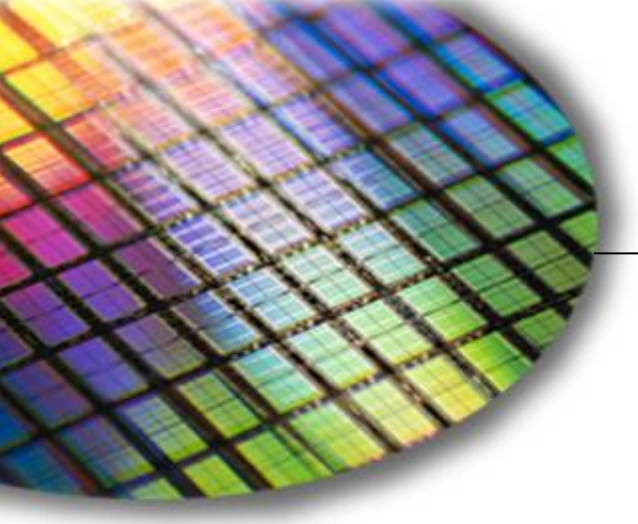


The World Leader in High Performance Signal Processing Solutions

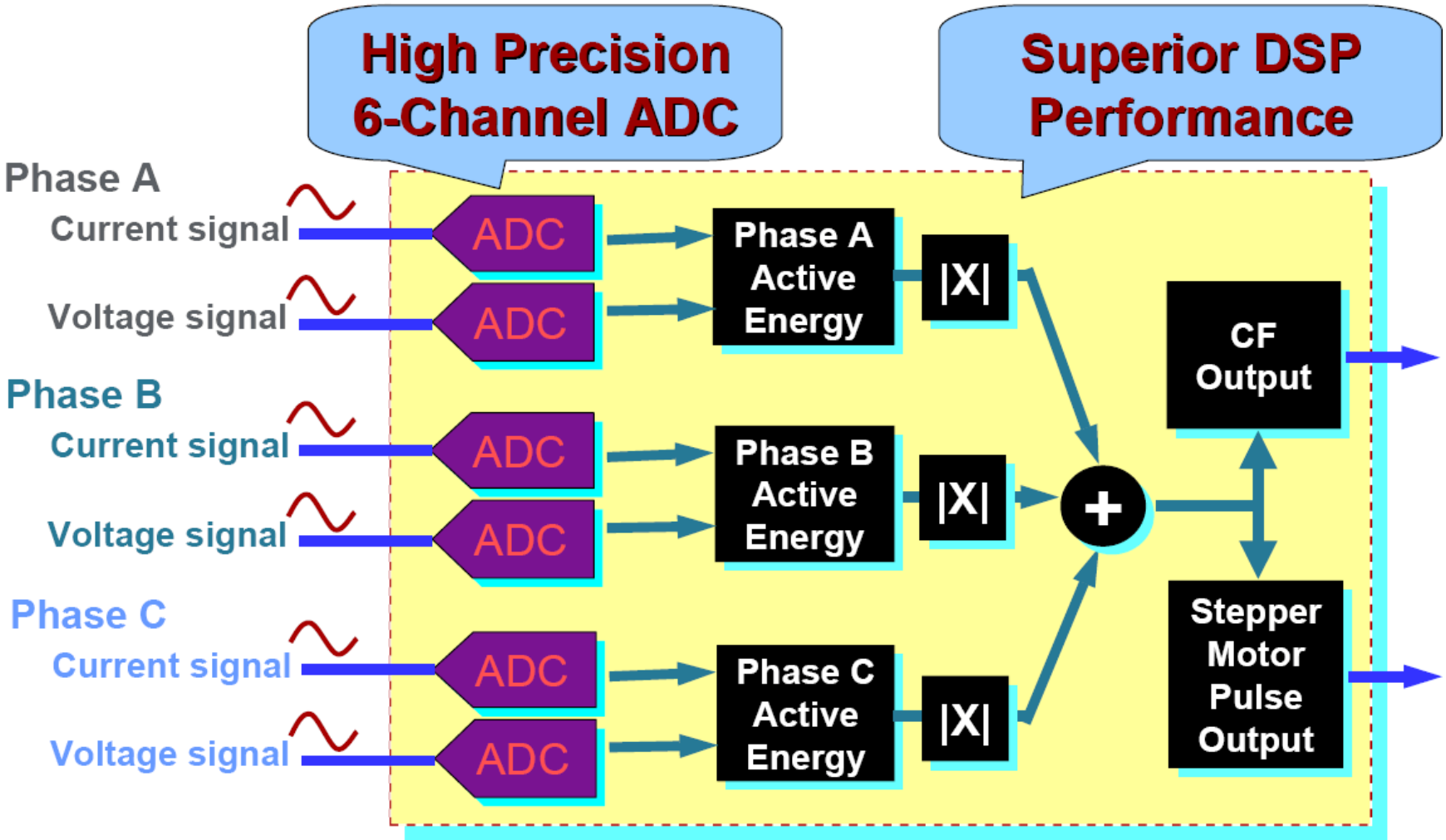
Three Phase Energy Metering IC with Pulse Output

ADE7752

Energy Measurement Group
Precision Converters (PRC) Division

ANALOG DEVICES

ADE7752 Overview



ADE7752 Overview

- Surpasses IEC1036 Class 1 meter requirement. Less than 0.1% error over a wide current dynamic range

- Suitable for various types of three-phase connections:
  - **Direct Connect**
  - **Transformer operated**
  - **Three-wire service**
  - **Four-wire service**
- Reversed power polarity detection output
- Wide choices for stepper motors
  - **10:1**
  - **100:1**
  - **200:1**
  - **400:1**
- Low start-up current

ADE7752 Frequency Output

Frequency for CF, F1/F2 can be calculated using the following formula:

$$\text{F1/F2 Output Frequency} = \frac{6.825 \times \left(V_{AN} I_A + V_{BN} I_B + V_{CN} I_C\right) \times F_{1\text{-}5}}{V_{REF}^{\,2}}$$

$$\text{CF Output Frequency} = k \times \text{F1 (F2) Output Frequency}$$

- 8 different choices of frequency output through SCF, S1, S0 pins

SCF	S1	S0	$F_{1\text{-}5}$	Max F1/F2 (Hz)	k	Max CF (Hz)
0	0	0	1.19	0.48	160x	78.12
1	0	0	1.19	0.48	8x	3.90
0	0	1	4.77	1.95	160x	312.51
1	0	1	4.77	1.95	16x	31.26
0	1	0	19.07	7.8	16x	130.56
1	1	0	19.07	7.8	8x	62.49
0	1	1	76.29	31.3	8x	250
1	1	1	0.596	0.24	16x	3.90

ADE7752 Features

- **Reversed Power Polarity Indication**

  Output an active high signal if any one of the three phases has negative power signal. This feature helps detect improper wiring of the three-phase meter during installation.

- **Start-up current**

  The ADE7752 has a start-up power threshold. Only if the power is above 0.0007% of F_{1-5}, the ADE7752 will start accumulate energy. This feature is useful to ensure that there is no creep of the meter even for a long period of time.

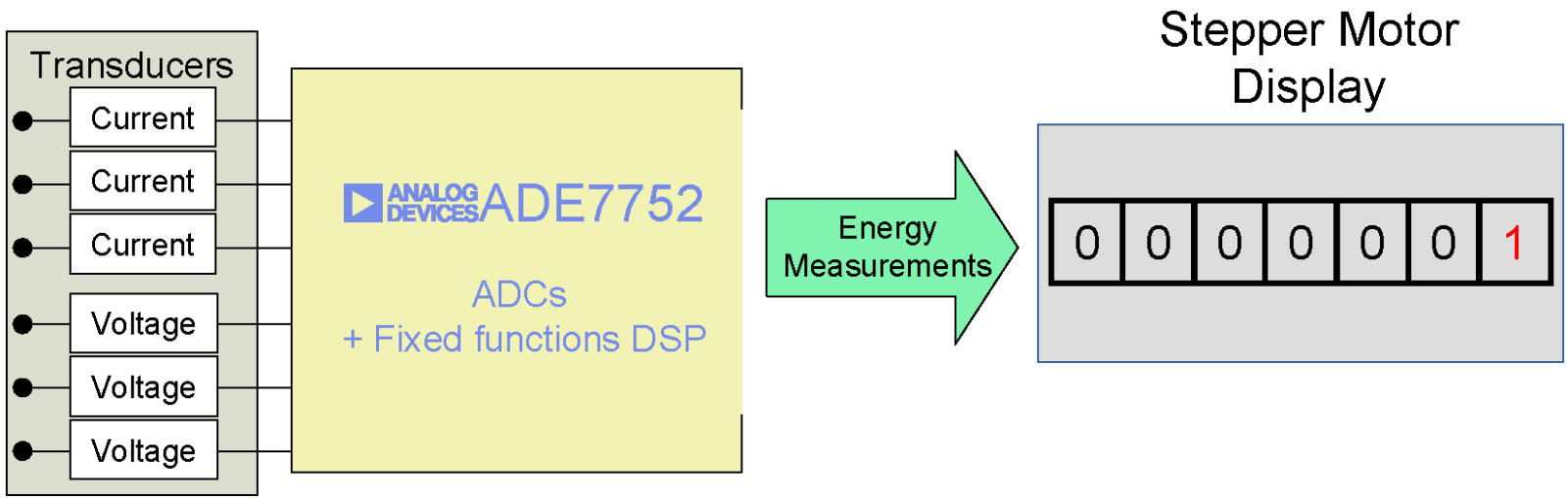
- **Absolute Accumulation**

  With the ABS pin tied low, the total energy becomes the sum of the absolute values of the individual phase energies.

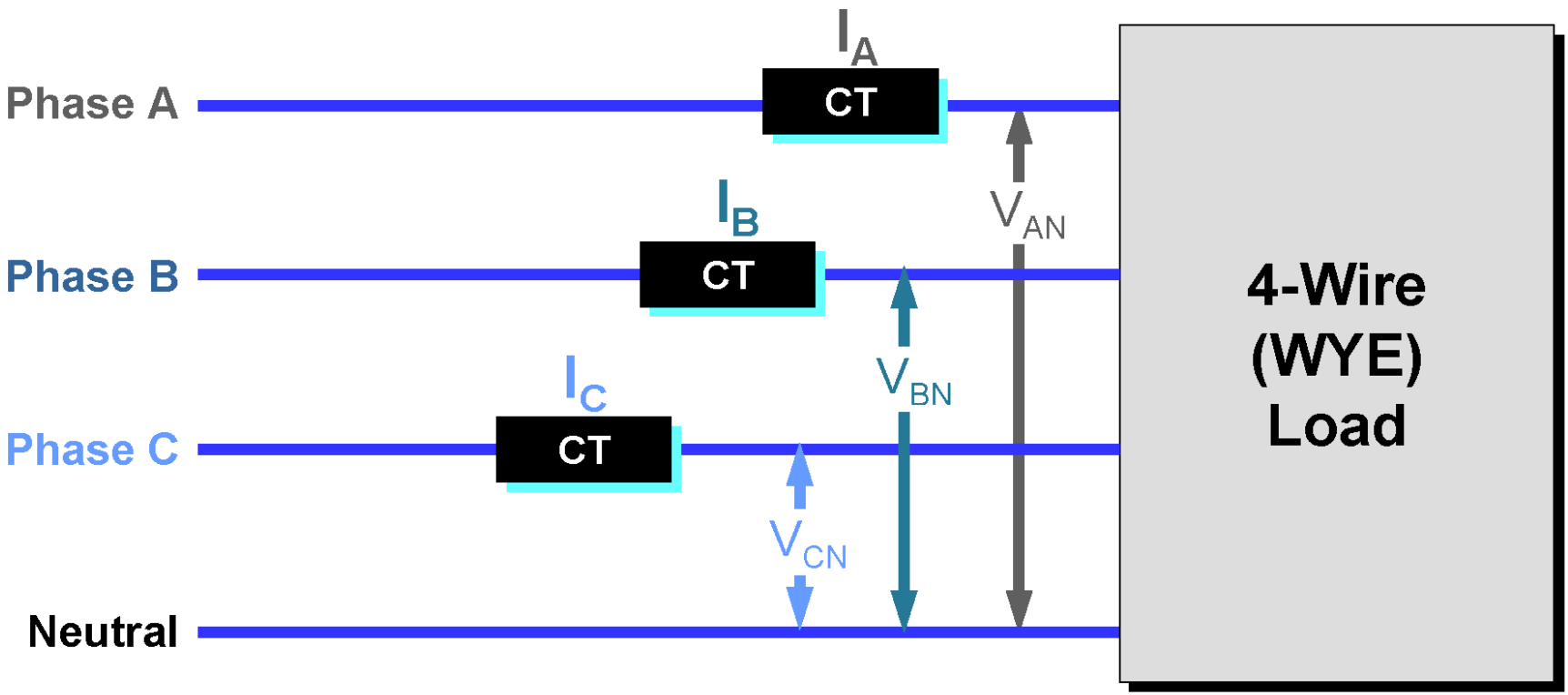
ADE7752 Specifications

- 24-pin SOIC package
- Single 5V Power Supply
- Temperature range from -40 C to 85C
- 500mV maximum analog input
- On-chip 2.4V reference
- Clock frequency = 10MHz

ADE7752 Single-chip Three Phase Energy Metering Solution



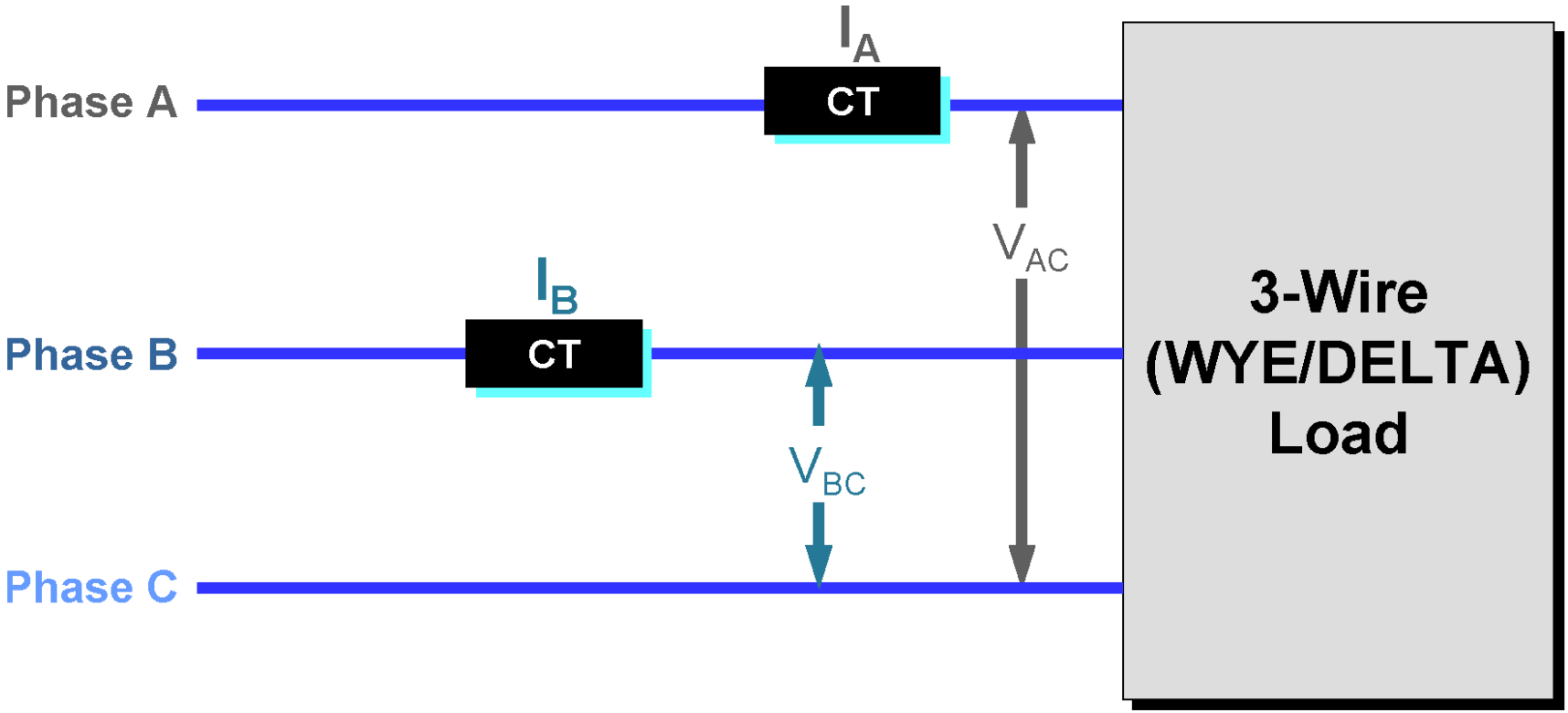
4-Wire Service Connection*



$$\text{Total Power} = V_{AN} * I_A + V_{BN} * I_B + V_{CN} * I_C$$

*Refer to ADE7752 datasheet for detailed connection to the ADE7752

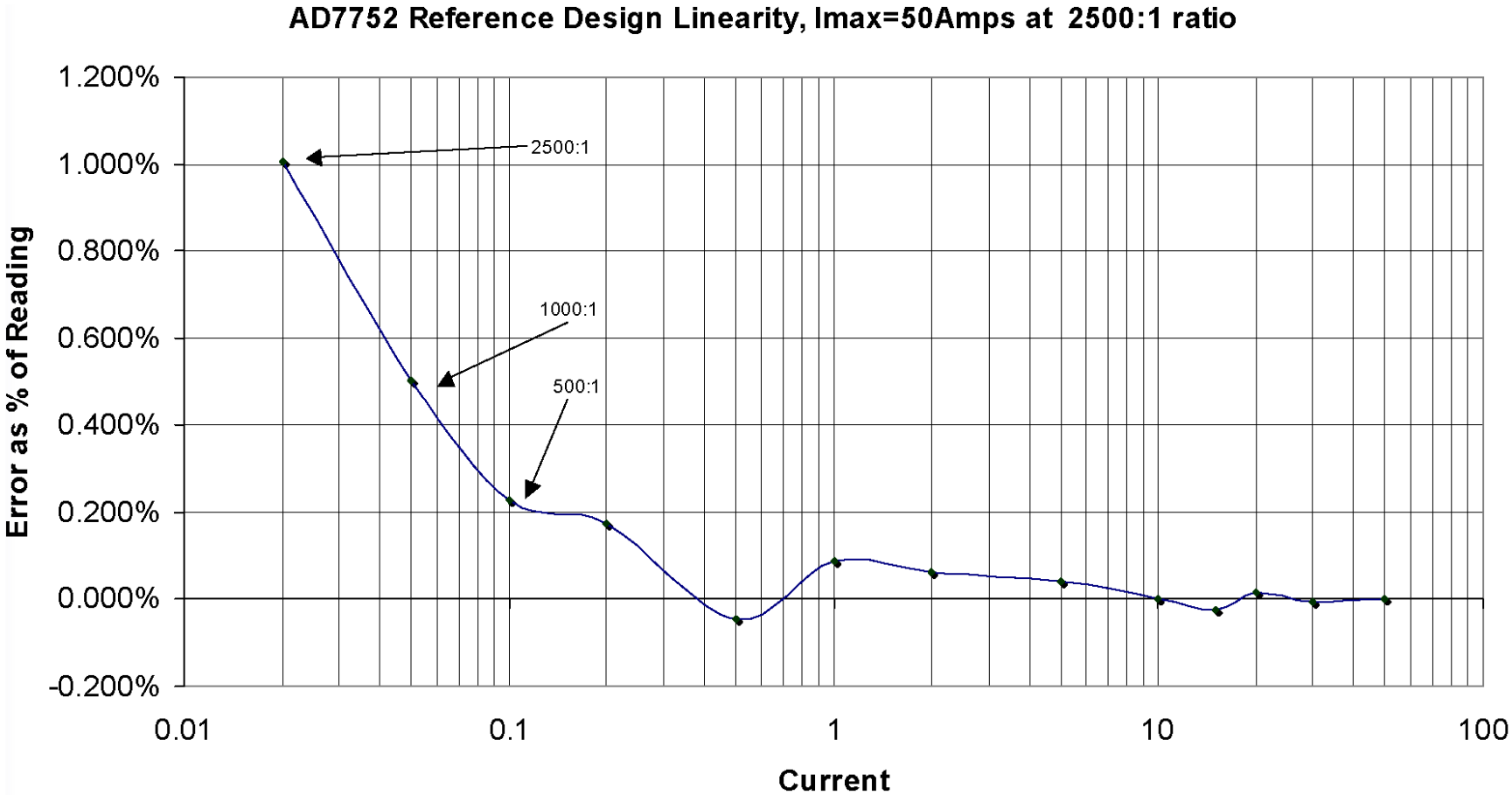
3-Wire Service Connection*



$$\text{Total Power} = V_{AC} * I_A + V_{BC} * I_B$$

*Refer to ADE7752 datasheet for detailed connection to the ADE7752

ADE7752 Application Example



ADE7752 Application Example

Parameters	Specifications
CT	2500:1
Voltage	Line-to-neutral voltage: 220V
Current	I_{max}=80A, I_b=20A
Stepper Motor	100 imp/kWHr (100:1)
Meter Constant	1600 imp/kWHr

Project: build a 4-wire, direct connect type three-phase meter

Step 1: Selecting F_{1-5} (Setting SCF, S1, S0)

Maximum expected output from F1/F2:

$$3 \quad \frac{220V \quad 80A}{1000W/kW} \quad \frac{100imp/kWHr}{3600sec/Hr} \quad 1.46667Hz$$

Choose F_{1-5}= 19.07Hz, CF = 16 x F1/F2 (S1=1, S0=1)*

Meter constant is 16 times that of the stepper Motor ratio

Choose CF = 16 x F1/F2 (SCF=0)*

*Refer to ADE7752 datasheet for how to select the F_{1-5}

ADE7752 Application Example

Project: build a 4-wire, direct connect type three-phase meter

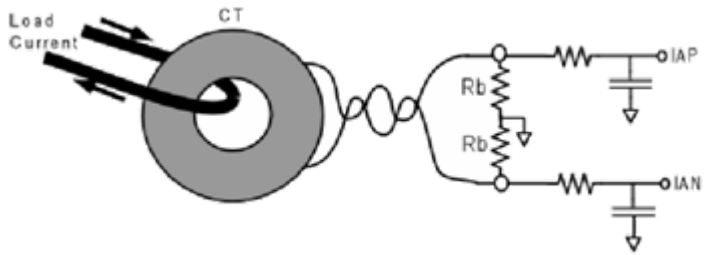
Parameters	Specifications
CT	2500:1
Voltage	Line-to-neutral voltage: 220V
Current	I_{max}=80A, I_b=20A
Stepper Motor	100 imp/kWHr (100:1)
Meter Constant	1600 imp/kWHr

Step 2: Burden resistor selection

At maximum current, the input signal at the current channel should be at half input full-scale* to allow headroom, i.e. at 80Arms, output voltage from the Z current sensor should be at around 0.500V / 2= 0.250V

I_{max}/C_{TRN} = 113.1A/2500 = 45.25mA

250mV/45.25mA = $2R_b$



Choose Burden resistance R_b = 2.76 ohm

*Refer to ADE7752 datasheet for the input full-scale range of the ADE7752

ADE7752 Application Example

Project: build a 4-wire, direct connect type three-phase meter

Parameters	Specifications
CT	2500:1
Voltage	Line-to-neutral voltage: 220V
Current	I_{max}=80A, I_b=20A
Stepper Motor	100 imp/kWHr (100:1)
Meter Constant	1600 imp/kWHr

Step 3: Design the voltage divider network

In a balanced situation:

$$\text{F1/F2 Output Frequency} = \frac{3 \times 6.825 \times V \times I \times F_{1\text{-}5}}{V_{REF}^{\,2}}$$

At 80A, the expected output frequency is: 1.466667Hz.The RMS signal output from the current sensor is I = 0.177V, $F_{1\text{-}5}$=19.07HzSubstitute those into the ADE7752's frequency equation and determine V:

$$1.4666667 = \frac{3 \times 6.825 \times V \times 0.177 \times 19.07}{2.5^2}$$

V = 0.134. Therefore, the 220V needs to be reduced by a factor of ~1640

Voltage Divider Network ~ 1 / 1640

ADE7752 Application Example

Parameters	Specifications
CT	2500:1
Voltage	Line-to-neutral voltage: 220V
Current	I_{max}=80A, I_b=20A
Stepper Motor	100 imp/kWHr (100:1)
Meter Constant	1600 imp/kWHr

Project: build a 4-wire, direct connect type three-phase meter

Step 4: Final checking for optimization

- Voltage inputs signal levels

  Make sure that the voltage channel input signal is “reasonable”.The signal at the current channel can be slightly reduced or increased to accommodate minor adjustment. Also look at the possibility of using a different $F_{1\text{-}5}$ if larger adjustment is needed.

- Calculate meter start up current

  ADE7752 start up at 0.0007% of $F_{1\text{-}5}$: 0.0007% x 19.07Hz = 0.000133Hz
  Using 100 imp/kWHr counter, this is equivalent to 4.8W.
  For a 220V system, the start-up current is then: 21.8mA (80mA required)

Design Finished

ADE7752Block Diagram