DATA SHEET

AA104-73/-73LF: 300 kHz-2.5 GHz One-Bit Digital Attenuator (32 dB)

Applications

- Sixth-bit value for Skyworks AA260-85 and AA101-80 digital attenuators
- IF and RF components for cable, GSM, PCS, EDGE, 3G, and ISM systems

Features

- One-bit attenuation of 32 dB (300 kHz to 1 GHz), 27 dB (1 GHz to 2 GHz), 24 dB (2 to 2.5 dB)
- Combines with Skyworks AA260-85 or AA101-80 digital attenuators for a 63 dB, six-bit solution
- Tune with one capacitor and/or resistor to desired operating frequency and attenuation
- Small SOT-6 package (MSL1, 260 °C per JEDEC J-STD-020)

Skyworks Pb-free products are compliant with all applicable legislation. For additional information, refer to *Skyworks Definition of Lead (Pb)-Free*, document number SQ04-0073.

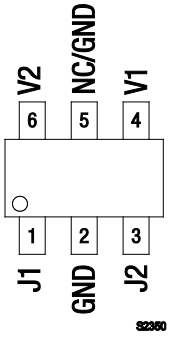


Figure 2. AA104-73/-73LF Pinout – 6-Pin SOT-6 (Top View)

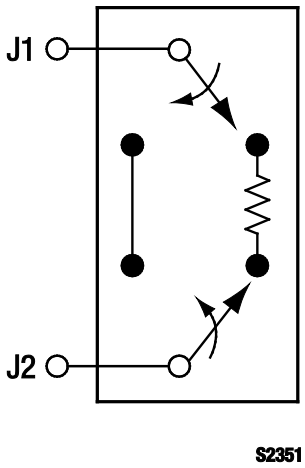


Figure 1. AA104-73/-73LF Block Diagram

Description

The AA104-73/-73LF are one-bit GaAs FET digital attenuators in a low-cost SOT-6 package. These devices provide up to 32 db total attenuation requiring two lines of voltage control.

The AA104-73/-73LF are particularly suited where high attenuation accuracy, low insertion loss, and low intermodulation products are required. A typical application is as a sixth-bit value for the AA260-85 and AA101-80 digital attenuators. A total attenuation of 63 dB in 1 dB steps can be obtained by combining the two attenuators.

A functional block diagram is shown in Figure 1. The pin configuration and package are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

Table 1. AA104-73/-73LF Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	J1	RF port. Must be DC blocked.	4	V1	DC control bias
2	GND	RF ground. Must be AC-coupled to ground.	5	NC/GND	No connect or ground.
3	J2	RF port. Must be DC blocked.	6	V2	DC control bias

Table 2. AA104-73/-73LF Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Units
RF input power	P_{IN}		1 W > 500 MHz 0/8 V 0.5 W @ 50 MHz 0/8 V	dBm dBm
Supply voltage	V_S		8	V
Control voltage	V_{CTL}	–0.2	+8.0	V
Operating temperature	T_{OP}	–40	+85	°C
Storage temperature	T_{STG}	–65	+150	°C

Note: Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit and all other parameters set at or below their nominal value. Exceeding any of the limits listed here may result in permanent damage to the device.

***CAUTION**: Although this device is designed to be as robust as possible, Electrostatic Discharge (ESD) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions should be used at all times.*

Electrical and Mechanical Specifications

The absolute maximum ratings of the AA104-73/-73LF are provided in Table 2. Electrical specifications are provided in Tables 3, 4, 5, and 6.

Typical performance characteristics of the AA104-73/-73LF are illustrated in Figures 3 through 13.

The state of the AA104-73/-73LF is determined by the logic provided in Table 4.

Table 3. AA104-73/-73LF Electrical Specifications (Note 1)
(V_{CTL} = 0/3 V and 0/5 V, T_{OP} = –40 °C to +85 °C, Characteristic Impedance [Z_0] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition (Note 2)	Min	Typical	Max	Units
Insertion loss	IL	0.0003 to 1.0 GHz 1.0 to 2.0 GHz 2.0 to 2.5 GHz		0.8 0.9 1.0	1.0 1.2 1.3	dB dB dB
Attenuation range		0.0003 to 1.0 GHz 1.0 to 2.0 GHz 2.0 to 2.3 GHz 2.3 to 2.5 GHz		32 27 24 23		dB dB dB dB
Attenuation accuracy (Note 3)		0.0003 to 0.5 GHz 0.85 to 0.95 GHz 1.7 to 2.0 GHz 2.0 to 2.3 GHz 2.3 to 2.5 GHz	± (0.4 + 10% of attenuation setting) ± (0.4 + 5% of attenuation setting) ± (0.5 + 6% of attenuation setting) ± (0.6 + 7% of attenuation setting) ± (0.7 + 7% of attenuation setting)			dB dB dB dB dB
Voltage Standing Wave Ratio (insertion loss state) (Note 4)	VSWR	0.0003 to 2.5 GHz		1.2:1	1.5:1	–
Voltage Standing Wave Ratio (attenuation state) (Note 4)	VSWR	0.0003 to 2.5 GHz		1.5:1	2.0:1	–
Switching characteristics: Rise/fall On/off Video feedthrough		 10/90% or 90/10% RF 50% V_{CTL} to 90/10% RF T_{RISE} = 1 ns, bandwidth = 500 MHz		 50 100 25		 ns ns mV
1 dB Input Compression Point	IP1dB	0.5 to 2.5 GHz, V_{HIGH} = 3 V 0.5 to 2.5 GHz, V_{HIGH} = 5 V	+14 +18	+21 +23		dBm dBm
3rd Order Input Intercept Point	IIP3	For two-tone input, P_{IN} = +10 dBm/tone, 0.5 to 2.5 GHz V_{HIGH} = 3 V V_{HIGH} = 5 V	 +36 +38	 +41 +44		 dBm dBm
Control voltages	V_{CTL}	V_{CTL} = V_{LOW} V_{CTL} = V_{HIGH}	0 3.0		0.2 5.0	V V
Control port current	I_{CTL}	V_{CTL} = V_{LOW} V_{CTL} = 3 V V_{CTL} = 5 V			20 100 200	µA µA µA

Note 1: Performance is guaranteed only under the conditions listed in this Table.

Note 2: Operates to 300 kHz when controlled with negative voltage. Bypass capacitor not required.

Note 3: Attenuation value set by bypass capacitor. Attenuation referenced to insertion loss.

Note 4: Input/output and in band.

Table 4. Compression Point vs Voltage and Temperature

Control Voltage (V)	Temperature (°C)	1 dB Compression Insertion Loss State (dBm)	1 dB Compression 32 dB State (dBm)
3	–40	+21	+16.5
3	+25	+21	+15.0
3	+85	+21	+14.0
5	–40	+22	+22.5
5	+25	+22	+22.5
5	+85	+22	+22.5

Table 5. IIP3 vs Voltage and Temperature

Control Voltage (V)	Temperature (°C)	IIP3 @ +10 dBm, Each Tone (dBm)
3	–40	+41
3	+25	+42
3	+85	+40
5	–40	+43
5	+25	+44
5	+85	+42

Two-tone input power: +10 dBm each tone.
Tone frequencies: 500 and 501 MHz.

Table 6. AA104-73/-73LF Truth Table

Attenuation, J1 to J2	V1 (Pin 4)	V2 (Pin 6)
Insertion loss	V_{HIGH}	0
32 dB	0	V_{HIGH}

Note: V_{HIGH} = +3 V to +5 V
All other conditions not recommended.

Typical Performance Characteristics

(V_{CTL} = 0/5 V, T_{OP} = –40 °C to +25 °C, Bypass Capacitor = 12 pF, Blocking Capacitor = 47 pF, Unless Otherwise Noted)

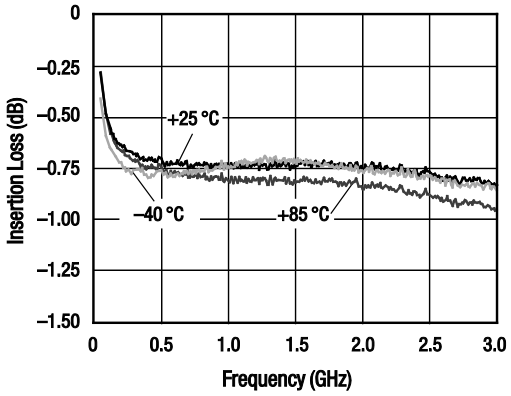


Figure 3. Insertion Loss vs Frequency

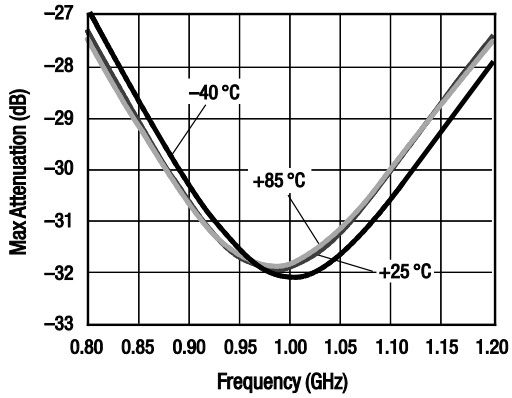


Figure 4. 32 dB State vs Frequency

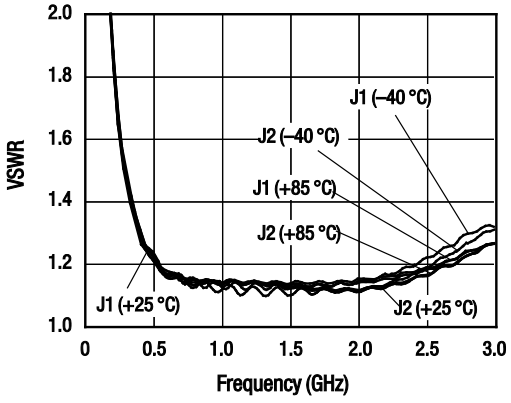


Figure 5. VSWR vs Frequency (Insertion Loss State)

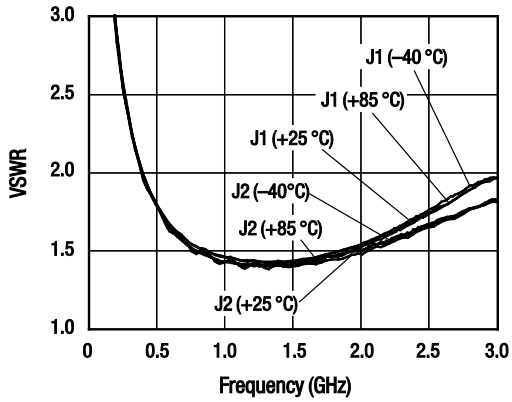


Figure 6. VSWR vs Frequency (32 dB State)

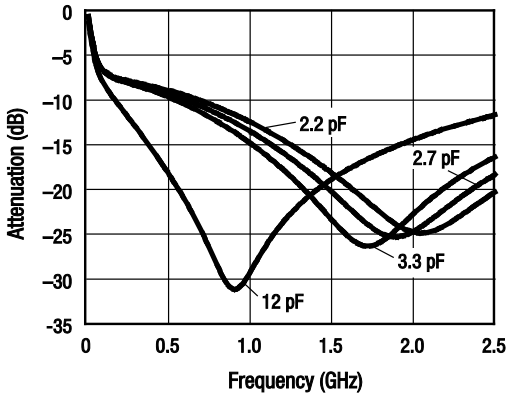


Figure 7. Attenuation vs Frequency, DC to 2.5 GHz (Bypass Capacitor = 2.2, 2.7, 3.3, and 12 pF)

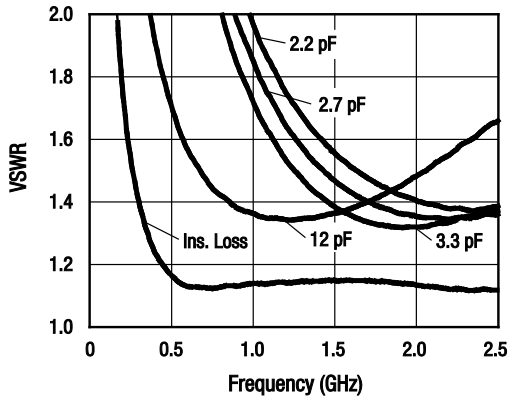


Figure 8. VSWR vs Frequency, DC to 2.5 GHz (Bypass Capacitor = 2.2, 2.7, 3.3, and 12 pF)

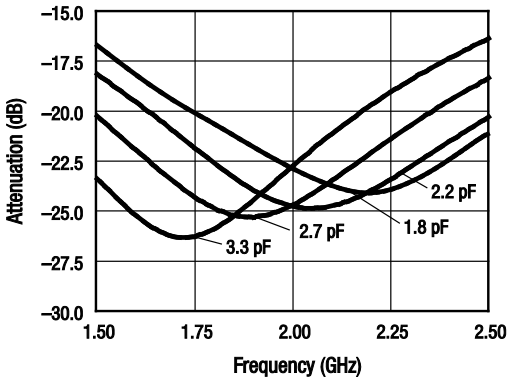


Figure 9. Attenuation vs Frequency, 1.5 to 2.5 GHz (Bypass Capacitor = 2.2, 2.7, and 3.3 pF)

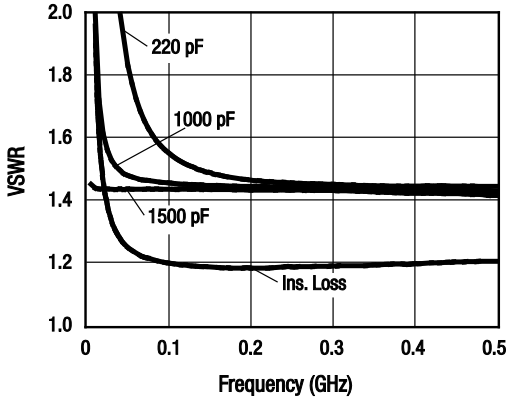


Figure 10. VSWR vs Frequency, DC to 0.5 GHz (Bypass Capacitor = 220, 1000, and 1500 pF)

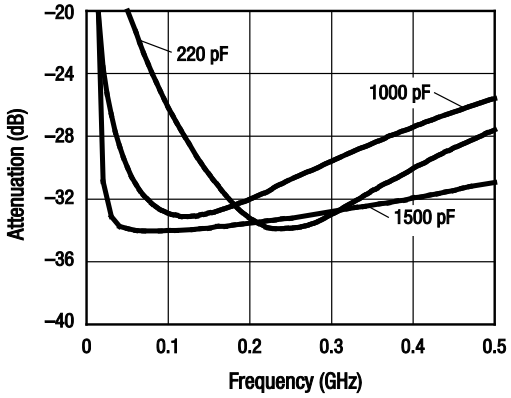


Figure 11. Attenuation vs Frequency, DC to 0.5 GHz (Bypass Capacitor = 220, 1000, and 1500 pF)

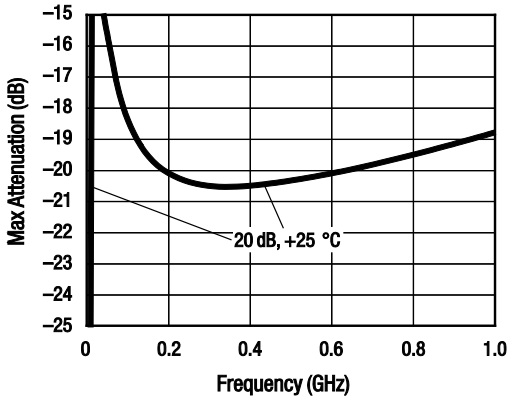


Figure 12. 20 dB State vs Frequency (Bypass Capacitor = 100 pF, Blocking Capacitor = 220 pF, Bypass Resistor = 15 Ω)

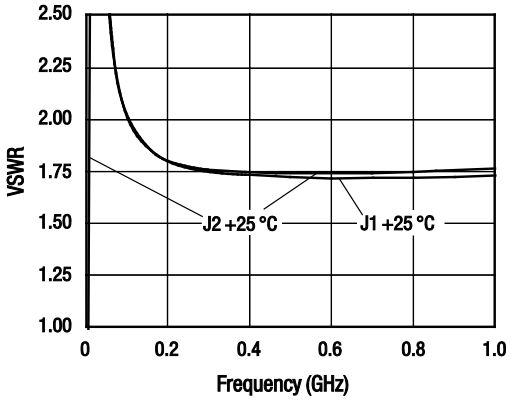


Figure 13. VSWR vs Frequency (20 dB State)

Evaluation Board Description

The AA104-73/-73LF Evaluation Board is used to test the performance of the AA104-73/-73LF digital attenuator. An Evaluation Board schematic diagram is shown in Figure 14.

Table 7 provides a list of the blocking and bypass capacitor values that are used to produce operating frequencies between 0.015 and 2.5 GHz.

For 6-bit attenuator requirements, refer to the following Skyworks Application Notes:

Six-Bit, 63 dB IF Digital Attenuator Solution, 1-500 MHz (document #200622)

Six-Bit, 63 dB RF Digital Attenuator Solution, 500-2000 MHz (document #200623)

Package Dimensions

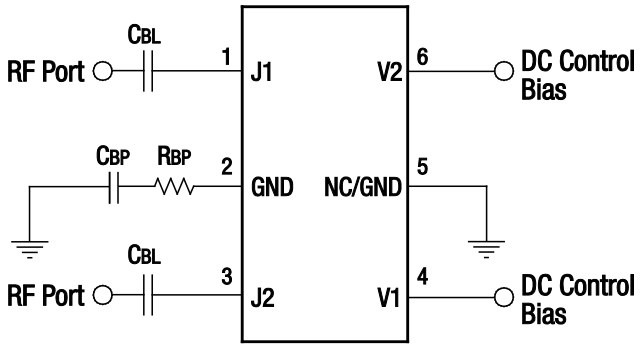
Package dimensions for the 6-pin SOT-6 are shown in Figure 15, and tape and reel dimensions are provided in Figure 16.

Package and Handling Information

Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

THE AA104-73/-73LF is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *Solder Reflow Information*, document number 200164.

Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.



Note: C_{BL} = 47 pF for frequencies >500 MHz operation. C_{BL} = 220 pF, C_{BP} = 100 pF, R_{BP} = 15 Ω, center frequency = 400 MHz. Center frequency and attenuation value can vary.

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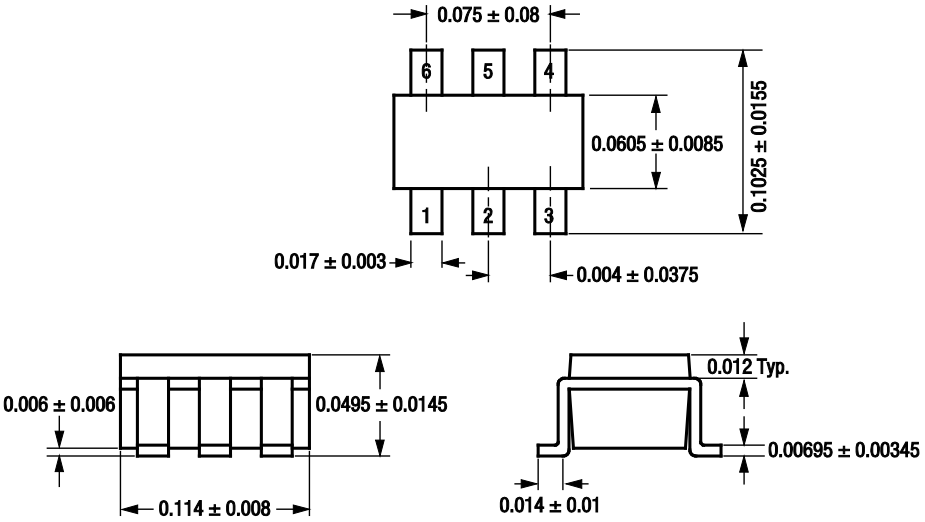
Figure 14. AA104-73/-73LF Evaluation Board Schematic Diagram



Notes:
1. *Dimensions are in inches*
2. *Body length dimension does not include mold protrusions or gate burrs. Mold protrusions and gate must not exceed 0.005 in. per end. Body width dimension does not include interlead mold protrusions. Interlead mold protrusions must not exceed 0.005 in. per side.*
3. *Lead width dimension does not include dambar protrusion/ intrusion. Allowable dambar protrusion must be 0.003 in. total in excess of lead width dimension at maximum material condition.*
4. *Details of pin 1 identifier are optional, but must be located within the zone indicated.*
5. *JEDEC standard practices and procedures apply (JEDEC Standard No. 95-1, Section 3).*

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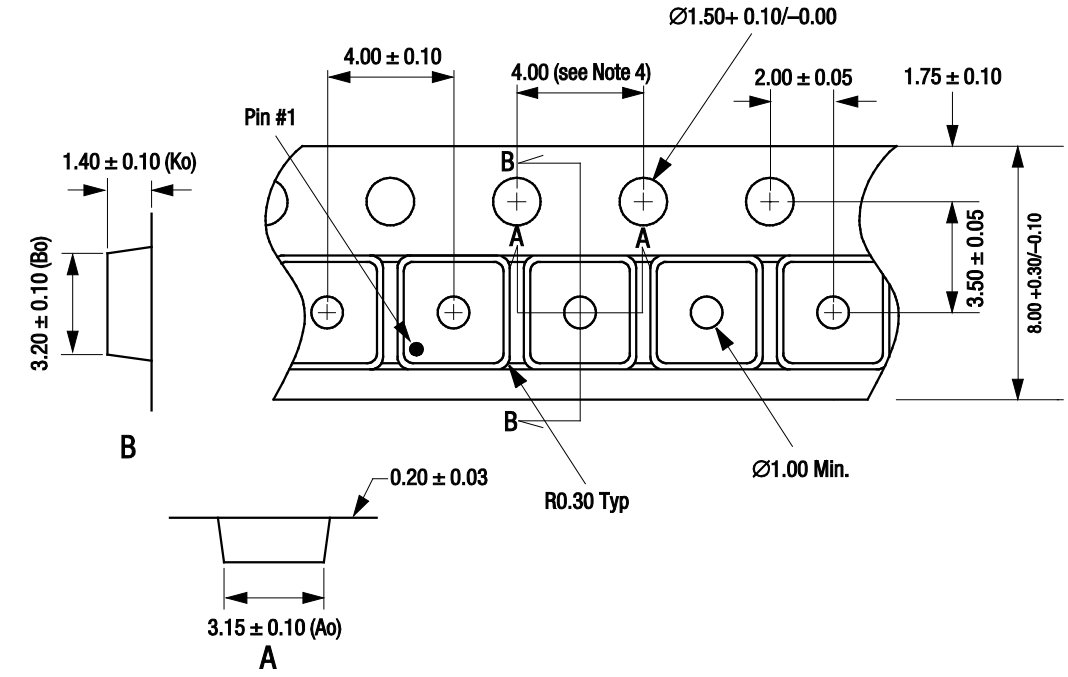
Figure 15. AA104-73/-73LF 5-Pin SOT-6 Package Dimensions



Notes:
1. *Carrier tape: black conductive polystyrene.*
2. *Cover tape material: transparent conductive HSA.*
3. *Cover tape size: 5.40 mm width.*
4. *Ten sprocket hole pitch cumulative tolerance = ±0.20 mm.*
5. *All measurements are in millimeters.*
6. *Standard reel size is 7 inches. Standard reel quantity is 3000 pcs.*

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Figure 16. AA104-73/-73LF Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Numbers
AA104-73/-73LF One-Bit Digital Attenuator	AA104-73/-73LF	AA104-73/-73LF-EVB