

Shunt Resistor Industry & Potential of Shivalik Bimetal

19.05.2020

Disc: All datas in this document are from various freely available resources on internet

Industry Profile

Cross References

LRMA...Current Sense Resistors

TTE PN	Bourns	Isabellenhütte	Koa	Ohmite	Panasonic	SEI	Vishay	Yageo
LRMAM0805	CRF0805					CSRF0805	WSL(P)0805	
LRMAM1206	CRF1206	LMK VMK	TLR2B		ERJMP2[K/M]	CSNL1206 CSRF1206 CSS1206	WS[L/K/P]1206	PE1206
LRMAM2512	CRE2512 CRF2512				ERJMP4[M/P]	CSNL2512 CSRF2512	WSL2512	
LRMAM2512					ERJMP4[M/P]		WSL2512	
LRMAN0612		VLK					WSL0612	
LRMAP2512	CRA2512 CSS2H-2512	BVT LMS VMS	TLR3A		ERJM[S4/P4Q]	CSM2512 CSSH2512	WSL(P)2512	PA2512...7T
LRMAP2512	CRA2512 CSS2H-2512	BVT LMS VMS	TLR3A		ERJM[S4/P4Q]	CSM2512 CSSH2512	WSL(P)2512	PA2512...7T
LRMAT2010		LMP VMP	TLR2H		ERJMP3[K/M]	CSNL2010 CSRF2010 CSS2010	WSL2010	PE2010
LRMAT2512					ERJMP4[M/P]	CSNL2512 CSRF2512	WSLT2512	PA2512...07 PA2512...7W
LRMAT2512					ERJMP4[M/P]		WSLT2512	
LRMAP3920	CSS2H-3920	BVS		EBWA		HCS3920	WSLP3921 WSR2...3	PU3921
LRMAP5930	CSS2H-5930	BVE		EBWB			WSLP5931	

The breadth of our portfolio is matched only by Vishay and we generally offer lower values and better TCRs.

- ❖ 9 major players as per competitor TTE
- ❖ Company ROHM is missing in this list
- ❖ TTE and VISHAY are full fledged supplier with large coverage
- ❖ Shivalik is delivering only metal strips to Vishay
- ❖ If needed, further processing (packaging with plastic) is done(?) from Vishay end
- ❖ Seems all major players are collaborating with minor Players to reduce manufacturing cost

Industry Profile

15 Company Profiles

15.1 Yageo

15.2 TE Connectivity

15.3 KOA Corporation

15.4 Panasonic

15.5 Vishay

15.6 ROHM Semiconductor

15.7 Viking Tech Corporation

15.8 Murata

15.9 TT Electronics

15.1 Bourns

15.11 Additional Companies

15.11.1 Asia Oceania

15.11.1.1 Ralec

15.11.1.2 Japan Resistor

15.11.1.3 Token Electronics

15.11.2 North America

15.11.2.1 NIC Components

15.11.2.2 Cal-Chip Electronics

15.11.2.3 International Manufacturing Services

15.11.2.4 Riedon

15.11.2.5 Ohmite

15.11.3 Europe

15.11.3.1 AMC Technologies

15.11.3.2 Isabellenhuette Heusler

❖ List of major and smaller companies(box)

❖ Chinese companies are missing in this list

❖ Seems, all companies which are capable of making shunt resistor at par quality, and has the basic knowhow and has the potential to scale up to match the competitor

Established players such as Vishay, Yageo, Rohm, Koa, Panasonic, Bourns, and Isabellenhuette offer a wide range of thick film power and shunt resistors for various industries. These players have adopted various strategies such as mergers & acquisitions, joint ventures, expansion, and new product development. For instance, Koa introduced a 0.2 mΩ resistance value current sense resistor, which can be used for current detection and is ideal for transportation and industrial markets in applications such as DC to DC.

However, many small and medium-sized companies such as Token, Queen Mao Electronic, ASJ PTE, Zonkas Electronics, Riedon, and Cal-Chip Electronics provide thick film power and shunt resistors in the local market. These companies are giving stiff competition to established players by offering products at a competitive price. Also, their products offer satisfactory performance and meet the client requirement. The increasing presence of local players has resulted in intense competition for established companies and may adversely affect the business growth of renowned manufacturers.

Industry Profile

Info from Manufacturer TTE

Market Outlook Metal Current Sense

Market Overview

- CAGR 2019 – 2024: 6.4% - fastest growing segment within fixed resistors market
- Increased number of metal shunt competitors result in lower margin environment
- Expect a 10% average price reduction in the market

Our Portfolio

- Portfolio development in growth metal shunt segment – we now have widest value range, lowest values, and leading low TCRs
- Continuous evaluation of make vs. buy to respond to market conditions

Working to Improve our Competitiveness

- LRMA1206 – 2512 competitive for lower and medium volume demand
- LRMA1206 and LRMAP2512 equivalents will be part of the Uniohm JV with in-house manufacture and so will be competitive in high volume markets soon
- LRMAP3920 and 5930 competitive for lower and medium volume demand, working to improve
- New generation of cost improved ULR introduced with PCN competitive at high volume demand
- Additional OARS machine in Mexicali will double output



Industry Profile

RESEARCH AND MARKETS
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Home / Categories / Telecommunications and Computing / Computing and Technology / Semiconductor



Thick Film Resistor Market by Industry (Automotive, Electrical & Electronics & Telecommunication), Resistor Type (Thick Film & Shunt), Vehicle Type (ICE, Electric & Hybrid Vehicles) and Region - Global Forecast to 2025

ID: 4769505 | Report | April 2019 | Region: Global | 161 pages | Markets and Markets

DESCRIPTION

TABLE OF CONTENTS

SAMPLES

SUMMARY

COMPANIES MENTIONED

The global thick film power and shunt resistor market is projected to reach USD 614.6 million by 2025 from USD 435.0 million in 2018. Asia Oceania is estimated to be the largest market owing to the high demand for consumer electronics goods and electrical products in the region. Also, Asia Oceania accounted for the largest share of 61.6% and 75.0% in the production of passenger cars and heavy commercial vehicles in 2018, respectively. Rising disposable income and purchasing power, changing lifestyle preferences, growing ecommerce activities, and increasing urbanization have boosted the market in this region.

Also, infrastructural development programs by regional authorities have driven market growth in Asian countries. For instance, China is expected to invest USD 13.1 billion in the development and construction of the Beijing International Airport, which is designed to

- ❖ ~ 180 Million \$ growth in 7 years
- ❖ 180 Million includes thickfilm power resistor as well.
- ❖ Shunt resistor is fastest growing thickfilm resistor segment

Industry Profile

WHITE PAPER



INTRODUCTION

The rechargeable battery industry has experienced significant growth and is expected to continue to grow into the future. Most of this growth is expected to be propelled by next-generation high voltage energy systems for electric vehicles, and marine and home storage applications that use series-connected battery packs. The most popular batteries for these applications are lithium-ion or nickel metal hydride batteries that require battery management systems (BMS) to monitor and maintain the cells in good condition so as to maximize output power. Analyst firm *Markets and Markets* confirms the huge expected growth, estimating that the battery management system market will grow from 1.98 billion USD in 2015 to 7.25 billion USD by 2022, at a CAGR of 20.5 % between 2016 and 2022.

Another important function of a BMS is to help enhance the life expectancy of battery cells and protect them from damage. To achieve maximum efficiency and long battery cell life, the BMS needs to determine the state of charge (SOC) to govern the capacity remaining in the battery, and also to control the rate of charging or discharging.

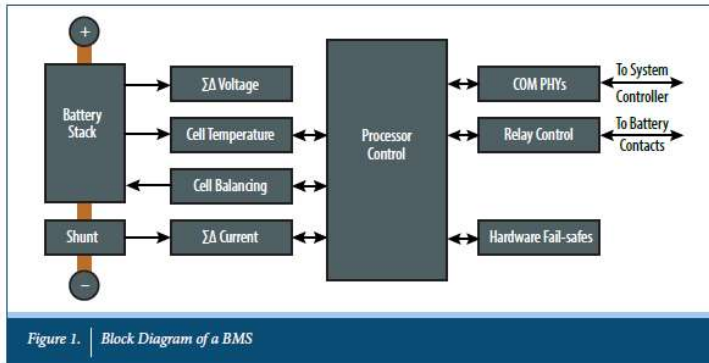


Figure 1. Block Diagram of a BMS

This paper reviews the trends in the BMS market and challenges that designers of BMS face. It focuses on the isolation of communications and transient protection challenges, and introduces isolated sigma delta converters with dynamic ranges less than 200 mV. The attractiveness of shunt-based current measurement for BMS is also reviewed.

❖ Shunt based solution is newer tech and seems to have more advantage to offer

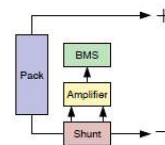
Table 1. Difference Between Shunt- and Hall-Based Isolated Current Sensing

CATEGORY	SHUNT-BASED	HALL-BASED
Solution size	Similar	Similar
offset	Very low	Medium
Offset drift over temperature	Low	Medium
Accuracy	<0.5% after calibration	<2% after calibration
Noise	Very low	High
Bandwidth	Similar	Similar
Latency	Similar	Similar
Nonlinearity	Very low	High
Long-term stability	Very high	Medium
Cost	Similar	Similar
Vibration impact	Very low	Low
Power dissipation	Low	Very low
Customization	Flexible	Limited

Industry Profile

1c. Battery-pack sensing: Current

- Battery pack current measurements are required:
 - To ensure safety.
 - To log abuse conditions.
 - By most state-of-charge and state-of-health algorithms.
- There are two basic sensing methods: Shunt and Hall effect.
- Shunt sensor is low-value (e.g., 0.1 mΩ) high-precision resistor in series with battery pack, usually at low-voltage end.
- Current computed by measuring voltage drop: $I = V_{\text{shunt}} / R_{\text{shunt}}$.



- Some comments on current-sensing shunts:
 - Power and sense connections must be made separately: four-wire voltage measurement via a Kelvin connection.
 - Current shunts have no offset at zero current, regardless of temperature, so they are good to avoid drift in coulomb counting (but, offset might still be introduced by measurement electronics).
 - Current shunts are not isolated from the pack. If BMS must be isolated from pack, extra circuitry is required.

Further Examples of Usage



RESISTORS SUCCESS STORY

Gogoro required precision current sensing in a small space with high power for an e-scooter BMS and “swap & go” charging station application for their smart scooter range. The customer required local technical support, long-term stability and an AEC-Q200 certified product.

Our Sales and FAE teams worked closely with the customer to recommend and approve LRMAP5930 – 300,000 pieces a year with the scope for growth in the future.

WHY WE WON

- Best long term stability versus competition
- Quick response from FAE, Sales and BU
- Quick sample turn-around
- Competitive pricing & LT

APPLICATION DESCRIPTION

- E-scooter
- Rechargeable battery
- Current sense



FUTURE OPPORTUNITIES

- Sunwoda
- BYD
- TD HiTech
- Misum Korea



RESISTORS SUCCESS STORY

Dyson - market leading consumer goods manufacturer – required compact ultra-low value current sense resistors for battery & motor monitoring.

TT Electronics provided low value metal alloy LRMA series surge tolerant resistors. 2018: 41M pcs

WHY WE WON

- Strong local relationships with R&D centres
- Footprint to fulfil the supply chain globally via multiple channels
- We are considered a top level supplier

APPLICATION DESCRIPTION

- V6/8/10 battery pack and motor drive current sense

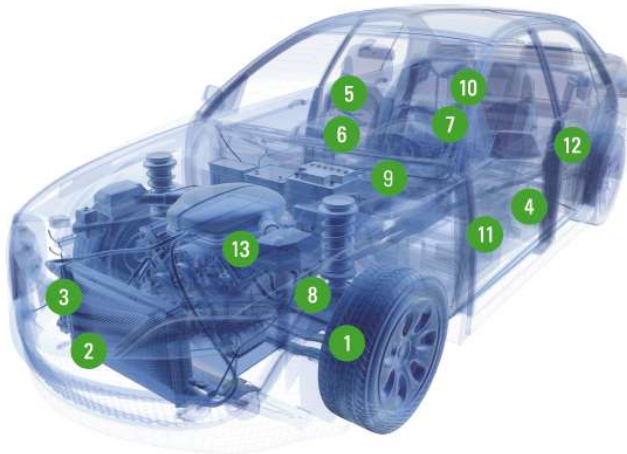


❖ opportunities other than BMS is also worth considering

Further Examples of Usage – From Isabelenhütte



PRECISION AND POWER RESISTORS



- | | |
|-----------------------|----------------------------|
| 1 EPS | 2 Front Blower ECU |
| 3 Lighting | 4 Electrical Parking Brake |
| 5 Seat belt tensioner | 6 Air Conditioner |
| 7 Infotainment | 8 Transmission Control |
| 9 Battery Management | 10 Airbag Control |
| 11 Window Lifter | 12 Keyless Entry |
| 13 Motor ECU Ignition | |

Tech Details for personal reference

LRMAP3920/5930 – Low Resistance Metal Alloy Power

LRMAP3920/5930 gives designers stable and accurate sensing of AC and DC currents up to 150A/200A in a compact chip resistor format.



- Bulk metal alloy technology
- Large copper terminations for minimal joint resistance
- 5 x 10 & 8 x 15mm footprints
- Power ratings up to 10W & 15W continuous
- Resistance values 200 $\mu\Omega$ to 2m Ω , Tolerance to $\pm 1\%$
- Up to 33J for fast surges, up to 50W for 5s overloads
- Dual rated for use on thermal substrates e.g. IMS & DBC
- Low thermal impedance minimises temperature rise and enhances product reliability
- High surge tolerance gives reliability under inrush and momentary short circuit conditions

For guaranteed stable and accurate sensing of AC and DC currents up to 200A in SMT assemblies, TT Electronics' LRMAP5930 high power shunt resistors match or surpass the power ratings of key competitors' parts in most ohmic values.



Figure 3.3: Shunt current sensor a) Metal Strip b) Chip resistor

A 5W, 100 $\mu\Omega$ resistance, WSMS5515 by *Vishay* [17], is chosen for this particular application. It is an alloy of copper and manganese (manganin), providing it with a small temperature coefficient and a small thermoelectric voltage, making it an excellent choice for precision measurements [18].

EBW8518 – E-Beam Welded Shunts

EBW8518 gives designers stable and accurate sensing of AC and DC currents in the hundreds of amps range in a robust busbar format.

- Electron beam welded technology for performance critical industrial and automotive applications
- Rating 36W continuous, up to 180W for 5s overloads
- 85 x 18mm (8518 format) with same 60mm mounting pitch as the larger footprint 8420 format
- Values 50 to 250 $\mu\Omega$
- Tolerance to $\pm 1\%$
- TCR to $\pm 100\text{ppm}/^\circ\text{C}$ (alloy 10ppm / $^\circ\text{C}$)
- Inductance <5nH, Thermal EMF <1 $\mu\text{V}/^\circ\text{C}$ for high precision applications
- The robust e-beam welded technology and low thermal EMF make this resistor advantageous for HEV battery management, energy metering and welding power supplies
- Inherent low self-heating reduces equipment temperature and improves reliability

Custom terminal plating and sense connection options available. The EBW8518 provides the fullest selection of values in TT Electronics' chosen range.



Informations – Related to Shivalik Bimetal

Spec of Japan resistor – matches with Shivalik Spec.

固定抵抗器 FIXED RESISTORS

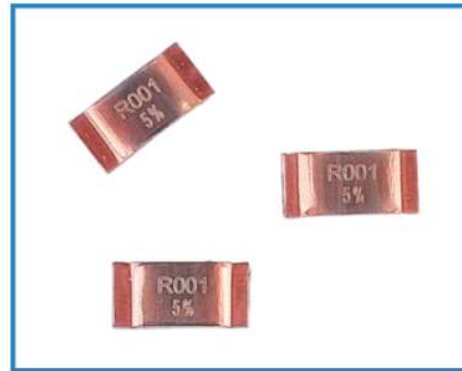
JRM

面実装シャント抵抗器

Current Sensing SMD Shunt Resistor

SBA series

- 低抵抗値・面実装 2512インチ形状
- 連続負荷電流 最大77A (0.5mΩ)
- 優れた長期安定性
- RoHS 対応品
- Low Ohmic value 2512inch
- Constant Current up to 77A (0.5mΩ)
- Excellent Long Term Stability
- RoHS Complied



- ❖ Shivalik supplies to Japan resistor
- ❖ Not full variety like Vishay

■電気的、機械的特性 Electrical and mechanical characteristics

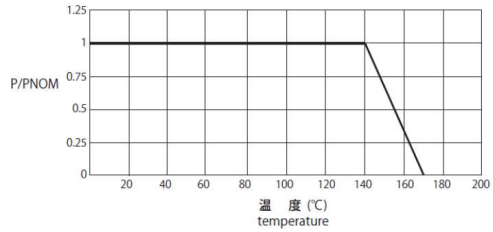
特性 Characteristics	規格値 Standards	試験方法 Test methods
抵抗値と抵抗値許容差 Resistance and Resistance tolerance	抵抗値 Resistance 0.3 0.5 1.0 1.3 2.0 3.0 4.0 5.0 6.8 10.0 (mΩ) 抵抗値許容差 Resistance tolerance ±1%(F) ±2%(G) ±5%(J)	
抵抗温度特性 Temperature coefficient	0.3mΩ / ±100ppm/°C max. (※1) 0.5mΩ / ±75ppm/°C max. (※1) 1.0mΩ ≤ R / ±50ppm/°C max. (※1)	
定格電力 (100°C) Power rating	2.0mΩ ≥ R / 3W 3.0-4.0mΩ / 2W 5.0-6.0mΩ / 1.5W 10.0mΩ / 1W	
定格負荷 Power rating load	ΔR/R ≤ ± 0.5% (端子温度 Terminal Temperature=110°C) ΔR/R ≤ ± 1.0% (端子温度 Terminal Temperature=140°C)	定格負荷 90分 ON 30分 OFF 2000時間 Rated power load 90 minutes ON and 30 minutes OFF for 2000 hours
インダクタンス Inductance	< 2nH	
半田付け性 Solderability	95% 以上新しい半田で覆われること 95% coverage min. with new solder	245 °C for 2 seconds
使用温度範囲	-55°C ~ +170°C	

Spec of Japan resistor – matches with Shivalik Spec.

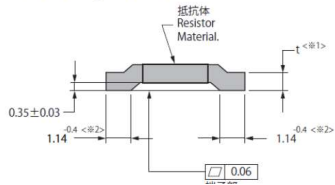
JRM

■規格 Standards

●定格電力軽減曲線 Power Derating Curve



●形状・寸法 Configuration (mm)



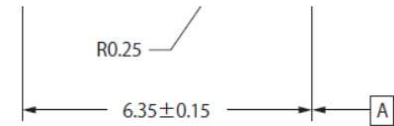
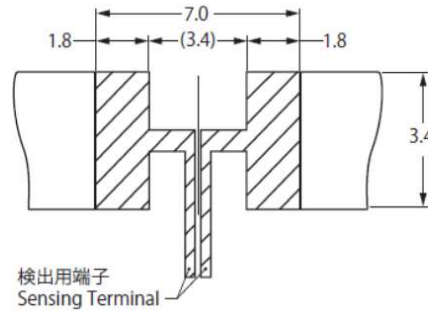
※1 板厚 $t^{①}$ は別表をご参照ください。 See the above table for thickness of $t^{①}$.
 ※2 左図 $②$ 公差は $t \leq 0.1$
 Tolerance for $t \leq 0.67$

品番 Part No.	抵抗値 (mΩ) Resistance value	t寸法 t(mm) Dimensions	定格電力 (W) Power Rating ※100°C
R0003	0.3	0.95	3
R0005	0.5	0.85	3
R001	1.0	0.42	3
R0013	1.3	0.33	3
R002	2.0	0.67	3
R003	3.0	0.45	2
R004	4.0	0.33	2
R005	5.0	0.33	1.5
R0068	6.8	0.33	1.5
R010	10.0	0.33	1

FIXED RESISTORS
固定抵抗器

SBA

●推奨ランド寸法 Recommended Pad Dimension (mm)



■受注生産品 Products by order

※3 リール情報 Reel information	
準拠基準 Reference Standard	DIN EN 60286-3
リール幅 (mm) Width of reel	12 mm
1リール reel	5000 pcs

Seidentechno – Another customer to Shivalik at Japan

SEF-セイデントテクノ株式会社 - www.seidentechno.co.jp.png

to



New Product









低抵抗電子ビーム溶接 SMD 精密抵抗器 Low Ohmic EB Welded SMD Precision Resistor

抵抗体と銅端子の溶接に電子ビーム溶接技術を用いて均一な溶接面を可能にしています。電流密度分布と銅端子による高い熱伝導率に優れた金属板シャント精密抵抗器です。

◆用途

電流検出 フィードバック 車載（パワーステアリング・エネルギー回生・バッテリー管理など）

電源モジュール 周波数変換器 インバーター 低インダクタンス用

	SBA		SBF		SBB
	SBC		SBG		SBD
	SBE		SBZ		






❖ Full offer from Shivalik product Line up

Bimetal Japan – Another customer to Shivalik at Japan

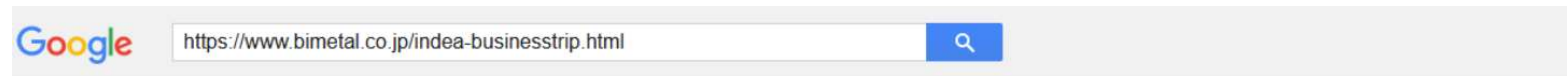
<https://www.bimetal.co.jp/ebw-shunt.html>



From: Japanese To: English

Technology introduction	Products handled	application	Company information
	抵抗値	抵抗材	抵抗値公差 定格電力 サイズ
	1 ~ 25mΩ	Copper Manganese, Aluchrom Alloy	1%, 3%, 5% 2W, 5W 3812 4524
SBE			
	抵抗値	抵抗材	抵抗値公差 定格電力 サイズ
	0.3 ~ 2mΩ	Copper Manganese, Aluchrom Alloy	1%, 3%, 5% 4, 5W 3820
SBF			
	抵抗値	抵抗材	抵抗値公差 定格電力 サイズ
	0.2 ~ 5mΩ	Copper Manganese, Aluchrom Alloy	1%, 5% 2 ~ 12W 3920
SBG			
	抵抗値	抵抗材	抵抗値公差 定格電力 サイズ
	0.5 ~ 5mΩ	Copper Manganese, Aluchrom Alloy	1%, 2%, 5% 2 ~ 12W 2725
SBH			
	抵抗値	抵抗材	抵抗値公差 定格電力 サイズ
	4, 5mΩ	Aluchrom Alloy	1%, 3%, 5% 4 ~ 5W 4527 4521
SBZ			
	抵抗値	抵抗材	抵抗値公差 定格電力 サイズ

Bimetal Japan – Another customer to Shivalik at Japan



Translate From: To:

	Technology introduction	Products handled	application	Company information	Contact Us
--	-------------------------	------------------	-------------	---------------------	------------

I arrived at the factory near 16:00. We have 3 other employees, one from me, and one from a company that is about to start trading. First, visit the factory. Since the Q & A session was over and the factory floor was over, I left the company after 19:00. It was a busy day today.

■ Day 3

An Indian company provided a clean resort hotel in a beautiful landscape.

First of all, I wanted the car to pick me up at the factory, so I took a detour. Here too, the story was buzzing, and the arrival at the intended factory was significantly late.

Since we don't have time, we have lunch meetings where we can see samples and have business talks in a large room at the top of the factory. No matter how many questions are asked and the answers are diverse, it never ends.

Dinner was invited to his home. It seemed that a dedicated cook was hired. First of all, there are many kiwi shelves on the large site. There was a billiard room next to the restaurant for guests who couldn't understand the garden because it was dark. He and his son at the bar counter recommended us Japanese whiskey "Hibiki". He himself was sipping Japanese tea. Is it because it is a customer from Japan? I was asked to make my next souvenir Hibiki. It didn't seem to be a joke. If his life as a family member of a family-owned company is like this, I wonder what kind of mansion Maharaja lives in. Returning to the hotel was quite late.

■ Day 4

Check the summary, make a final break and leave before noon. The audit passed although there were some improvements. Stroke your chest.

There were many different cases before, so I was impressed that the Indian company was making speedy and meticulous efforts to meet the Japanese standard.

Shivalik delivery to USA – Vishay and other customers

REGISTRES DE SHIVALIK BIMETAL CONTROLS LTD.

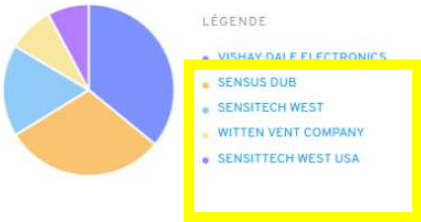
OBTENEZ UN HISTORIQUE COMPLET DU FOURNISSEUR ACTUALISÉ AU: 2020-05-15

[APERÇU](#) [EXPÉDITIONS](#) [IMPORTATEURS](#) [À PROPOS DE](#)

NOMBRE TOTAL D'EXPÉDITIONS **364** 1M 3M 6M 1A 3A TOUT 2006-11-01 - 2020-05-15



PRINCIPAUX PARTENAIRES COMMERCIAUX



PRINCIPAUX PORTS



Not Shunts, only Bimetal and other products To Sensitech

CHSL155295030DEL	THERMOSTATIC BIMETAL PARTS INVOICE NO 255 14-15 DT 31.07.2014 SB NO 4211612 DT 02.08.2014 NET WT 1710.500 KGS IEC NO 0588070076 OCEAN FREIGHT COLLECT THC COLLECT	SENSITECH WEST	SHIVALIK BIMETALS CONTROLS LTD.	2014-09-17	INDIA
CHSL151361227DEL	02 WOODEN BOXES CONTAINING THERMOSTATIC BIMETAL PARTS INVOICE NO 80 14-15 DT. 29.05.2014 S. BILL NO. 3019603 DT. 30.05.2014HS CODE 85381010 EXPORTER S REF. 0588070076 SHIPMENT S TERM FOB DELHI OCEANFREIGHT COLLECT IHC COLLECT	SENSITECH WEST	SHIVALIK BIMETAL CONTROLS LTD.	2014-08-09	SINGAPORE
CHSL149256280DEL	THERMOSTATIC BIMETAL PARTS, GRADE ALLOY 72, GRADE SBC 721.112. INVOICE NO 28 14-15 DT 29.04.2014 SB NO 2472072 DT 01.05.2014 NET WT 1315.800 KGS IEC NO 0588070076 HS CODE 85381010 FOB DELHI	SENSITECH WEST	SHIVALIK BIMETAL CONTROLS LTD.	2014-07-10	INDIA

Shivalik delivery to USA – Vishay and other customers

PRODUIT	IMPORTATEUR	FOURNISSEUR	DATE D'ARRIVÉE	PAYS D'ORIGINE	POIDS BRUT
EB WELDED SHUNT STRIPS	VISHAY DALE ELECTRONICS, LLC.	SHIVALIK BIMETAL CONTROLS LTD.	2020-05-15	SPAIN	2285 KGS
CEMENT RESISTORS SQM TYPE	VISHAY DALE ELECTRONICS INC.	ELYTONE ELECTRONIC CO LTD	2020-05-12	CHINA TAIWAN	802 KGS
CARRIER TAPE	VISHAY DALE ELECTRONICS, INC.	LASER TEK TAIWAN CO.,LTD	2020-05-11	CHINA TAIWAN	257 KGS
RESISTOR CAPS	VISHAY DALE ELECTRONICS	N/A	2020-05-08	GERMANY	751 KGS
PLASTIC TUBE HS CODE 3917230000 23 PALLETS 552CTNS	VISHAY DALE ELECTRONICS	PROFILEX PLASTIC TECHNOLOGY	2020-05-08	CHINA	10283 KGS
EB WELDED SHUNT STRIPS	VISHAY DALE ELECTRONICS	SHIVALIK BIMETAL CONTROL LTD	2020-05-06	INDIA	2548 KGS
CARRIER TAPE	VISHAY DALE ELECTRONICS, INC.	LASER TEK TAIWAN CO.,LTD	2020-05-03	CHINA TAIWAN	257 KGS
PLASTIC REELS	VISHAY DALE ELECTRONICS (351)	VISHAY ISRAEL LTD	2020-04-26	ISRAEL	3360 KGS

Shivalik delivery to USA – Vishay and other customers

PRODUCT	IMPORTER	SUPPLIER	ARRIVAL DATE	COUNTRY OF ORIGIN	GROSS WEIGHT KG
----- TRHU3664297 DESCRIPTION-----1 X 20'ST CONTAINER TOTAL 23 PACKAGES ONLY TOTAL TWENTY THREE PACKAGES ONLY EB WELDED SHUNT (2.0 50.6) (22.8-5-22.8) G INV NO. SBCL/E0951 /19-20 DT. 18.02.2020 S.B. NO. 1516952 DT. 19.02.2020, 5701 LAKE WRIGHT DRIVE NORFOLK UNITED STATES TEL:+1757 961 2100 FAX:+1757 961 2151 CMA-CGM NVOCC HOUSE BILLS CROSS REFERECNE WITMASTER BILLS NO CAD0409274 -----GENERIC DESCRIPTION-----	VISHAY DALE ELCTRONICS, LLC	SHIVALIK BIMETAL CONTROLS LTD.	2020-03-27	INDIA	19475 KGS
9 EB WELDED SHUNT	VISHAY DALE ELCTRONICS LLC	SHIVALIK BIMETAL CONTROLS LTD.	2020-02-28	INDIA	3473 KGS
----- CMAU0472779 DESCRIPTION-----1 X 20'ST CONTAINER TOTAL 24 PACKAGES ONLY TOTAL TWENTY FOUR PACKAGES ONLY EB WELDED SHUNT INV NO. SBCL/E0839/19-20 DT. 16.01.2020 S.B. NO. 9744455 DT. 18.01.2020, -----GENERIC DESCRIPTION-----	VISHAY DALE ELCTRONICS LLC	SHIVALIK BIMETAL CONTROLS LTD.	2020-02-22	INDIA	19396 KGS
----- CMAU1237692 DESCRIPTION-----1 X 20'ST CONTAINER TOTAL 23 PACKAGES ONLY TOTAL TWENTY THREE PACKAGES ONLY CONTAINING: EB WELDED SHUNT STRIPS INV NO. SBCL/E0807 /19-20 DT.07.01.2020, -----GENERIC DESCRIPTION-----	VISHAY DALE ELCTRONICS, LLC,	SHIVALIK BIMETAL CONTROLS LTD.	2020-02-12	INDIA	19273 KGS
EB WELDED SHUNT STRIPS INV # SBCL/E0717 /19-20 DT. 03.12.2019 S.B.# 8725129 DT. 04.12.2019 IEC # 0588070076 HS CODE # 74099000.	VISHAY DALE ELCTRONICS LLC	SHIVALIK BIMETAL CONTROLS LTD.	2020-01-18	INDIA	19345 KGS
24 PALLETS EB WELDED SHUNT STRIPS INV # SBCL/E0653/19-20 DT. 11/11/2018 S.B.# 8221998 DT. 13/11/2019 IEC # 0588070076 HS CODE # 74099000 ALL DESTINATION CHARGES TILL CONSIGNEE DOOR/NE 68601, USA PREPAID CLEARANCE/DUTY/TAXES ON SHIPPERS ACCOUNT RIT & DF NOT A PART OF	VISHAY DALE ELECTRONICS LLC	SHIVALIK BIMETAL CONTROLS LTD.	2019-12-29	INDIA	19535 KGS

- ❖ Shunt Delivery to Vishay every month
- ❖ 2 Tonnes almost every month

Summary

Industry Overview:

- ❖ Minimum 10 Tier 1 Shunt resistor suppliers – TTE, Vishay, Isabellenhütte, Bourns, Rohm, Panasonic, Yageo, Koa, Ohmite, SEI
- ❖ Many subsuppliers to tier 1 – List is endless and shivalik is one of them. Industry growth rate 6.4% until 2025 as per supplier TTE
- ❖ Shunt resistor seems to be superior technology to Hall effect sensor
- ❖ Not only BMS, many more usage in automotive and other battery related products(scooter, Vacuum cleaner).
- ❖ Seems Other applications provide more growth opportunities than BMS

Points related to Shivalik:

- ❖ Shivalik is subsupplier to Vishay and almost 20 Tonnes of delivery to Vishay
- ❖ Vishay is major competitor with large product base and quality as per competitor TTE and shivalik seems to be one of the main supplier based on shipping order
- ❖ Shivalik seems to supply to 3 japanese companies and one of them is japan Resistor. Bimetal and Seidentechno are other 2 customers. Their product line up matches with shivalik product range.
- ❖ As per company Bimetal, shivalik seems to have quality product which fulfills japanese requirements.