

TOREX SEMICONDUCTOR | 6616

Sponsored Research
June 27, 2022

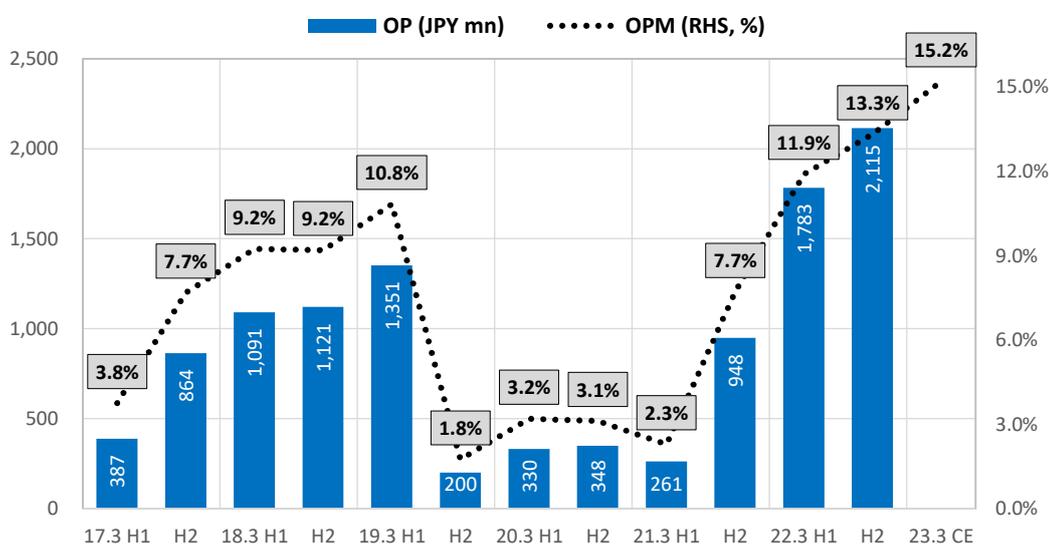


Surpassed FY3/24 MTP targets in FY3/22 FY3/23 initial guidance for OP and OPM to exceed FY3/26 targets

SUMMARY

- ▶ TOREX announced its 5-year Medium-Term Management Plan which covers the period from FY3/22 through FY3/26 on February 15, 2021. Numerical targets included in the MTP include: year three (FY3/24) net sales ¥30,000mn, OP ¥3,000mn and OPM 10.0%, and year five (FY3/26) net sales ¥35,000mn, OP ¥4,000mn and OPM 11.4%. Relative to these targets, actual results for FY3/22 (year one) were: net sales ¥30,864mn, OP ¥3,897mn and OPM 12.6%, topping year three targets in year one, and **initial guidance for FY3/23 (year two) is: net sales ¥33,000mn, OP ¥5,000mn and OPM 15.2%, guiding to top year five OP and OPM targets in year two.** Put another way, 3-year CAGR from the low in FY3/20 in the wake of the US-China tariff dispute of net sales ¥21,500mn, OP ¥678mn and OPM 3.2% to FY3/23 initial guidance forecasts are: net sales +15.4%, and OP +94.6%.
- ▶ The US Bureau of Labor Statistics reported the CPI for March 2022 was 8.5%, and for May 8.6%, the highest levels in 40 years, and Fed officials have signaled they may need to raise rates to 'restrictive' levels to stabilize inflation and the economy. While there may be legitimate concerns about a slowdown in demand for general electronics products going forward, **the TOREX Group has entered a new growth period driven by the convergence of structural demand drivers**, including economy-wide DX initiatives (RPA/AI, smart factories, etc.), global rollout of 5G service, rapid growth in IoT connected devices, global EV new model ramp, connected cars, ADAS, and demand for next-generation power devices (climate change). Due to brisk earnings growth, **the current P/E is trading 53% below its historical average.** Also, there is potentially significant upside to profits from the Company's conservative forex assumption for FY3/23 of USD 120.

TOREX Group OP and OPM Semiannual Trend → Further Improvement in FY3/23



Source: compiled by SIR from company TANSIN financial statements.

4Q Follow-up



Focus Points:

Power management IC specialist with attractive growth profile from new applications driven by 5G, IoT-connected devices and the electrification of cars.

Key Indicators

Share price (6/24)	2,630
YH (22/1/4)	3,485
YL (22/5/10)	2,151
10YH (21/11/30)	3,960
10YL (14/5/20)	725.8
Shrs out. (mn shrs)	11.554
Mkt cap (¥ bn)	30.388
EV (¥ bn)	26.006
Equity ratio (3/31)	65.4%
23.3 P/E (CE)	8.2x
23.3 EV/EBITDA (CE)	3.8x
22.3 ROE (act)	14.9%
22.3 P/B (act)	1.27x
23.3 DY (CE)	2.13%

6M weekly share price



Source: SPEEDA price data

Chris Schreiber CFA

Company Specialist

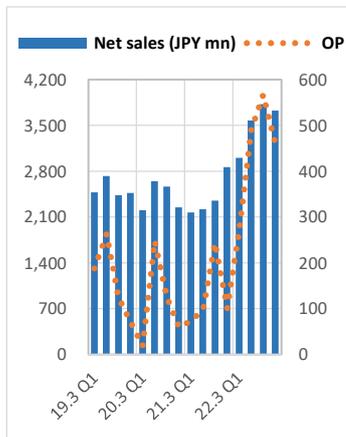
research@sessapartners.co.jp



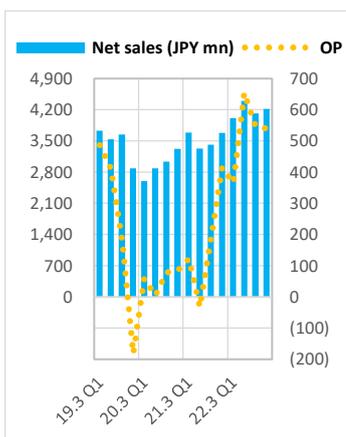
This report was prepared by Sessa Partners on behalf of TOREX SEMICONDUCTOR, LTD. Please refer to the legal disclaimer at the end for details.



TOREX Parent



Phenitec contribution



Source: compiled by SIR from IR quarterly results briefing materials.

Record profits on booming demand

Brisk market conditions expected to continue in FY3/23

RESULTS SUMMARY

- ▶ TOREX SEMICONDUCTOR announced consolidated financial results for 4Q FY3/22 at 15:30 on Friday 5/13, and it held a results briefing on Thursday 5/19 from 16:00, disclosing the briefing materials that afternoon. Headline numbers for the full term ended March 31, 2022 were net sales +30.2% YoY, OP +222.3%, and profit attributable to owners of parent +238.2%, topping 3Q revised full-term guidance by +1.2%, +18.1% and +21.4%, respectively.
- ▶ By entity, TOREX the parent posted 1.5x growth in net sales and 3.5x growth in OP, the highest profits since listing, thanks to strong sales growth in all regions. Phenitec contribution net sales increased 1.2x YoY, and OP tripled, posting the highest profits since becoming a consolidated subsidiary, thanks to strong sales in Japan. Japan sales increased significantly due to a recovery in the automotive market, and high capacity utilization rates drove a sharp increase in OPM from 4.9% → 12.6%.
- ▶ Initial guidance for FY3/23 is net sales +6.9% YoY and OP +28.3%, with OPM improving further from 12.6% → 15.2%. Regarding shareholder returns, despite the full-term overshoot on profits, the company maintained its revised FY3/22 full-term DPS indication for ¥44.0, and is initially guiding for FY3/23 full-term DPS of ¥56.0, giving consolidated dividend payout ratios of 15.2% and 17.5% (below the target minimum 20%), respectively, citing high investment needs toward future growth.

TOREX SEMICONDUCTOR Consolidated Financial Results Summary

JPY mn, %	FY3/17 act	FY3/18 act	FY3/19 act	FY3/20 act	FY3/21 act	FY3/22 act	FY3/23 init CE
Net sales	21,560	23,997	23,897	21,501	23,713	30,864	33,000
YoY	—	11.3	(0.4)	(10.0)	10.3	30.2	6.9
• Phenitec contribution	11,378	13,828	13,792	11,837	14,107	16,740	—
YoY	—	21.5	(0.3)	(14.2)	19.2	18.7	—
• Torex parent	10,181	10,168	10,104	9,663	9,605	14,124	—
YoY	—	(0.1)	(0.6)	(4.4)	(0.6)	47.0	—
Gross profit	5,900	7,177	6,494	5,452	5,959	9,474	—
GPM	27.4%	29.9%	27.2%	25.4%	25.1%	30.7%	—
SG&A	4,649	4,964	4,943	4,774	4,750	5,577	—
Ratio to sales	21.6%	20.7%	20.7%	22.2%	20.0%	18.1%	—
Operating profit	1,251	2,212	1,551	678	1,209	3,898	5,000
YoY	—	76.8	(29.9)	(56.3)	78.3	222.3	28.3
OPM	5.8%	9.2%	6.5%	3.2%	5.1%	12.6%	15.2%
• Phenitec contribution	571	1,579	904	225	693	2,108	—
YoY	—	176.5	(42.7)	(75.1)	208.0	204.2	—
OPM	5.0%	11.4%	6.6%	1.9%	4.9%	12.6%	—
• Torex parent	680	633	646	453	516	1,789	—
YoY	—	(6.9)	2.1	(29.9)	13.9	246.7	—
OPM	6.7%	6.2%	6.4%	4.7%	5.4%	12.7%	—
Yen-dollar (USD) rate	¥108.9	¥110.8	¥110.7	¥109.1	¥106.2	¥112.9	¥120.0
Capex	988	1,149	3,323	1,497	1,179	1,916	3,646
Depreciation	1,219	934	1,085	1,312	1,208	1,311	1,904

Source: compiled by SIR from TANSBIN financial statements and IR results briefing materials.

Kagoshima Fab



Okayama Daiichi (No.1) Fab



Okayama Head Office (No. 2) Fab



▶ **CAPEX PLANS**

As can be seen from the bottom right-hand corner of the table on P2, initial guidance for FY3/23 is forecasting significant increases in both capex (+90% YoY) and depreciation (+45% YoY). Based on our follow-up interview, of the budgeted ¥2.5bn in capex for last term, roughly ¥0.5bn was delayed into this term due to the equipment delivery schedule. The majority of capex this term is for capacity increases at Phenitec’s Kagoshima Plant, and a portion for work on the Okayama Daiichi (No. 1) Plant (adding a number of apparatus in shortage rather than large-scale investment). The Company is targeting a 5-10% capacity increase at the Kagoshima Plant. This entails raising current monthly wafer processing capacity of 18,000 – 19,000/month to a ‘stable’ 20,000 wafers/month. ‘Stable’ here refers to production yields across a range of different products.

Ultimately, Phenitec’s high profit margins are a function of the high utilization rates at the Daiichi (No. 1) Plant, as well as high utilization of the older Head Office Plant (renamed the No. 2 Plant), as facilities are mostly depreciated.

▶ **FOREX ASSUMPTIONS AND SENSITIVITY**

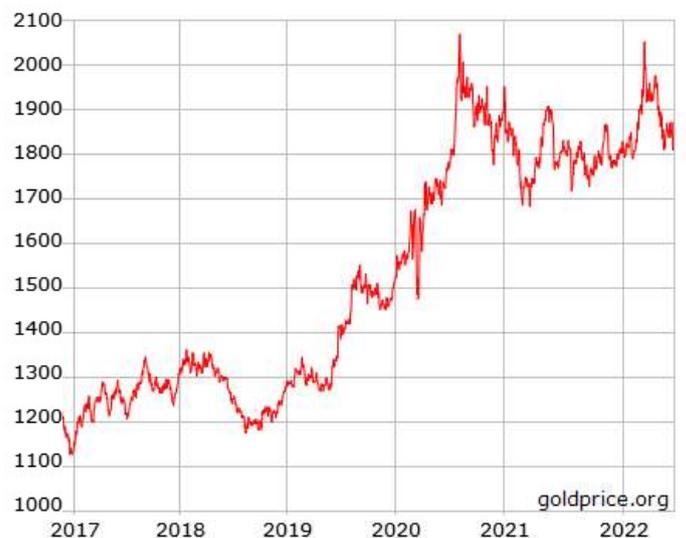
Similarly, from the bottom right-hand corner of the table on P2, the effective yen-dollar rate achieved in FY3/21 was USD 106.2, and in FY3/22 was 112.9. Initial guidance for FY3/23 assumes USD 120.0. Roughly 70% of consolidated Group sales transactions are denominated in USD, so the forex rate has a large impact. Even when fixed costs such as depreciation increase, the increase in gross profit due to the weaker yen is larger, and according to the Company, this is the largest factor behind the projected rise in OPM to 15.2%. Of course, this is not the only factor, as there are ongoing initiatives to address the rise in raw materials costs etc., however, the yen’s sharp depreciation is clearly a nice tail wind for profits.

Sensitivity for a ¥1 annual fluctuation is: net sales roughly ¥140mn, and OP ¥115mn. As can be seen in the lower left-hand graph, relative to the Company’s assumption for 120, the USD is now trading near 135. For example, a rough calculation changing the assumption to 130 would boost OP from ¥5,000mn → over ¥6,000mn.

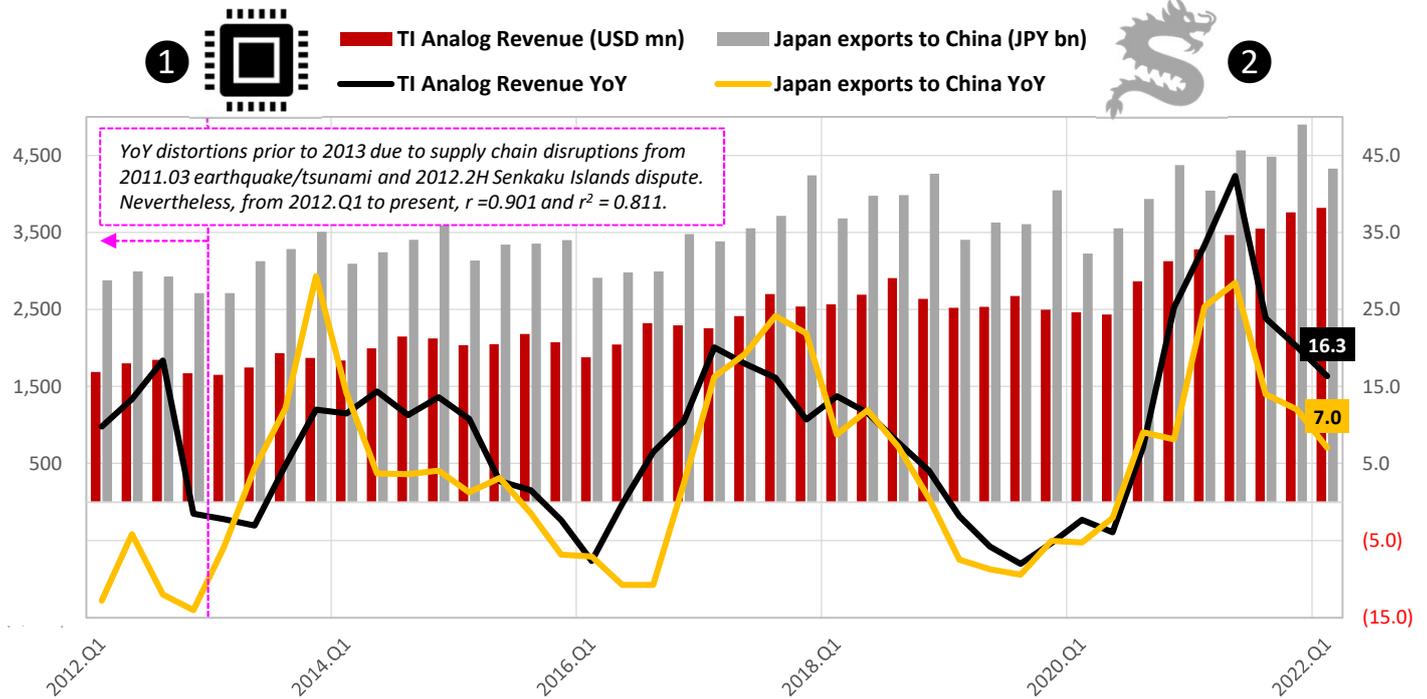
USD-JPY



Gold USD/oz



Business environment and current phase in the cycle: the growth rate is slowing, but still growing



Japan exports to China have been a **reliable proxy** for the general health of the global electronics supply chain, likely a function of Japan's ongoing leadership in critical electronic components and advanced materials.

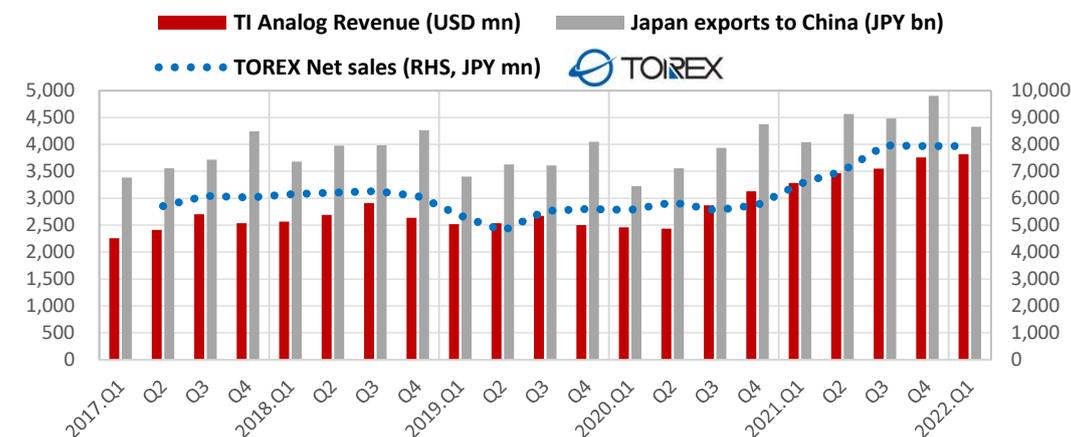
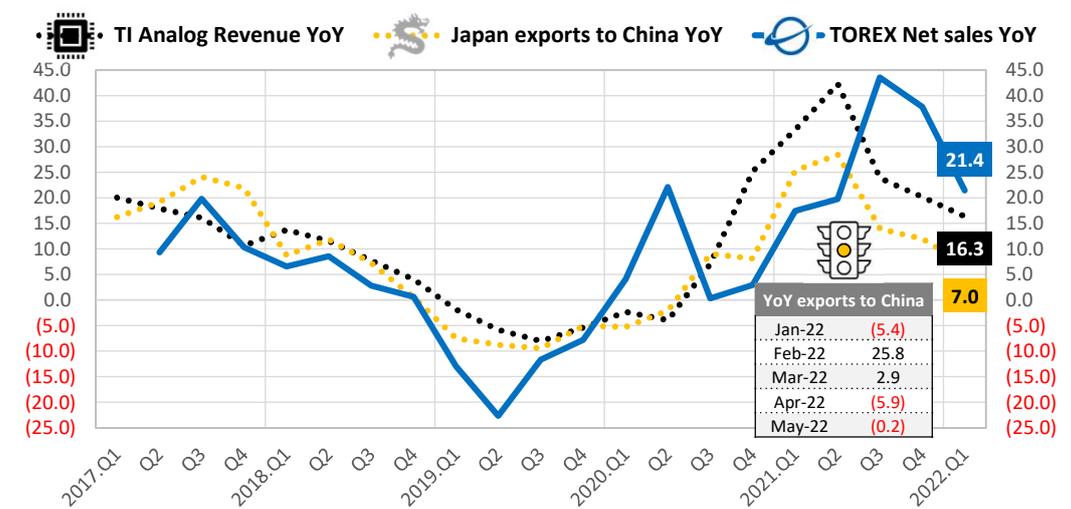
Robust Statistical Correlation

parameter	since
(between 1 and 2)	2012
correlation coefficient (r)	0.901
coefficient of determination (r^2)	0.811

Note: r measures the strength and direction of the linear relationship between two variables. r^2 measures the goodness of fit of a linear regression model (variance of one variable explained by the other). Of course, correlation does not imply causation.

Source: compiled and calculated by SIR.

Small and nimble TOREX Group can outperform (underperform) from time to time



Source: compiled by SIR from MOF Trade Statistics, Texas Instruments IR data and TOREX financial statements.

WSTS Semiconductor Market Forecast Spring 2022

USD bn, %	2018 act	YoY	2019 act	YoY	2020 act	YoY	2021 act	YoY	2022 Jun est	YoY	2023 Jun est	YoY
• Americas	103	16.4	79	(23.7)	95	21.3	121	27.4	149	22.6	156	4.4
• Europe	43	12.1	40	(7.3)	38	(5.8)	48	27.3	58	20.8	61	5.1
• Japan	40	9.2	36	(9.9)	36	1.3	44	19.8	49	12.6	52	4.8
• Asia Pacific	283	13.7	258	(8.8)	271	5.1	343	26.5	391	13.9	412	5.5
TOTAL WORLD	469	13.7	412	(12.0)	440	6.8	556	26.2	646	16.3	680	5.1
• Discrete	24	11.3	24	(0.9)	24	(0.3)	30	27.4	33	10.2	35	3.8
• Optoelectronics	38	9.2	42	9.3	40	(2.8)	43	7.4	44	0.3	45	3.7
• Sensors	13	6.2	14	1.2	15	10.7	19	28.0	22	15.7	23	3.6
• Integrated Circuits	393	14.6	333	(15.2)	361	8.4	463	28.2	547	18.2	577	5.4
Analog	59	10.8	54	(8.2)	56	3.2	74	33.1	88	19.2	93	5.7
Micro	67	5.2	66	(1.2)	70	4.9	80	15.1	89	11.4	94	5.3
Logic	109	6.9	107	(2.5)	118	11.1	155	30.8	187	20.8	201	7.3
Memory	158	27.4	106	(32.6)	117	10.4	154	30.9	183	18.7	189	3.4
TOTAL PRODUCTS	469	13.7	412	(12.0)	440	6.8	556	26.2	646	16.3	680	5.1

Source: compiled by Sessa Partners from World Semiconductor Trade Statistics (WSTS) press release archive.

Business Environment Key Takeaways (pp4-5)

- ▶ Based on our follow-up interview, TOREX expects tight conditions in the market to persist through the end of this year. Given the high level of backlogs, **utilization rates are expected to remain at or near full capacity.**
- ▶ From the two tables on P5, this view is consistent with the WSTS revised forecast for 2022 for **double-digit growth in both discrete and analog** semiconductors, and as of April, according to Arrow Electronics HK Market Trend Report, **average factory lead-times remain extended.**
- ▶ The three graphs on P4 show that, while YoY growth has peaked for both Texas Instruments and TOREX, **sales are still growing at double-digits.** However, one point of caution is that **Japan exports to China turned negative in April and May.** Given high inflation and rising interest rates, demand for electronics products can be expected to slow going forward.

Arrow Electronics HK 2022 Q2 Purchasing Market Trends - Asia

Product Segment	Avg. factory lead-time Oct-21 est	Avg. factory lead-time Jan-22 est	Avg. factory lead-time Apr-22 est	Lead-time trend Apr-22 est	Pricing trend Apr-22 est
SEMICONDUCTORS					
Analog					
Commodity amplifiers	31 - 35 weeks	31 - 35 weeks	31 - 35 weeks	↗	↗
Comparators	31 - 35 weeks	31 - 35 weeks	31 - 35 weeks	↗	↗
Regulators	31 - 35 weeks	31 - 35 weeks	31 - 35 weeks	↗	↗
Discrete					
Power Mosfet	26 - 42 weeks	26 - 42 weeks	26 - 42 weeks	↗	↗
Power rectifiers	26 - 42 weeks	26 - 42 weeks	26 - 42 weeks	↗	↗
Small signal diodes/transistors	18 - 29 weeks	18 - 29 weeks	18 - 29 weeks	↗	↗
Embedded					
32-bit	24 - 41 weeks	24 - 41 weeks	24 - 41 weeks	↗	↗
8-bit	30 - 48 weeks	30 - 48 weeks	30 - 48 weeks	↗	↗
Logic					
CMOS single/dual gate	14 - 42 weeks	14 - 42 weeks	14 - 42 weeks	↗	↗
HC/HCT	14 - 42 weeks	14 - 42 weeks	14 - 42 weeks	↗	↗
Programmable logic					
CPLD	44 - 65 weeks	44 - 65 weeks	45 - 65 weeks	↗	→
FPGA	45 - 65 weeks	45 - 65 weeks	45 - 65 weeks	↗	→
Memory					
EEPROM	20 - 24 weeks	20 - 24 weeks	20 - 24 weeks	→	↗
Flash (3V)	22 - 26 weeks	22 - 26 weeks	22 - 26 weeks	→	→
DRAM	22 - 28 weeks	22 - 29 weeks	22 - 29 weeks	→	→
SRAM	18 - 20 weeks	18 - 20 weeks	18 - 20 weeks	→	→
PEMCO*					
Connectors					
I/O box to box	13 - 21 weeks	13 - 21 weeks	13 - 21 weeks	→	↗
Electro-mechanical					
Switch	13 - 20 weeks	13 - 20 weeks	13 - 20 weeks	→	↗
Passives					
Capacitor - MLCC	14 - 28 weeks	14 - 28 weeks	19 - 32 weeks	↗	↗
Circuit protect	16 - 38 weeks	16 - 38 weeks	15 - 38 weeks	↗	↗
Resistor	32 - 42 weeks	32 - 42 weeks	32 - 45 weeks	↗	↗
Power supplies	38 - 46 weeks	41 - 46 weeks	47 - 53 weeks	↗	↗

*Note: Passive, Electro-mechanical and Connectors

Source: compiled by SIR from Arrow Electronics (HK) quarterly surveys.



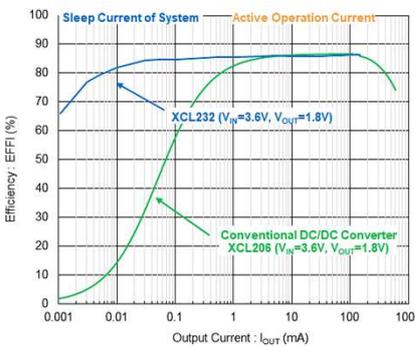
Five new products, two aimed at IoT devices, a new wireless charger IC for Li-ion batteries, CV charging to 105°C for industrial use, and LDO regulators with Green Operation Function (high-speed and power-save mode)



① Expanded Lineup of Ultra-Low Quiescent Current, Inductor Built-in 150mA Step-down DC/DC Converters "micro DC/DC" XCL232 Series

Features of this new product are 1) ultra-low consumption current: 200 nA, output voltage from 0.5 V, and 2) high power conversion efficiency from standby current. Efficiency at an output current of several μA to 10 μA has been improved by 70% or more compared to conventional products (left-hand figure). Compatible with low consumption MCUs and SoCs. In addition, a low output voltage from 0.5V can be selected, making it ideal for low voltage SoCs. The XCL232 series are **suitable for IoT/mobile/wearable and all devices that place emphasis on better battery life where small size, small space, and high efficiency performance at a light load current** are important.

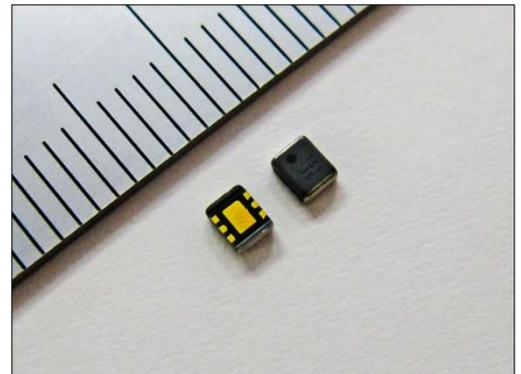
XCL232 vs XCL206 Efficiency Graph



XCL232 Mounting Board



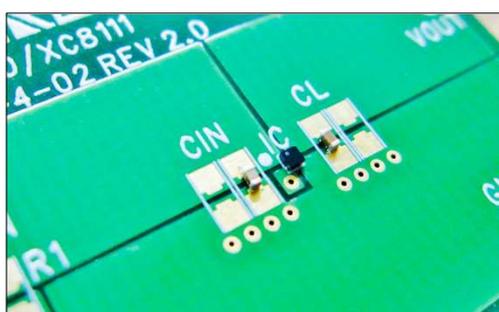
CL-2025-03 Package (2.0 x 2.5 x h1.04mm)



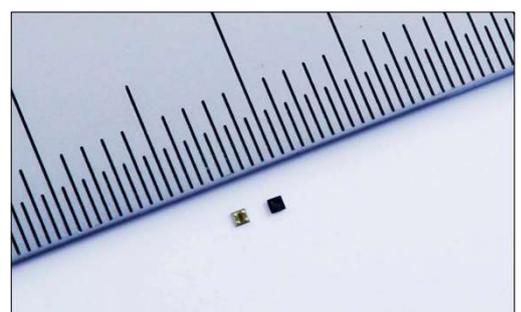
② Expanded Lineup of load switch IC with ideal diode function XC8110/XC8111 series

TOREX load switch technology develops the 'ideal diode.' Features of this new product with ideal diode function are 1) forward current: low loss with low on-resistance, reverse current: 0 μA , and 2) built-in current limit circuit, on/off function. When compared with using Schottky barrier diodes, the 'ideal diode' XC8110/11 series functioned as a replacement low-loss device with 84.6% reduction. Also, it is a compact product compared to general diodes. In an example of power saving for IoT devices, where the forward voltage (V_f) was 0.45 for an SBD and 0.075 for the XC8110/11 series, both with load current (A) of 0.5, unit power consumption (Wh) was 0.225 for the SBD and 0.0375 for XC8110/11 series, i.e. 1/6 that of the SBD due to its low forward current.

XC8110/XC8111 Mounting Board

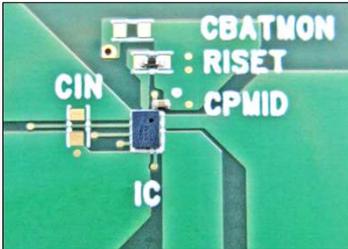
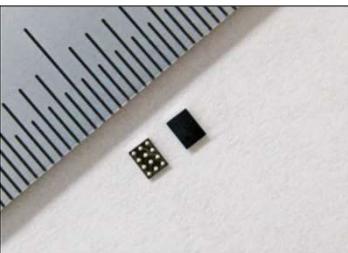
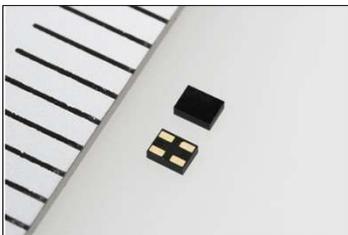
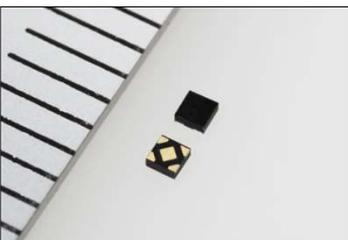


WLP-4-02 Package (0.82 x 0.82 x h0.5mm)





XC6810 Mounting Board


 Package WLP-12-01
 (1.57 x 1.17 x h0.33mm)

 Package USPN-4
 (0.9 x 1.2 x h0.4mm)

 USPQ-4B05 Package
 (1.0 x 1.0 x h0.33mm)


③ Wireless power transfer compatible, multi-function ultra-compact charger IC for Li-ion batteries XC6810 Series

The XC6810 series is suitable for wearables, hearables, or IoT devices. It has various functions such as charge and discharge control, wireless power supply support, etc.

Charging current is 1mA – 25mA, suitable for small lithium-ion batteries, and it can provide a wide range of charging voltage of 3.8V – 4.4V. The XC6810 series is **equipped with a shutdown function to suppress battery discharge when stored or not in use, and wake-up function using an external push button, extending the life of batteries** and devices. In addition to the conventional LED-driven display, CSO terminal which indicates the charging status has a type that indicates charging level by frequency, and supports charging monitoring using a microcontroller.

The product is equipped with a battery voltage monitoring function, which can directly monitor the battery voltage through a microcontroller, or a low battery voltage notification function. The wide input voltage range from 3.5V – 28V **supports wireless power and energy harvester charging such as solar**. For contact-type charging using a cradle, etc., a type is available in which the CSO terminal modulates the power supply line and the charging status can be notified by two-wire communication.

④ Charging Regulator IC for Secondary Batteries Compatible with CV (Constant-Voltage) Charging 105°C Compatible XC6242 Series

In recent years, a variety of battery types such as semi-solid state batteries and all-solid state batteries have been developed, and the XC6242 series is a dedicated IC optimized for CV charging of 2.3V small lithium secondary batteries (LTO batteries). By supporting the operating temperature of + 105°C, it has become possible to charge CV to batteries used in high temperature environments such as industrial applications.

The charging regulator ICs have an output voltage compatible with the charging voltage of 2.3V-type lithium secondary batteries, and are capable of charging without exceeding the maximum charging voltage limit of secondary batteries in the temperature range up to +105° C. While charging is not being performed, the sink current to charging ICs from secondary batteries can be kept to a low level, contributing greatly to the extension of battery drive times.

⑤ Ultra-low current consumption expanded lineup of LDO regulators with Green Operation Function XC6241 Series

The XC6241 series is a CMOS process high-speed LDO regulator IC that achieves low current consumption, high accuracy, and high ripple rejection, available in small and thin packages. The output voltage is fixed internally and can be set in the range of 1.2V to 5.0V (0.05V step). **It has a Green Operation (GO) function that achieves both a high-speed operation and a low current consumption, and switches automatically between a high speed (HS) mode and a power save (PS) mode depending on the output current.**

At light loads, high efficiency is realized by operating in PS mode with low current consumption, and at heavy loads, high speed operation is enabled by operating in HS mode. This is ideal for applications that require both low current consumption and high speed operation.



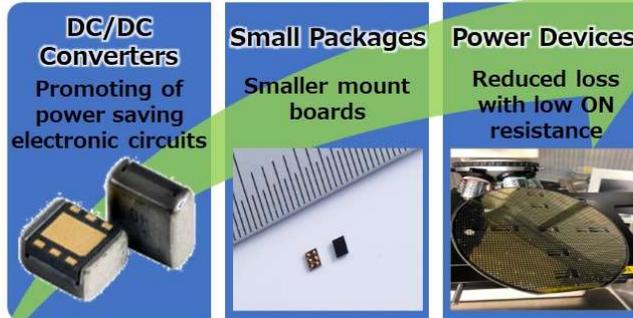
**New 5-Year MTP
2021 – 2025
[FY3/22 – FY3/26]**

The new MTP promotes 'GX green transformation' through promoting power-saving circuits, reducing mounting board area and promoting low power-loss devices that suppress heat generation.

Parent Torex will continue to focus on developing high value-added power management ICs, including further share expansion of inductor built-in micro DC/DC converters, products specialized for 5G/IoT, solutions for solid-state and semi solid-state batteries, ultra-compact large-capacity packages, etc.

Initiatives for Phenitex include development of silicon-based power devices and compound semiconductors at Kagoshima, and thorough measures for manufacturing cost reduction, following completion of the Daiichi Plant integration project at Okayama.

Torex Group GX Green Transformation:
 · Promotes power saving ICs and reduced mounting board size
 · Promotes low-loss power devices that dissipate heat generation
 ⇨ Aiming for a carbon-free society.



From a company contributing to society with compact, power-saving technologies

Decarbonized Society

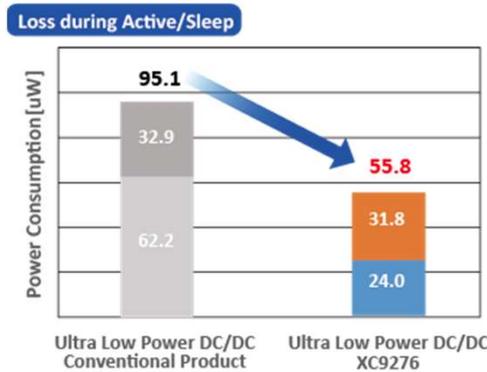


Contributing to the realization of a net zero carbon-neutral society through:

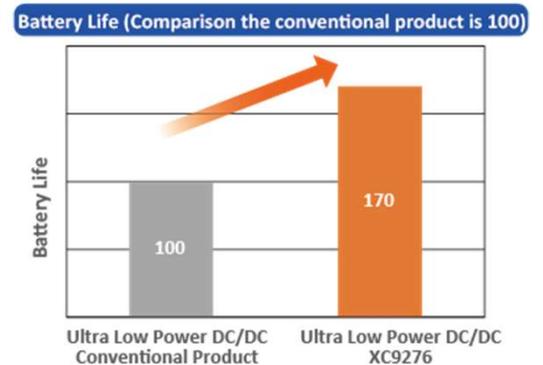
① Development of highly efficient, energy-saving power mgt. IC products

The step-down DC/DC converter XC9276 Series was awarded the 2020 Energy Conservation Grand Prize in the Product & Business Model category, by the Energy Conservation Center of Japan. By using the newly developed VSET function for switching the 2-value output voltage, the XC9276 series reduces power consumption by 41.3% and increases battery life by 1.7 times compared with traditional products.

**Reduced Power Consumption
41.3%**

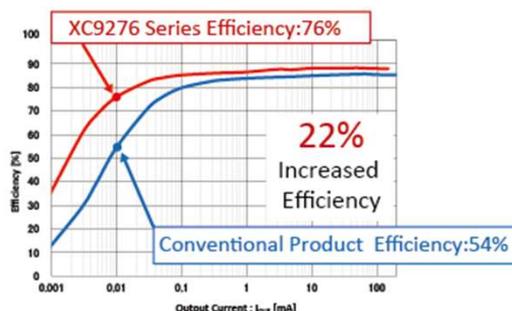


**Battery Life
170%**



Technology of ultra-low power

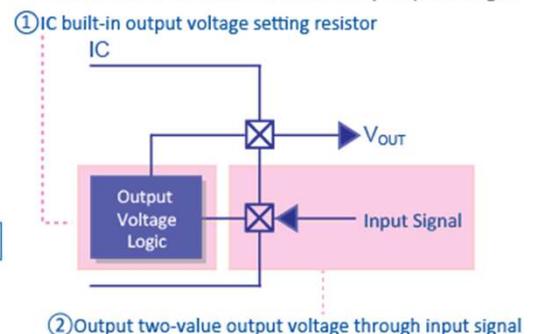
Stop the internal circuit of the IC according to the control status of the IC. Realize ultra-low current consumption.



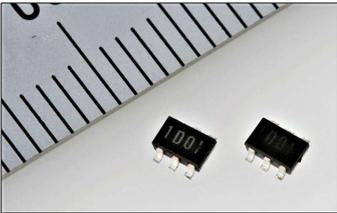
Source: company website.

Technology of switching between two-value output voltage

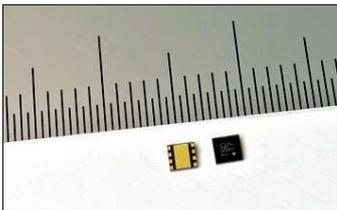
Only input signal without external parts, Achieves a function that can switch between binary output voltages.



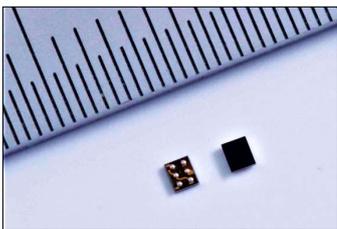
SOT package
(small-outline transistor)



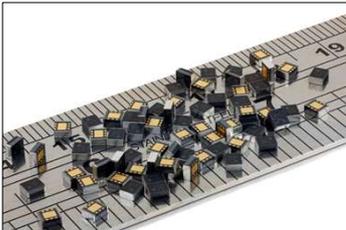
USP package
(ultra-small package)



WLP package
(wafer-level package)



Powerfully small.



“Micro DC/DC” XCL Series
Ultra small DC/DC converters that integrate a coil and a control IC. Simultaneously achieve **space-saving, high efficiency, low noise, high heat dissipation, and low cost.**

② Resource conservation with PKG miniaturization and space-saving design

The XC9276 series is expected to be deployed in products such as **small IoT devices and wearable devices** that are small and need to be driven for a long time.

■ Technology of reduce mounting area

The installation area is reduced by reducing the coil inductance value and the IC package area.

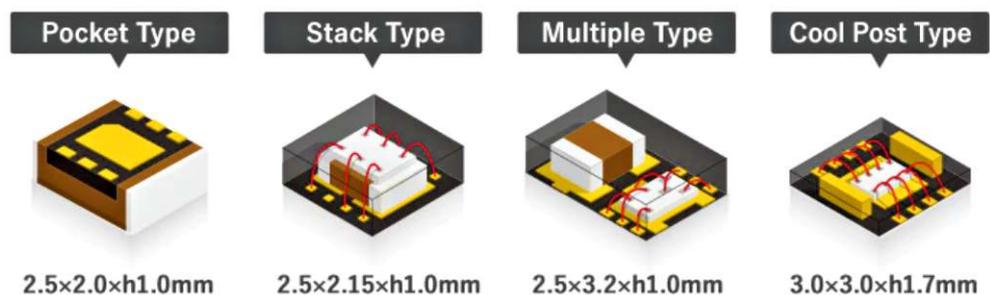


High-growth focus product: Inductor Built-in Micro DC/DC converters

The Micro DC/DC XCL Series is ultra small DC/DC converters that integrate a coil and a control IC using Torex's unique technology, which realize devices that **simultaneously achieve space-saving, high efficiency, low noise, high heat dissipation, and low cost.**

Wireless and GPS functions are being added to a wide variety of devices, and radio-frequency interference and noise have become key concerns in electrical circuit design. Torex's Micro DC/DC XCL Series is optimized to achieve a lower noise than with a discrete DC/DC converter configuration. Improving power conversion efficiency is a key point in miniaturizing a power circuit. When semiconductor and electronic components are made smaller, the resistance component increases, and the loss appears as heat generation. The Micro DC/DC XCL Series reduces the loss of efficiency that accompanies miniaturization.

Different package types emphasize the required properties of 1) low EMI noise, 2) small, low-cost, 3) high efficiency/heat dissipation for large current, and 4) high heat dissipation and low noise for high withstand voltages.



The XCL303/XCL304 series below targets high-speed optical transceivers for 5G applications, and it is the first inductor built-in Micro DC/DC converter product on the market to handle negative output voltage.



Source: company website.

③ Reduced power loss with low ON resistance* through development and sales promotion of next-generation silicon carbide (SiC) and gallium oxide (β -Ga₂O₃) power devices

Phenitex schedule for advancing development of next-generation SiC power devices

Development of SiC devices at 6-inch Kagoshima Plant, start-up of process line, and mass production Development of price-competitive SiC SBDs (Schottky barrier diodes) in progress

→ SiC SBD Gen1 650V/10A Sample shipping now

Participating as an Associate Member of Tsukuba Power Electronics Constellations (TPEC) promoted by the National Institute of Advanced Industrial Science and Technology (AIST) toward further cost reduction and R&D of SiC MOSFETs



2021	2022	2023	2024	2025
------	------	------	------	------

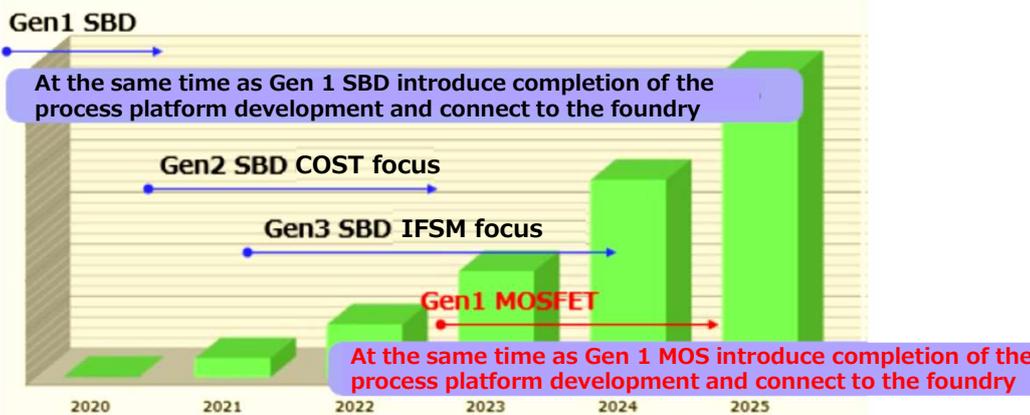
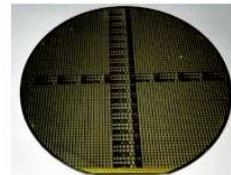
Gen 2 sample shipments by end of FY3/22

Uses high-concentration substrate

↓
Process simplification
Chip size shrink

- ↓
- ✓ Low cost
 - ✓ High quality

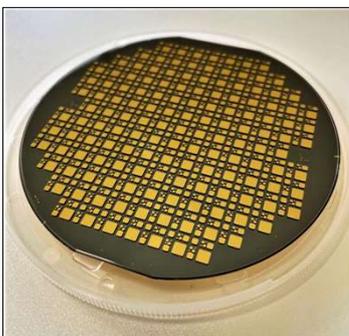
SiC devices produced in-house



In the future, we will make capital investment according to the progress of development and mass production of SiC-SBD and SiC-FET.

Source: excerpt from 4Q FY3/21 IR results briefing materials, May 24, 2021, updated with 3Q FY3/22 IR results briefing materials, February 14, 2022.

NCT 4-inch beta-gallium oxide β -Ga₂O₃ epitaxial wafer



Source: Novel Crystal Technology June 16, 2021 press release.

Torex capital tie-up partner Novel Crystal Technology achieves world's first mass production of 100mm (4-inch) beta-gallium oxide (β -Ga₂O₃) epitaxial wafers, making it possible to mass produce next-generation power devices (June 16, 2021)

Previously Novel Crystal Technology had announced in April 2019 that it succeeded in developing high-quality 50mm (2-inch) beta-gallium oxide (β -Ga₂O₃) epitaxial wafers, and it has been manufacturing them and selling them since then, but they are limited to use for R&D since mass production is not economically viable with 2-inch wafers. Compared with silicon carbide (SiC) and gallium nitride (GaN), beta-gallium oxide (β -Ga₂O₃) has large band gap energy of 4.5eV (electron volts) which translates to lower loss of power, making it ideal for applications such as electric vehicles (EV) and other industrial equipment. In addition, beta-gallium oxide bulk single crystals are grown using the melt growth method, which is 100 times faster than the vapor growth method used for SiC and GaN. Finally, since beta-gallium oxide has a hardness similar to silicon, it can be processed (cutting and polishing) using existing equipment for silicon wafers (reducing the capex burden for customers).

NCT succeeded in demonstrating beta-gallium oxide low-loss Schottky barrier diodes (SBD) with a trench structure in September 2017, and it will continue to build mass production technology for trench-type SBDs on the 100mm line. The company plans to supply 150mm (6-inch) beta-gallium oxide (β -Ga₂O₃) epitaxial wafers in 2023.

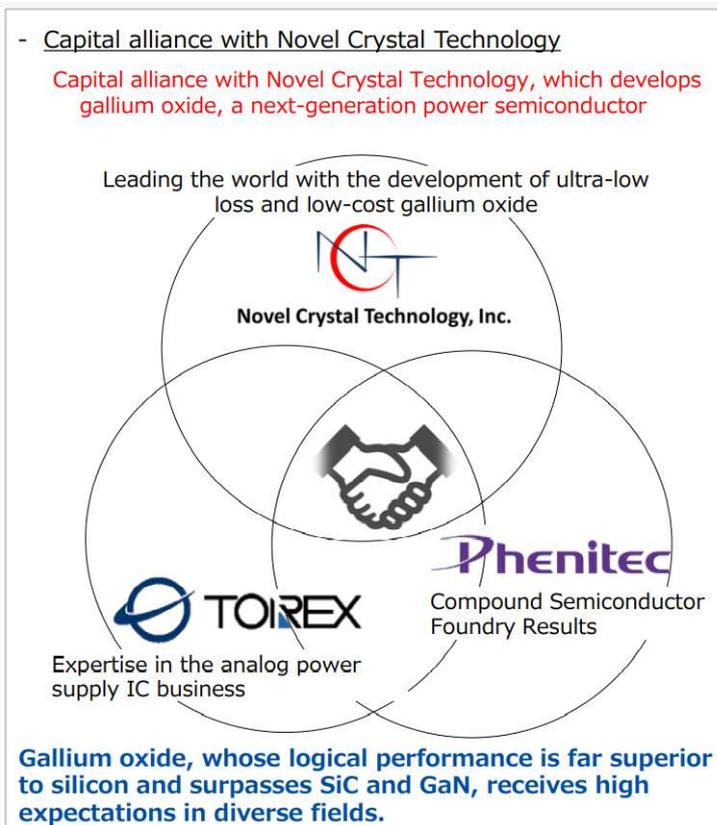
***ON Resistance**

The resistance value between the Drain and Source of a MOSFET during operation (ON) is called the ON Resistance $R_{DS(on)}$. The smaller the value, the lower the power loss.



Source: NCT website.

Torex announced a capital tie-up with Novel Crystal Technology on June 30, 2020, as Group subsidiary Phenitec is also working on developing next-generation power devices, and the market for ultra low-loss and low-cost power devices is expected to grow rapidly over the next decade. NCT's $\beta\text{-Ga}_2\text{O}_3$ is summarized below. **On February 21, 2022, TOREX announced it is increasing its stake in Novel Crystal Technology.**



Source: excerpt from IR material "FY2021 – 2025 Mid-Term Management Plan," February 15, 2021.

NCT Business Description

- Manufacture and sale of substrates with gallium oxide epitaxial film
- Manufacture and sale of single crystals and their applied products
- Manufacture and sale of semiconductors and their applied products

Head Office

2-3-1 Hirosedai, Sayama City, Saitama

President and CEO

Akito Kuramata

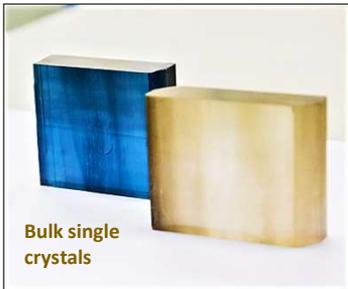
Summary of Novel Crystal Technology's next-generation power device material beta-gallium oxide ($\beta\text{-Ga}_2\text{O}_3$) epitaxial wafers and bulk single crystal growth technology

Established in June 2015, Novel Crystal Technology Inc. is a carve-out venture of Tamura Corporation (6768 TSE1) and a technology transfer venture of NICT (National Institute of Information and Communications Technology), and along with the Tokyo University of Agriculture and Technology, it is advancing research on beta-gallium oxide, a promising next generation power device material, aiming to IPO in 2023.

Novel Crystal Technology Inc. is developing and manufacturing $\beta\text{-Ga}_2\text{O}_3$ substrates and epitaxial wafers. It also leads the world in bulk single crystal growth technology, epitaxial film-forming techniques and power device fabrication technology. With the growing call for a carbon-free society, renewable energy development and efficient power usage are expected to build momentum. $\beta\text{-Ga}_2\text{O}_3$ power devices have promising applications in electric vehicles, robots and a host of other industrial equipment, contributing to sustainable society.



Large band gap energy of 4.5eV (electron volts) means lower loss of power. Silicon is reaching its theoretical limit to lower ON resistance.



NCT Shareholders:

- Tamura Corp. (6768): 38%
- Individual investors: 36%
- Corporate investors: 26%

Corporate investors:

- AGC (5201)
- TDK (6762)
- Iwatani Venture Capital
- Satori Electric (7420)
- Shindengen Electric (6844)
- JX Nippon Mining & Metals
- Sojitz Machinery Corp.
- **Torex Semiconductor (6616)**
- Yaskawa Electric (6506)

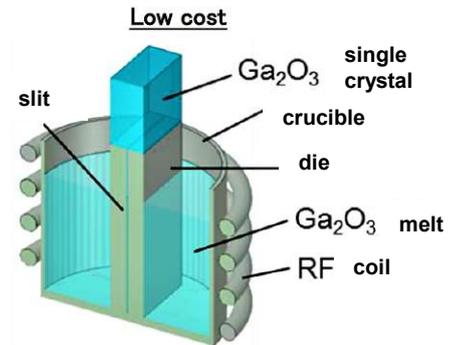
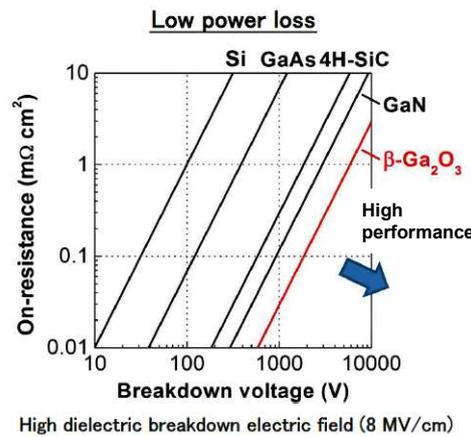
Source: NEDO Project Review: Practical Development of Ampere-grade Gallium Oxide Power Device <July 2018 – May 2020>



Source: NCT company website

Features of β -Ga₂O₃: Promising Next-Generation Power Device Material

– Comparison with other wide band-gap semiconductor materials



Single crystal growth method diagram

High growth rate due to melt growth (30 mm/h)

The closer to the bottom-right corner, the greater the material’s ability to realize a device that both saves energy and has a high breakdown voltage. Silicon is the material currently used for power devices, yet it is reaching its performance limits. Silicon carbide (SiC) and gallium nitride (GaN) have wider band gaps and greater theoretical values than Si, yet beta gallium oxide (β -Ga₂O₃) surpasses them both.

★ Cost / performance advantages of beta-gallium oxide (β -Ga₂O₃)

① Difference in bulk crystal growth speed

With SiC and GaN, bulk single crystals are generally grown using the vapor growth method. However, the issues with this method are that only several hundred micrometers can be grown per hour, and high-quality crystals are difficult to produce. Meanwhile, beta gallium oxide (β -Ga₂O₃) is grown using the melt growth method. With a growth rate of several dozen millimeters per hour, this method is approximately 100 times faster than the vapor growth method, enabling the production of high-quality bulk single crystals. The speed at which the bulk single crystals can be grown translates to noticeably lower crystal growth costs.

② Easy to process (cutting, polishing)

Because both SiC and GaN are extremely hard materials, the process of cutting out substrates from bulk single crystals and polishing them is time-consuming and labor intensive. Meanwhile, β -Ga₂O₃ has a hardness similar to silicon. This means it can be processed easily in the same facilities as silicon.

③ Development of large-diameter substrates has progressed rapidly

With SiC, it took roughly 15 years to develop a 6-inch substrate (1997 – 2012). With β -Ga₂O₃, the same was achieved in just 5 years (2012 – 2017).

Summary of beta-gallium oxide (β -Ga₂O₃) characteristics:

- 1) Energy saving / high breakdown voltage (ultra low-loss)
- 2) Bulk single crystals can be grown rapidly (100x faster than the vapor method)
- 3) The material is easy to process on existing equipment for silicon wafers
- 4) Large diameter substrates were achieved in a short time period



Share Price, Valuations and Shareholder Rebates



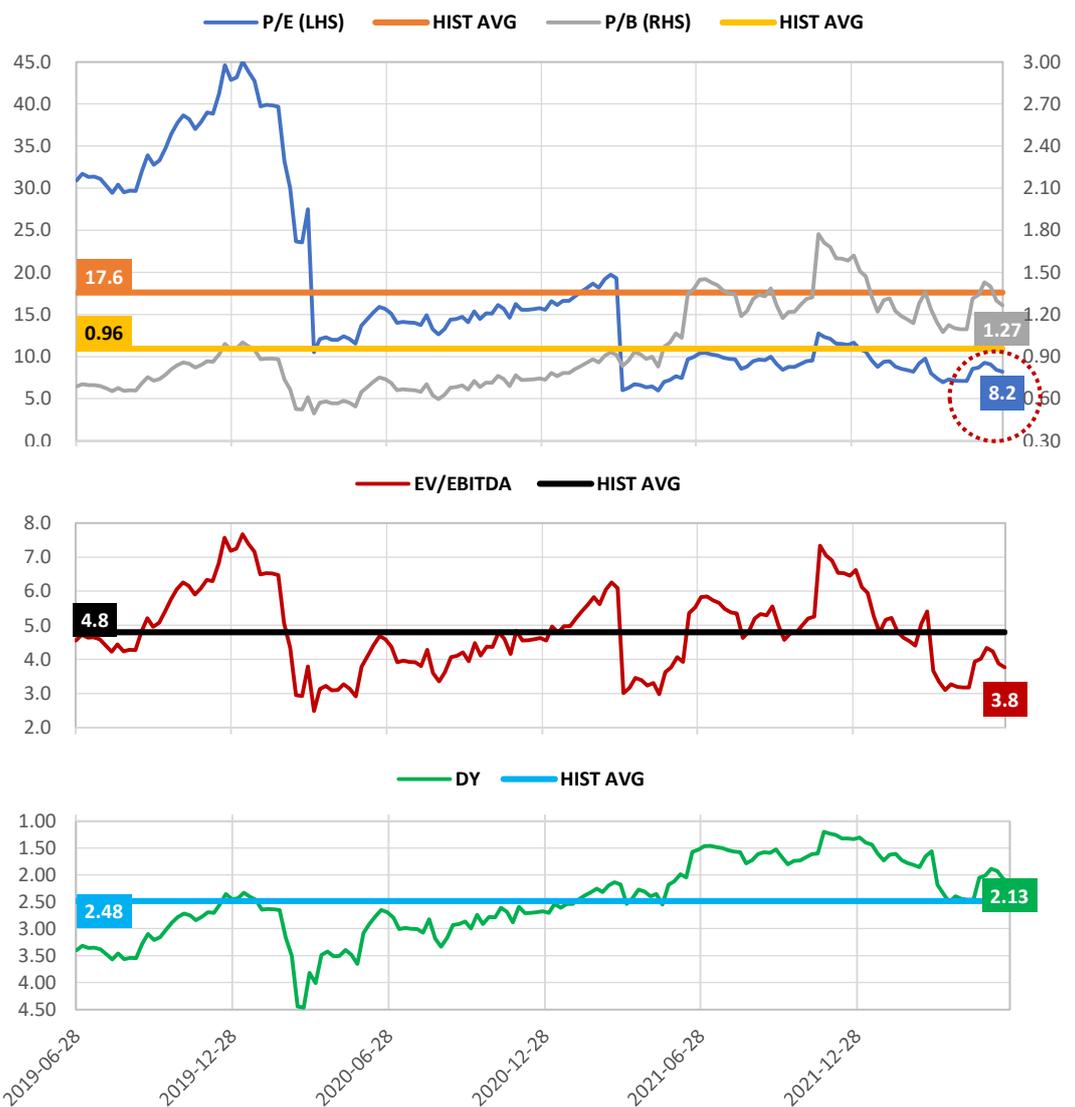
Performance and Valuations: SESSA Smart Charts

- ✓ The P/E of 8.2x is 53% below the historical avg. Torex has revised up full-term guidance for 5 consecutive quarters, and still beat 4Q CE. EV/EBITDA is 22% below the historical avg.
- ✓ Ultimately this is the nature of powerful cyclical recoveries, and current-term forecasts cannot capture the true upside potential.
- ✓ While high inflation and rising interest rates are a concern for demand for general electronics, structural growth drivers for TOREX include 5G rollout/IoT device proliferation, EV/hybrid ramp, and demand for next-gen power devices to combat climate change.



Analyst's view

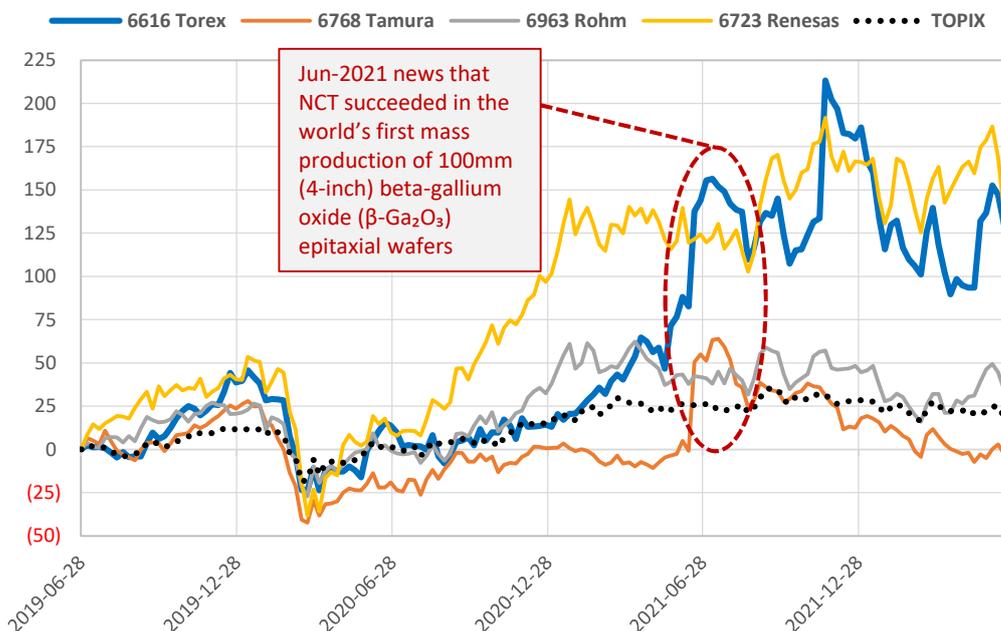
Sessa Smart Charts: 3-Year Weekly Share Price and Valuations Trend



Source: compiled by SIR from SPEEDA historical earnings and price data. Valuations calculated based on CE.



3-Year Weekly Relative Performance Trend



Koji Shibamiya (President)

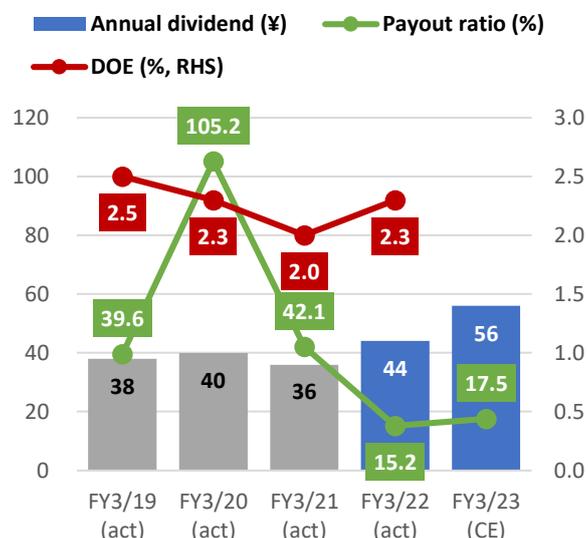
The lower left table shows that **both Phenitec Chairman Fujisaka and Torex President Shibamiya are in the top 10 shareholders, whose interests are aligned with all shareholders, an attractive point that cannot be understated in our view.**

The company's stated dividend policy is highlighted in the graph below: consolidated dividend payout ratio of at least 20%, aiming for DOE of 3.0%. Like many Japanese companies, a common point of frustration among foreign shareholders is policy which emphasizes 'stable' dividends. It is also true that Torex has a large net cash position, and given that its business is highly cash generative, the unrelenting increase in shareholders' equity will make the DOE target of 3.0% increasingly difficult to achieve. HOWEVER, it is also true that management did not hesitate to approve a 5.2% share buyback in 2019, which is not the same as many Japanese companies, nor is two top managers among the top 10 shareholders. "Actions speak louder than words."

TOREX SEMICONDUCTOR Major Shareholders

Rank	Shareholder	2021.3.31	2022.3.31
1	Master Trust Bank of Japan, Ltd. (Trust Acct)	9.01%	12.67%
3	THE BANK OF NEW YORK 133652	6.93%	7.42%
2	Custody Bank of Japan, Ltd. (Trust Acct)	7.02%	5.09%
4	Tomoyuki Fujisaka (Phenitec Chairman)	4.60%	4.54%
5	The Chugoku Bank, Limited	4.28%	4.28%
6	ARS Co., Ltd.	4.10%	4.10%
7	Kibi Kogyo Co., Ltd.	3.61%	3.61%
8	Takanori Ozaki	2.91%	2.91%
9	Koji Shibamiya (Torex President)	2.67%	2.68%
10	THE BANK OF NEW YORK MELLON 140051	—	2.34%
Top 10 —		46.99%	49.64%

Source: Notice of Convocation of the 27th Ordinary General Meeting of Shareholders.



LEGAL DISCLAIMER

This report is intended to provide information about the subject company, and it is not intended to solicit or recommend investment. Although the data and information contained in this report have been determined to be reliable, we do not guarantee their authenticity or accuracy.

This report has been prepared by Sessa Partners on behalf of the concerned company for which it has received compensation. Officers and employees of Sessa Partners may be engaged in transactions such as trading in securities issued by the company, or they may have the possibility of doing so in the future. For this reason, the forecasts and information contained in this report may lack objectivity. Sessa Partners assumes no liability for any commercial loss based on use of this report. The copyright of this report belongs to Sessa Partners. Modification, manipulation, distribution or transmission of this report constitutes copyright infringement and is strictly prohibited.



Sessa Partners Inc.

5-3-18, Hiroo, Shibuya-ku, Tokyo
info@sessapartners.co.jp