuned to the third harmonic of the mains frequency (150Hz at 50Hz mains voltage). The third harmonic in the voltage across Lp is short circuited by this filter link, and the output voltage improves to an approximate sinewave with harmonic content of less than 3%. The filter also suppresses higher order harmonics. The output voltage wave form is determined by the magnetic saturation in the secondary part of the core and the properties of the filter. The output voltage becomes close to sinusoidal, even if the primary is supplied by other waveforms than sinewave. The primary can even be supplied with a square wave voltage without any significant distortion of the voltage waveform.

Compensation Winding

The compensation winding which is placed in the primary windon gives a volteg which is coupled in phase opposition to the voltage across Lp. The winding ratio is adapted so that influence of variations in mains voltage and load is reduced to a minimum. This winding gives a better voltage stability to the **Reguvolt**.

Automatic Current Limiting

At secondary short circuit the voltage is taken up by the relatively high series inductance which limits the short circuit current to approximately 2 times nominal current (see fig. 5).

Suppression of Parasitic and Transient Signals

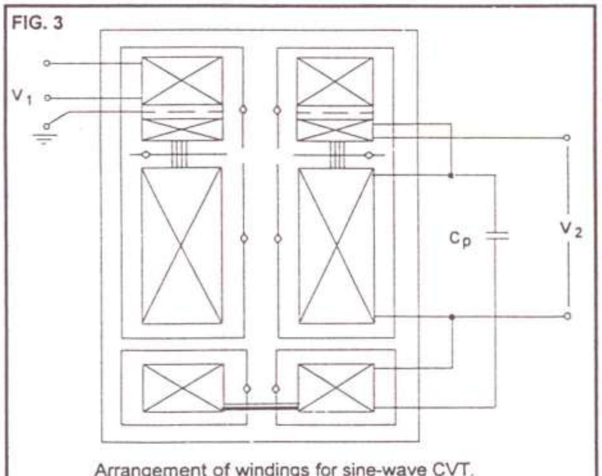
In the classic transformer parasitic or transient signals can be transmitted between primary and secondary by capacitive coupling and mutual induction. Usually the coils are wound one on top of the other. This type of construction brings with it a large mutual induction and significant parasitic capacity between the two circuits.

While the introduction of an electrostatic screen between the coils will reduce the capacity there is little that can be done to diminish the mutual inductance between them.
In the **Reguvolt**, the primary and secondary coils are separated by a magnetic shunt, which considerably reduces the mutual induction and the parasitic capacitance.

The existence of shunts and the saturation of the secondary core further lowers the output level of the parasitic due to mutual induction.

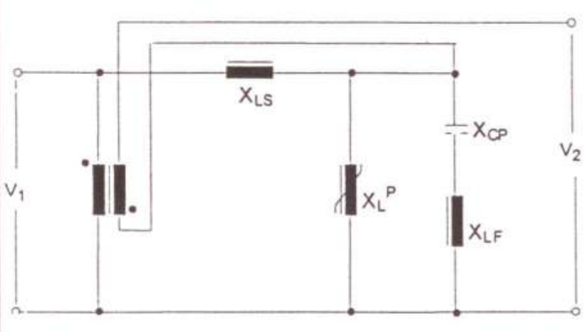
An electrostatic screen interposed between the primary and compound winding, prevents the capacitive transmission of parasitic signals at that level. In **Reguvolts** requiring a high isolation between primary and secondary circuits (such as regulators supplied from square wave inverters), the compensating winding is removed, thus eliminating all couplings by mutual inductance. But in this case the regulation is slightly reduced.

FIG. 3



Arrangement of windings for sine-wave CVT.

FIG. 4



Equivalent circuit diagram for sine-wave CVT

Reguvolt Constant Voltage Transformers

Principles of Operation

Like a transformer, the Reguvolt achieves electrical isolation of the primary and secondary circuits.
In addition it provides any equipment powered from it with an almost complete immunity from irregularities arising from the source of supply. If fast or slow variations in voltage occur, it provides a constant output. In cases of wave form distortion the **Reguvolt** provides a sinusoidal wave, and attenuates considerably parasitic and transient signals. In the case of micro-interruptions, it provides a continuous output.
The sinusoidal **Reguvolt** brings together the properties of a shunt magnetic circuit and those of ferroresonant electrical circuit.

Design

The present **Reguvolt** design has evolved from the simpler form of Ferroresonant stabiliser know as non-sinusoidal or square wave type shown in fig. 1. On the centre leg of the core are primary and secondary windings placed one at each end and separated by a magnetic shunt. By this shunt the electromagnetic leakage between primary and secondary is increased. In parallel with the secondary winding is the so called Resonance Capacitor. In normal operation, the part of the core under the secondary winding is saturated due to the influence of the Resonance Capacitor. The secondary winding creates together with this capacitor, a tuned circuit at the mains frequency.

Equivalent Circuit Diagram

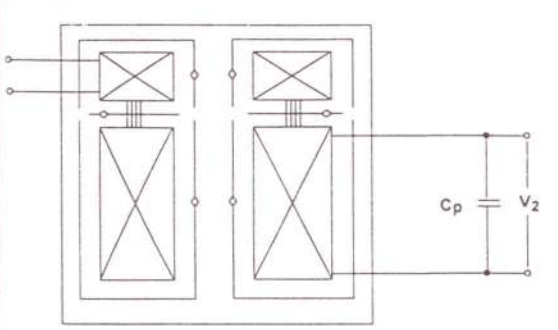
The equivalent diagram for a CVT can be drawn as shown in fig.2 in this case the resistances in windings and the dissipation in the core are ignored.
In the diagram the influence of the magnetic flux is equivalent to the series reactance X_{LS}.
Compare the equivalent diagram for a conventional transformer, where the series inductance is equivalent to leakage inductance.

The high magnetic saturation in the secondary part of the core is established by a relatively high number of ampere turns. The CVT is working in the horizontal part of the magnetisation curve. In the equivalent diagram this is compared with the parallel reactance X_{LP}, which is non-linear due to the influence of saturation in the core.
The regulation capacitor is connected in parallel with X_{LP}. Its reactance is labelled X_{CP}.

Operation

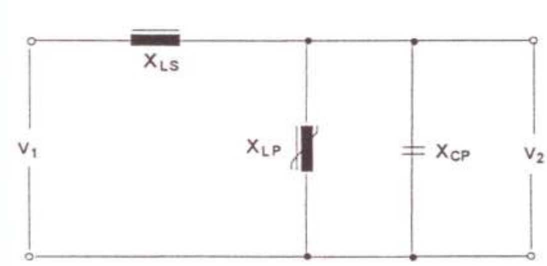
The inductive current through the X_{LP} creates a voltage drop across the series inductance X_{LS}.
The capacitive current through X_{CP} creates a voltage increase across the series inductance X_{LS}.
At nominal input voltage the inductive and capacitive currents through X_{LS} are approximately in balance.
If the primary voltage drops the reactance X_{LP} increases due to the decrease of the saturation in the core. At this moment the inductive current component through X_{LS}. The secondary voltage level therefore stays unchanged. In the same way the inductive current component increases if the primary voltage increases. the reactive volt drop across X_{LS} increases at the same time and the level of the secondary voltage is kept practically constant.
A stabiliser of this type keeps the output voltage on practically a constant level, independent of variations in supply or variations in load.
Due to the influence of saturation in the core, the shape of the output voltage does not remain sinusoidal but approaches a square wave and has a relatively large percentage of third harmonic.
The CVT described is very suitable as a mains transformer in DC power supplies and rectifiers, as the output voltage is approximately constant and the square wave voltage is well suited for rectification. Thanks to the weak coupling between primary and secondary windings and as the secondary part of the core is saturated, the CVT works as a very efficient filter against disturbance (transients) in the primary voltage.

FIG. 1



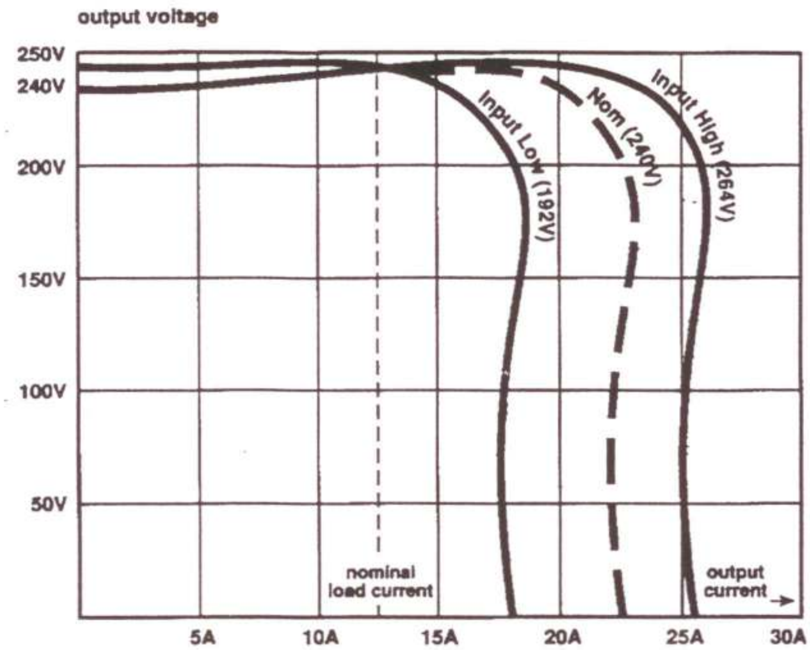
Arrangement of windings for basic CVT (without filter and compensation windings).

FIG. 2



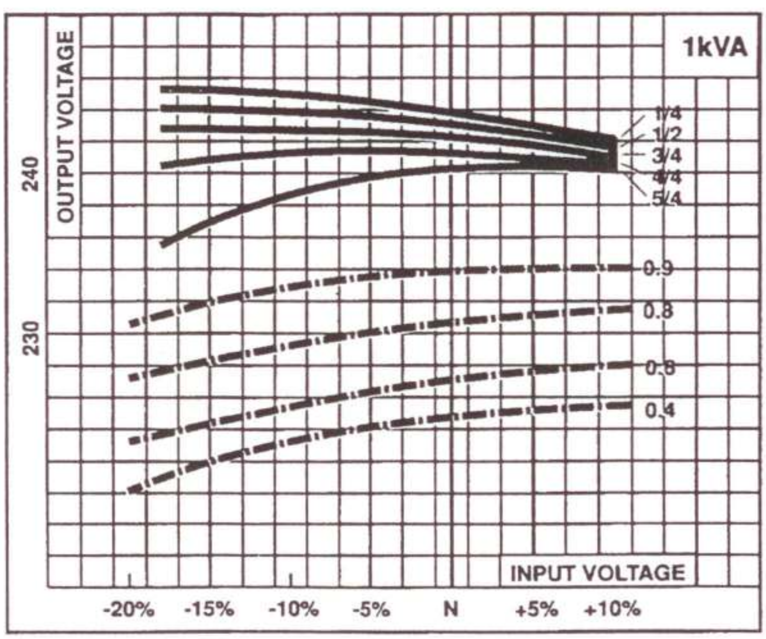
Equivalent circuit diagram for basic CVT (without filter and compensation windings).

Current Limiting Characteristics for 3kVA Reguvolt



Output voltage = f (output current)

Voltage Regulation Characteristics



Load variations at Unity PF
PF variations at Nominal Load

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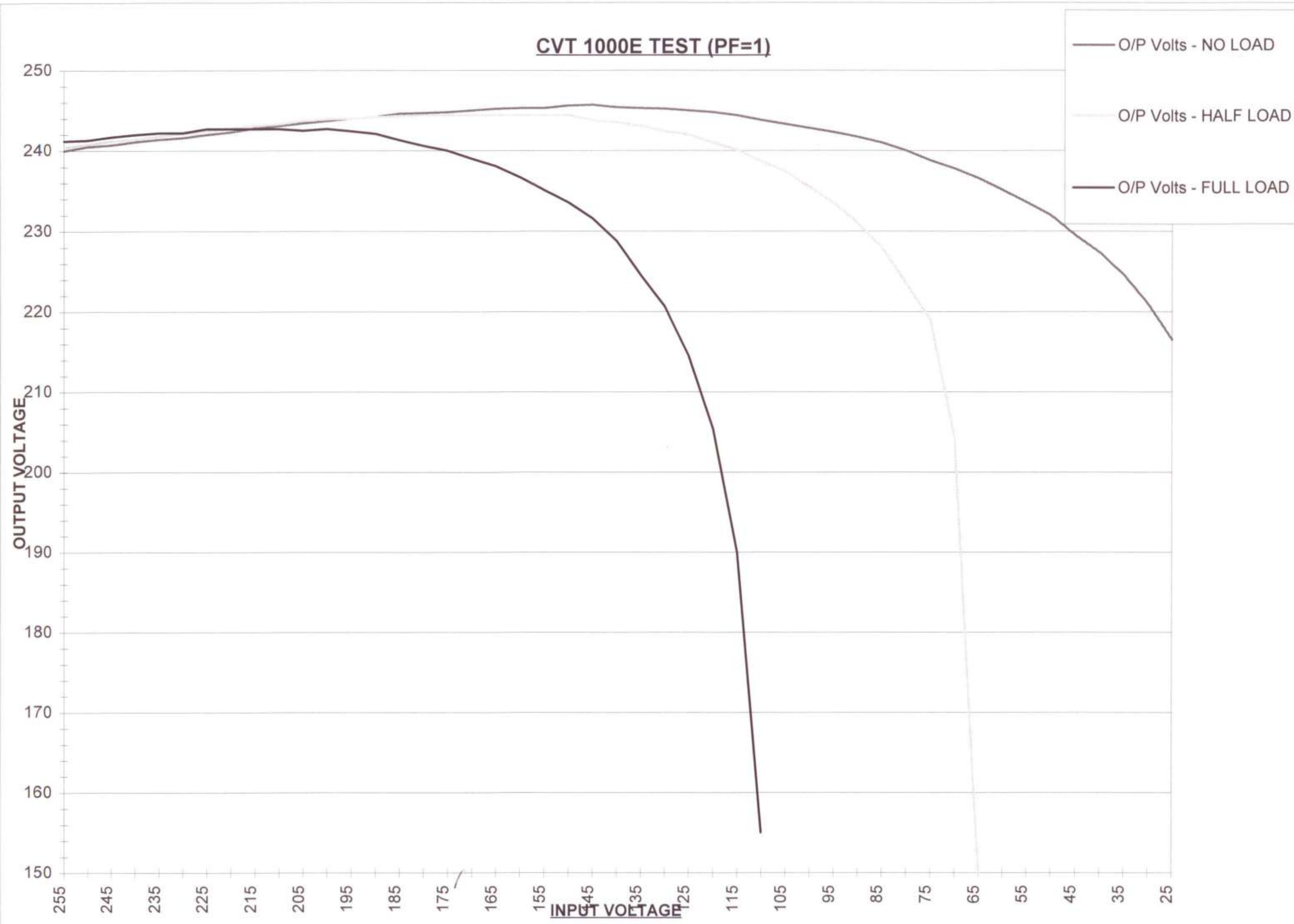

CVT 1000E TEST (PF=1)
O/P Volts - NO LOAD
O/P Volts - HALF LOAD
O/P Volts - FULL LOAD
OUTPUT VOLTAGE
250
240
230
220
210
200
190
180
170
160
150
INPUT VOLTAGE
255
245
235
225
215
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