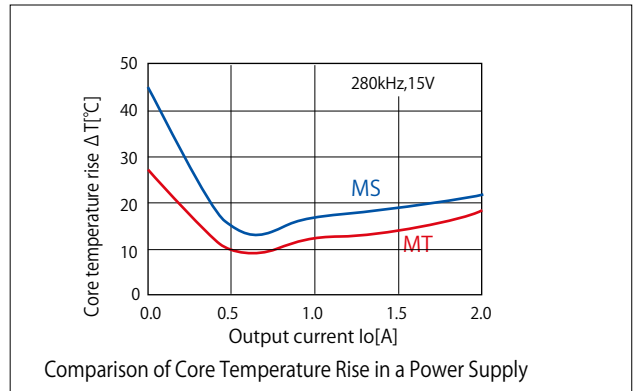
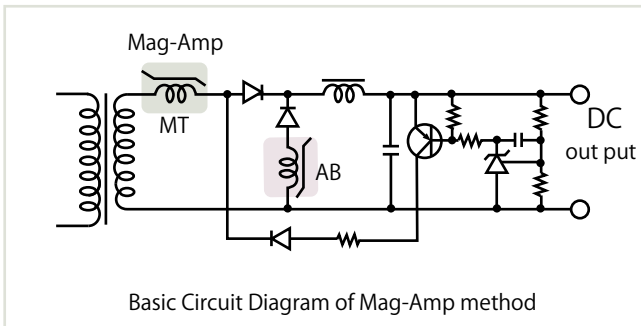


# 1. Saturable Cores for Mag-Amps

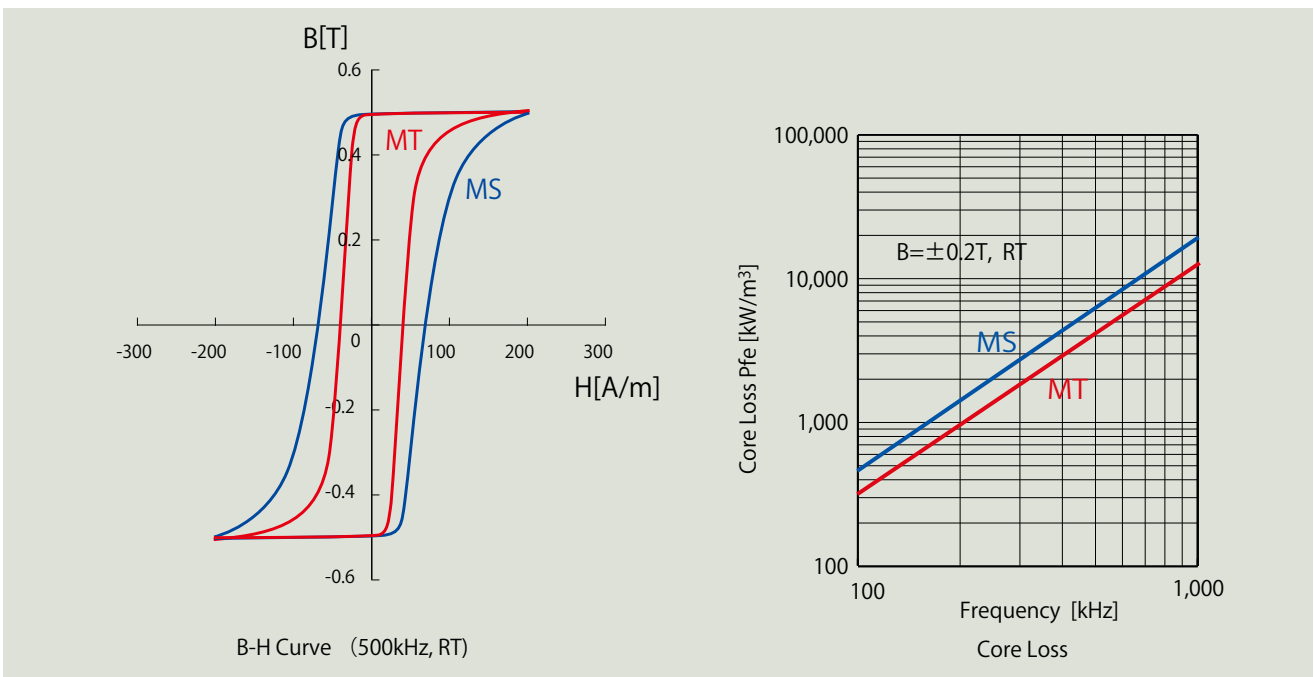
The Mag-amp method is one of several output voltage regulation methods used in switching power supplies. A saturable core is used in the secondary side of the main transformer to regulate voltage by magnetic pulse width modulation (PWM). The Mag-amp method is especially effective and economically attractive in low voltage/high current circuits and is frequently used in power supplies for information processing equipment, such as desktop PCs and computer servers, in power supplies for office equipment such as photocopier machines and printers, and in power supplies for communication equipment, such as mobile phone stations.

Miniaturization, high efficiency, low noise, high reliability, and high precision can be easily realized by adopting the Mag-amp method.

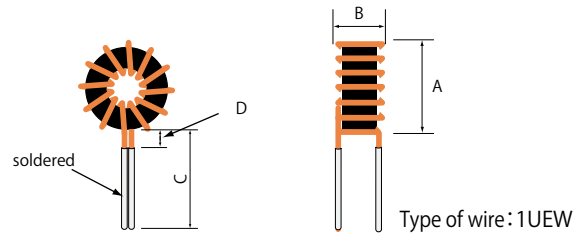
Utilizing the unique magnetic characteristics of cobalt-based amorphous alloys, we have realized low loss at high frequencies which cannot be realized using other materials. Our lineup consists of MS series cores, which are well suited for general purpose applications, and MT cores, which have lower loss than the MS series.



## Basic Characteristics (Typical Value)



### Standard Specifications



#### MT Standard Wired Series

| Type No. | Core Type No. | Wire Diameter $\phi$ [mm] | Parallel Number | N [turn] | Flux*1*2 [ $\mu$ Wb] | Example of Circuit (150kHz) <sup>*3</sup> |        | Finished Dimensions [mm] |       | Lead Length C [mm] | Length of Non Solder D [mm] | Package                 |
|----------|---------------|---------------------------|-----------------|----------|----------------------|---|--------|--------------------------|-------|--------------------|-----------------------------|-------------------------|
|          |               |                           |                 |          |                      | Vo [V]                                    | Io [A] | A max                    | B max |                    |                             |                         |
| MT12S115 | MT12X 8X4.5W  | 1.0                       | 1               | 15       | 94.7                 | 5   | 6      | 20                       | 13    | 20 $\pm$ 5         | 3 max                       | 1,000<br>[pcs in a box] |
| MT12S208 |               | 0.9                       | 2               | 8        | 50.5                 | 3.3                                       | 10     | 20                       | 13    |                    |                             |                         |
| MT15S125 | MT15X10X4.5W  | 1.0                       | 1               | 25       | 197                  | 12  | 6      | 25                       | 15    |                    |                             |                         |
| MT15S214 |               | 0.9                       | 2               | 14       | 110                  | 5   | 10     | 25                       | 15    |                    |                             |                         |
| MT18S130 | MT18X12X4.5W  | 1.0                       | 1               | 30       | 284                  | 15  | 6      | 28                       | 15    |                    |                             |                         |
| MT18S222 |               | 0.9                       | 2               | 22       | 208                  | 12  | 10     | 28                       | 15    |                    |                             |                         |
| MT21S134 | MT21X14X4.5W  | 1.0                       | 1               | 34       | 375                  | 24  | 6      | 32                       | 15    |                    |                             |                         |
| MT21S222 |               | 0.9                       | 2               | 22       | 243                  | 15  | 10     | 32                       | 15    |                    |                             |                         |

#### MT Series

| Type No.     | Finished Dimensions*4 [mm] |      |      | Core Size*5 [mm] |      |      | Effective Core Cross Section Ae [mm <sup>2</sup> ] *5 | Mean flux Path Length Lm [mm] *5 | Total Flux*2 $\phi c$ [ $\mu$ Wb]min | Coercive Force *2 Hc[A/m] | Rectangular Ratio *2 Br/Bm[%] | $\phi c \cdot AW$ [ $\mu$ Wb $\cdot$ mm <sup>2</sup> ] | Insulating Covers *6 |
|--------------|----------------------------|------|------|------------------|------|------|---|----------------------------------|--------------------------------------|---------------------------|-------------------------------|--|----------------------|
|              | O.D.                       | I.D. | H.T. | O.D.             | I.D. | H.T. |   |                                  |                                      |                           |                               |  |                      |
| MT10X7X4.5W  | 11.5                       | 5.8  | 6.6  | 10               | 7    | 4.5  | 5.06  | 26.7                             | 4.73                                 | 20 max                    | 94 min                        | 116  | A                    |
| MT12X8X4.5W  | 13.8                       | 6.   | 6.6  | 12               | 8    | 4.5  | 6.75  | 31.4                             | 6.31                                 |                           |                               | 215  | A                    |
| MT14X8X4.5W  | 15.8                       | 6.8  | 6.6  | 14               | 8    | 4.5  | 10.1  | 34.6                             | 9.46                                 |                           |                               | 323  | A                    |
| MT15X10X4.5W | 16.8                       | 8.8  | 6.6  | 15               | 10   | 4.5  | 8.44  | 39.3                             | 7.88                                 |                           |                               | 457  | A                    |
| MT16X10X6W   | 17.8                       | 8.3  | 8.1  | 16               | 10   | 6.0  | 13.5  | 40.8                             | 12.6                                 |                           |                               | 649  | B                    |
| MT18X12X4.5W | 19.8                       | 10.8 | 6.6  | 18               | 12   | 4.5  | 10.1  | 47.1                             | 9.46                                 |                           |                               | 834  | A                    |
| MT21X14X4.5W | 22.8                       | 12.8 | 6.6  | 21               | 14   | 4.5  | 11.8  | 55.0                             | 11.0                                 |                           |                               | 1371   | A                    |
| MT12X8X3W    | 13.7                       | 6.4  | 4.8  | 12               | 8    | 3.0  | 4.50  | 31.4                             | 4.20                                 |                           |                               | 126  | C                    |
| MT15X10X3W   | 16.7                       | 8.4  | 4.8  | 15               | 10   | 3.0  | 5.63  | 39.3                             | 5.25                                 | 277                       | C                             |  |                      |

#### MS Series

| Type No.       | Finished Dimensions*4 [mm] |             |            | Core Size*5 [mm] |      |      | Effective Core Cross Section Ae [mm <sup>2</sup> ] *5 | Mean Flux Path Length Lm [mm] *5 | Total Flux*2 $\phi c$ [ $\mu$ Wb]min | Coercive Force *2 Hc[A/m] | Rectangular Ratio *2 Br/Bm[%] | $\phi c \cdot AW$ [ $\mu$ Wb $\cdot$ mm <sup>2</sup> ] | Insulating Covers *6 |
|----------------|----------------------------|-------------|------------|------------------|------|------|---|----------------------------------|--------------------------------------|---------------------------|-------------------------------|--|----------------------|
|                | O.D.                       | I.D.        | H.T.       | O.D.             | I.D. | H.T. |   |                                  |                                      |                           |                               |  |                      |
| MS7X4X3W       | 9.1                        | 3.3         | 4.8        | 7.5              | 4.5  | 3.0  | 3.38  | 18.8                             | 3.15                                 | 25 max                    | 94 min                        | 23   | A                    |
| MS10X7X4.5W    | 11.5                       | 5.8         | 6.6        | 10               | 7    | 4.5  | 5.06  | 26.7                             | 4.73                                 |                           |                               | 116  | A                    |
| MS12X8X4.5W    | 13.8                       | 6.8         | 6.6        | 12               | 8    | 4.5  | 6.75  | 31.4                             | 6.31                                 |                           |                               | 215  | A                    |
| MS12X8X4.5W-HF | 13.8                       | 6.8         | 6.6        | 12               | 8    | 4.5  | 6.75  | 31.4                             | 6.31                                 |                           |                               | 215  | D                    |
| MS14X8X4.5W    | 15.8                       | 6.8         | 6.6        | 14               | 8    | 4.5  | 10.1  | 34.6                             | 9.46                                 |                           |                               | 323  | A                    |
| MS15X10X4.5W   | 16.8                       | 8.8         | 6.6        | 15               | 10   | 4.5  | 8.44  | 39.3                             | 7.88                                 |                           |                               | 457  | A                    |
| MS16X10X6W     | 17.8                       | 8.3         | 8.1        | 16               | 10   | 6.0  | 13.5  | 40.8                             | 12.6                                 |                           |                               | 649  | B                    |
| MS18X12X4.5W   | 19.8                       | 10.8        | 6.6        | 18               | 12   | 4.5  | 10.1  | 47.1                             | 9.46                                 |                           |                               | 834  | A                    |
| MS21X14X4.5W   | 22.8                       | 12.8        | 6.6        | 21               | 14   | 4.5  | 11.8  | 55.0                             | 11.0                                 |                           |                               | 1371   | A                    |
| MS26X16X4.5W   | 29.5<br>max                | 13.0<br>min | 8.0<br>max | 26               | 16   | 4.5  | 16.9  | 65.9                             | 15.8                                 |                           |                               | 2097   | B                    |
| MS12X8X3W      | 13.7                       | 6.4         | 4.8        | 12               | 8    | 3.0  | 4.50  | 31.4                             | 4.20                                 |                           |                               | 126  | C                    |
| MS15X10X3W     | 16.7                       | 8.4         | 4.8        | 15               | 10   | 3.0  | 5.63  | 39.3                             | 5.25                                 |                           |                               | 277  | C                    |

\*1 The amount of magnetic flux is equal to (N)  $\times$  ( $\phi c$ ).

\*2 Measuring condition : 100kHz, 80A/m (sine wave), R.T.

\*3 Recommend for designing (note : A design of a transformer in the case may be unable to use this data. Please set up the operating magnetic flux 70% or less of the magnetic flux.)

\*4 Dimensions of the Finished Insulating Covers ; Tolerance :  $\pm 0.2$ mm \*5 Reference value

\*6 Insulating cover is made with UL94V-0 approved material A : Black PET, B : Black PBT, C : Red LCP, D : Halogen-free

☆ Those other than standard winded articles can be manufactured. Please ask to sales department.

☆ MT sample kits are prepared. Please ask to sales department.

# Merits of the Mag-Amp Method

Since the Mag-amp method uses saturable cores to regulate voltage, there is a big advantage that cannot be achieved by semiconductor-based regulation methods. The advantage is especially clear when there are large changes in the current.

|                              |  |
|------------------------------|--|
| Miniaturization (Downsizing) | Large currents can be handled by small size cores. Also, there is no need for a heat sink and the number of parts as the regulation circuit is small. This results in a smaller mount area compared to semiconductor-based methods.                    |
| Power Saving                 | Because cobalt-based amorphous alloy is used, the operating loss at high frequencies is small. Also, the power needed for control of the Mag-amp is smaller, enabling power to be saved.   |
| Low Noise                    | The noise from the output diode is small because the Mag-amp is connected in series with the output diode. In semiconductor-based methods, since the number of switching elements increases, so also does the noise.                                   |
| High Reliability             | Since Mag-amps are magnetic parts, the cores are not destroyed by surges in voltage and current. For this reason, they have been used in power supplies requiring reliability such as those for electricity or large computers.                        |
| High Precision               | The Mag-amps realize precise output voltage because the secondary side of the main transformer is directly controlled. It is possible to conduct voltage tolerance with high precision ( $\pm 1\%$ ), from no-load conditions to full-load conditions. |

As seen above, when the Mag-amp method is used in regulating output voltage of switching power supplies, excellent characteristics can be achieved in size, efficiency, noise, reliability, and precision. Advantages in cost performance are especially realized in low voltage / high current circuits (example: 3.3V-5A).

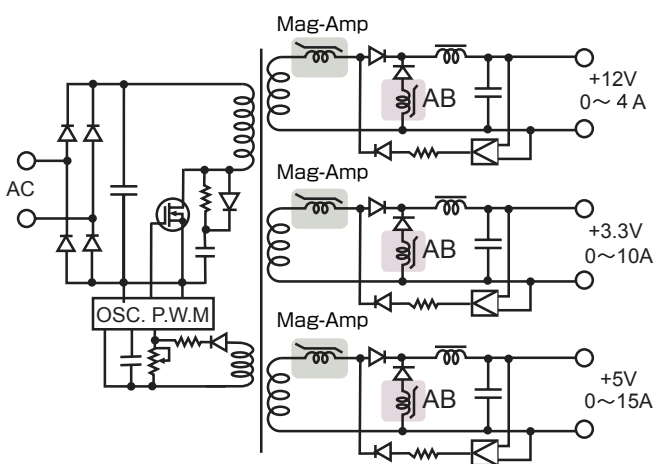
## Full Mag-Amp Method

The simple Mag-amp method is used mainly for voltage control of the post circuit in power supplies, called the cross-regulation (master-slave) method. This cross-regulation method stabilizes the output voltage by feedback of the main circuit to the primary side. Therefore, the post circuit output is affected by the situation of the load in the main circuit (cross regulation error). There is also the problem that power supplies do not operate unless some current (minimum current) is sent through the main circuit.

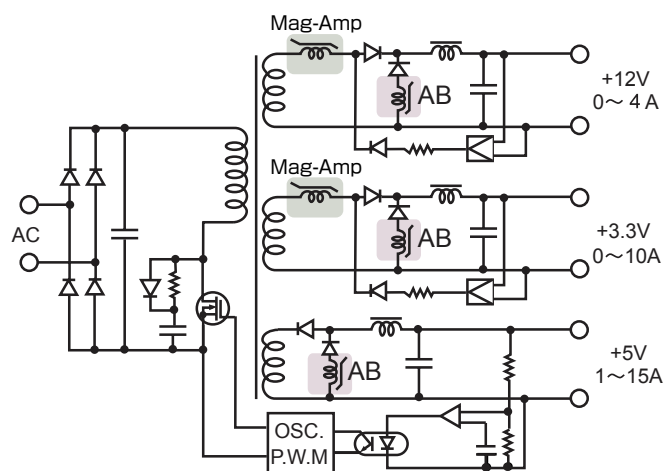
The Full Mag-amp method is a way to solve this problem.

The Full Mag-amp method controls each output at the secondary side. Therefore, there is no need for feedback to the primary side, and each output can be controlled from no-load conditions. Also, since each output operates independently, the optimization of the winding ratio for the main transformer and high efficiency can be realized compared to the cross-regulation method.

Furthermore, since each output is independent in the Full Mag-amp method, it is only necessary to adjust the circuit where the specification was changed. Therefore, time can be saved in the process of a design change.



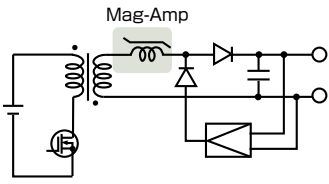
Full Mag-Amp Method



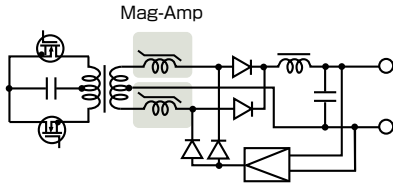
Cross-Regulation (Master-Slave) Method

# Examples of Circuits and Characteristics

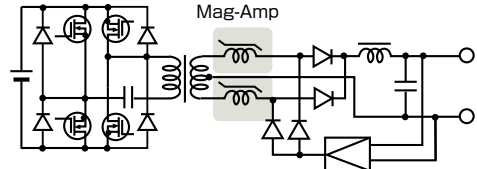
## Examples of Circuit



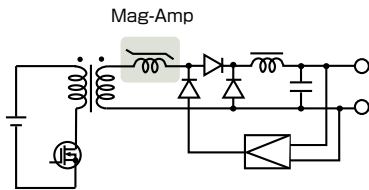
Flyback converter (ON-OFF Type)  
Ringing choke converter (RCC)



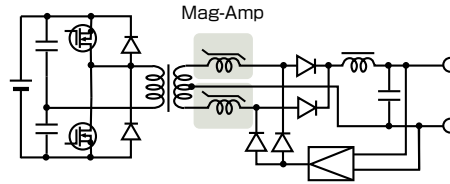
Push-pull converter (Center tap type)



Full bridge converter

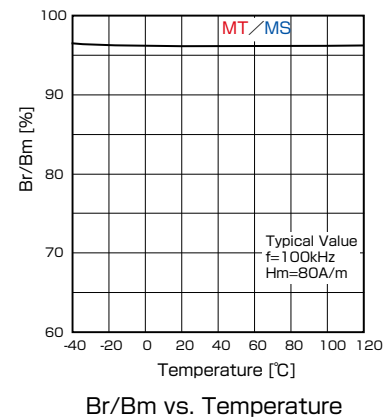
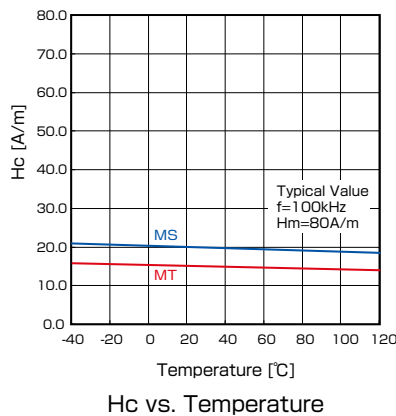
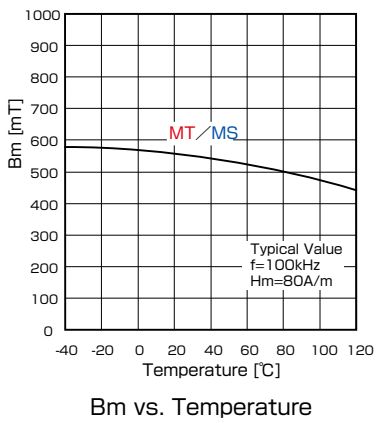
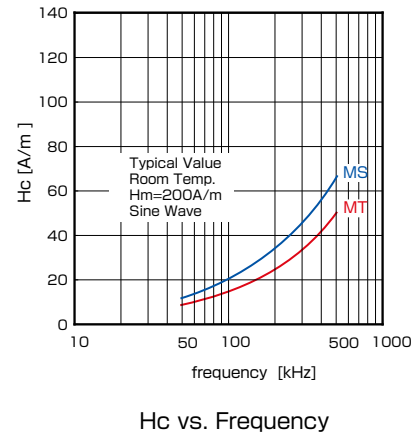
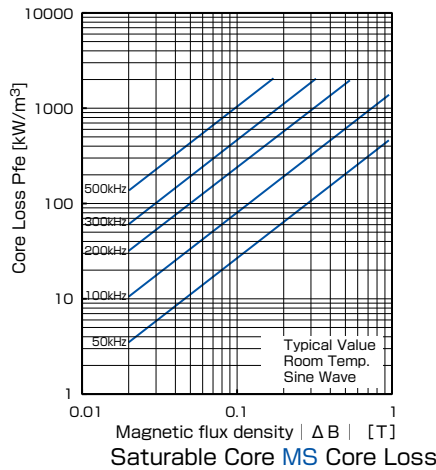
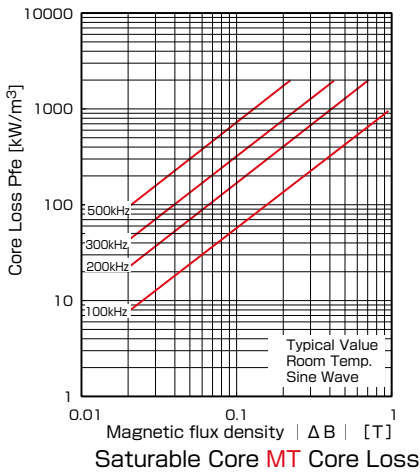


Forward Converter (ON-ON Type)



Half Bridge Converter

## Characteristics (Typical Value)



Examples of a use other than Mag-Amp :

Resonancer for Switching Power Supply ( Partial Resonance Element ), CT Magnetic Sensor,  
Transformer Core for Self-Invertor Oscillator, High Frequency Saturable Core for Current Delay or Timing Control