Transitioning from ICM-20602 to ICM-42670-P

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InvenSense, a TDK Group Company
1745 Technology Drive, San Jose, CA 95110 U.S.A
+1(408) 988–7339
invensense.tdk.com

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1 PURPOSE

This document explains how to replace ICM-20602 with ICM-42670-P. The ICM-20602 is NOT pin compatible with ICM-42670-P. PCB redesign is needed.

In addition to different chip packages, the MEMS, signal process path, and register map are different.

This document is to help user transition from ICM-20602 to ICM-42670-P.

2 RELATED DOCUMENTS

- ICM-20602 datasheet
- ICM-42670-P datasheet
- AN-000258 ICM-42607x and ICM-42670x DMP Mode Accel and Gyro Self-Test
- AN-000262 PCB Board Design Guide for ICM-42607x and ICM-42670x Products
- AN-000266 ICM-42607x and ICM-42670x Accelerometer Low Power Mode Implementation
- AN-000271 ICM-42607x ICM-42670x APEX Motion Function Desc Usage

3 TRANSITIONING FROM ICM-20602 TO ICM-42670-P

The ICM-20602 is NOT pin compatible to ICM-42670-P, which requires PCB layout changes to replace the ICM-20602.

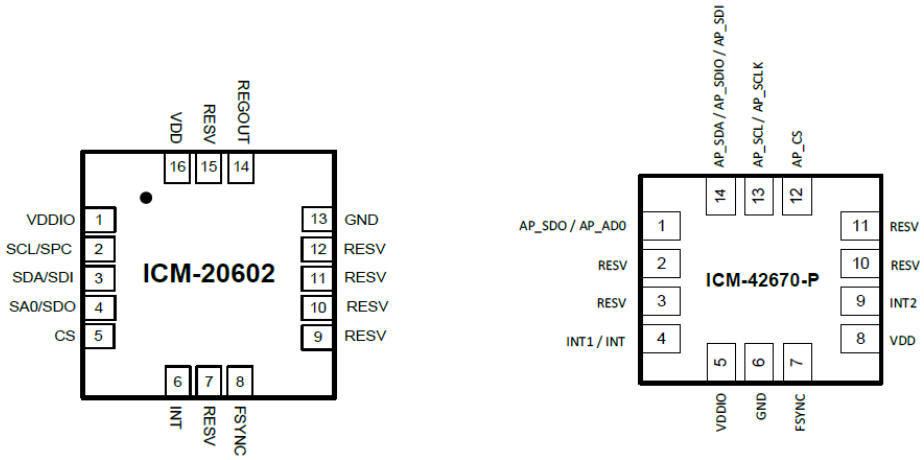
The register maps, MEMS, and signal process paths of the two devices are different.

The ICM-20602 can be replaced by ICM-42670-P using the changes described in this document.

3.1 PACKAGE DIFFERENCES

The ICM-20602 and ICM-42670-P package and pin differences are shown in Figure 1 and Table 1.

- The decoupling cap numbers and values are same for the two chips power supplies, 10 nf for VDDIO and 0.1 µF//2.2 µF for VDD.
- The REGOUT pin does not exist in ICM-42670-P; the decoupling cap on the REGOUT is not needed in ICM-42670-P.
- ICM-42670-P has an extra INT2 which can provide a second interrupt trigger to host application processor (AP).
- The RESV pins in ICM-20602 must be connected to GND but the RESV pins of ICM-42670-P can be open, connected to GND, or connected to VDDIO.



LGA Package (Top View)
16-pin, 3mm x 3mm x 0.75mm

Pin Out Diagram for ICM-42670-P
2.5x3.0x0.76 mm LGA

Figure 1. Package and Pins

Signals and Others	ICM-20602	ICM-42670-P
Chip package	3x3x0.75 mm 16-pin LGA	2.5x3x0.76 mm 14-pin LGA
SPI CS	Pin-5	Pin-12
SPI SCLK / I2C SCL	Pin-2	Pin-13
SPI SDI / I2C SDA	Pin-3	Pin-14
SPI SDO / I2C AD0	Pin-4	Pin-1
INT1/INT	Pin-6	Pin-4
INT2	NA	Pin-9
FSYNC	Pin-8	Pin-7
REGOUT	Pin-14	NA
VDD	Pin-16	Pin-8
VDDIO	Pin-1	Pin-5
GND	Pin-13	Pin-6
RESV	Pin-7/9/10/11/12/15	Pin-2/3/10/11

Table 1. Package and Pin Differences

3.2 MAIN DESIGN DIFFERENCES

Table 2 summarizes the main differences between these two chips.

Feature Difference	ICM-20602	ICM-42670-P
VDD and VDDIO range	1.71V~3.45V	1.71V~3.6V
Gyroscope Mechanical Frequencies	25 KHz~29 KHz	25 KHz~30 KHz
Digital interface	400 KHz I^2C, 10 MHz SPI	12.5 MHz I^3C, 1 MHz I^2C, 24 MHz SPI
Gyro operation mode	Low Noise Mode (2.55 mA) Low Power Mode (1.08 mA)*	Low Noise Mode (0.42 mA)
Accel operation mode	Low Noise Mode (0.32 mA) Low Power Mode (0.040 mA)*	Low Noise Mode (0.20 mA) Low Power Mode (0.027 mA)
Highest Output Data Rate (ODR)	4 KHz for Accel, 8 KHz for Gyro	1.6 KHz
FIFO size	1 KB	2.25 KB (see detail in FIFO section)
Gyro output bandwidth	With DLPF: 5~250 Hz Without DLPF: up to 8 KHz	With DLPF: 16~180 Hz Without DLPF: up to 517 Hz
Accel output bandwidth	With DLPF: 5~218 Hz Without DLPF: up to 1 KHz	With DLPF: 16~180 Hz Without DLPF: up to 517 Hz
Intelligent Motion Function	Wakeup-on-motion	APEX MOTION FUNCTIONS
Gyro/Accel Self-Test	Direct Mode	DMP mode
Register Access	All registers are in one block	Registers are in multiple blocks

Table 2. Main differences

* ICM-20602 does not support Gyro LP mode + Accel LP mode. When Gyro is in LP mode, Accel must be in LN mode in 6-axis case.

3.3 DIGITAL INTERFACE

In addition to a new interface using I^3C, ICM-42670-P has higher I^2C and SPI speed. The output signal slew rate can be adjusted by register settings. User can adjust the slew rate based on their board signal integrity to optimize the digital bus.

ICM-20602 does not have the slew rate adjustment.

If user plans to use ICM-42670-P with 1 MHz I^2C speed, I^2C pull up resister value can be reduced from 4.7K~10K for 400KHz bus to 1K~2.2K for 1 MHz bus.

3.4 POWER UP SENSOR STATUS

ICM-20602 will come up in **sleep mode** upon power-up. User must bring the device out of sleep be setting 0 to SLEEP bit (register 0x6B bit6) before configuring and enabling gyro and/or accel.

ICM-42670-P will come up in **sleep mode** upon power-up. There is no SLEEP bit. User can configure gyro/accel and enable them after power on and soft-reset.

3.5 REGISTER ACCESS

ICM-20602: all registers are in one block. There is no special procedure to access them. They can be accessed by direct mode.

ICM-42670-P: registers are in multiple blocks. Only the registers in bank0 can be accessed by direct mode. Registers not in bank0 will be acceded using indirect mode which is documented in the datasheet.

3.6 FIFO

To get the ICM-42670-P 2.25 KB FIFO size, its APEX needs to be disabled. The ICM-42670-P default configuration is APEX enabled and 1 KB FIFO. Please refer to the datasheet for instructions on how to disable APEX if needed.

3.6.1 Packet structure

ICM-20602 has three data packet types. There is no time stamp. Gyro, Accel, and Temperature are 16-bit data.

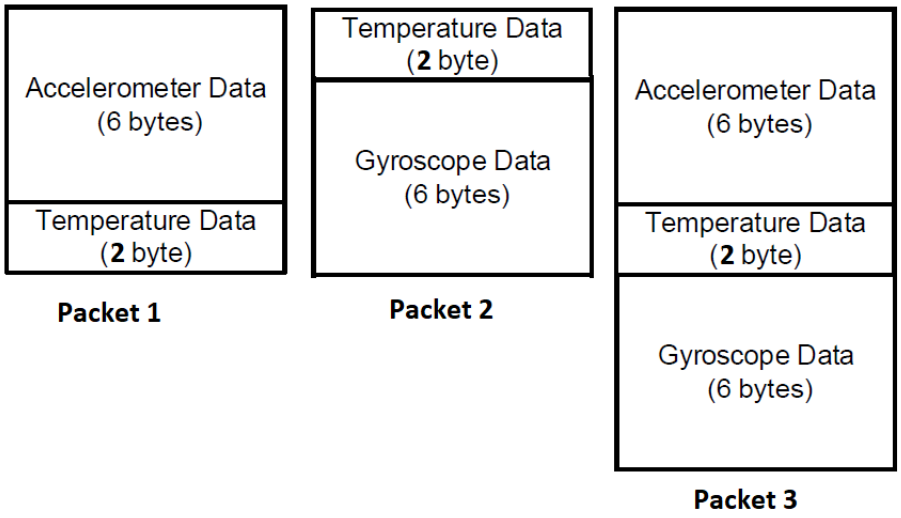


Figure 2. ICM-20602 FIFO Packet Structure

ICM-42670-P has four data package types. FIFO data can include 16-bit time stamp. Gyro and Accel can be 16-bit or 20-bit. Temperature data can be 8-bit or 16-bit.

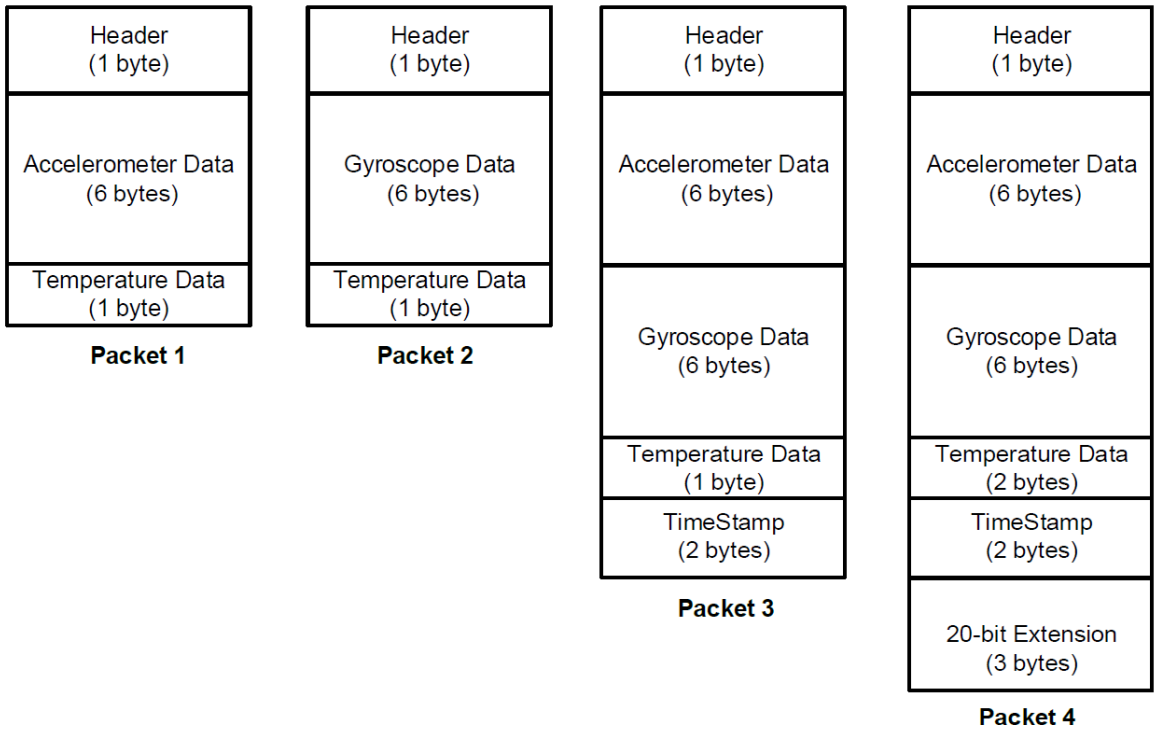


Figure 3. ICM-42670-P FIFO Structure

3.6.2 FIFO data rate

ICM-20602 FIFO data rate is same as sensor ODR.

For ICM-42670-P, user can configure the FIFO Data Rate (FDR) to control the rate at which FIFO packets are written to the FIFO. Register field FDR_SEL in register FDR_CONFIG (register 0x66h in Bank MREG1) provides FDR control.

3.7 SENSOR LOW POWER MODE

ICM-42670-P gyro low noise mode power consumption is 0.42 mA, which is much lower than ICM-20602 gyro low power mode (1.08 mA). Due to this very low power consumption, the ICM-42670-P does not have gyro low power mode.

Both ICM-20602 and ICM-42670-P have accel low power mode. The two chips' low power mode ODR, average number, power consumption, and noise level are different.

Table 3 and Table 4 show the two IMU accel low power mode noise and power vs averaging and ODR.

For information on how to use ICM-42670-P Accel low power, please refer to TDK App Note "AN-000266 ICM-42607x and ICM-42670x Accelerometer Low Power Mode Implementation."

	Averages	1x	4x	8x	16x	32x
	ACCEL_FCHOICE_B	1	0	0	0	0
	DEC2_CFG	X	0	1	2	3
	A_DLPF_CFG	X	7	7	7	7
	Ton (ms)	1.084	1.84	2.84	4.84	8.84
	NBW (Hz)	1100	442	236	122	62
	3-dB BW (Hz)	1046	420	219	111	56
	Noise TYP (mg-rms)	3.3	2.1	1.5	1.1	0.79
SMPLRT_DIV	ODR (Hz)	Low-Power Accelerometer Mode Current Consumption (µA)				
255	3.91	9.4	10.2	11.5	13.8	18.5
127	7.81	10.7	12.4	14.7	19.6	28.9
99	10	11.4	13.7	16.6	22.6	34.7
63	15.63	13.3	16.7	21.5	30.8	49.7
31	31.25	18.3	25.4	34.8	53.6	91.2
19	50	24.4	35.8	50.8	80.8	141.1
15	62.5	28.4	42.7	61.5	99.0	174.3
9	100	40.7	63.5	93.6	153.7	303.3
7	125	48.8	77.4	114.8	190.1	N/A
4	200	73.4	118.8	178.9	299.3	
3	250	89.6	146.5	221.6	N/A	
1	500	171.1	284.9	N/A		

Table 3. ICM-20602 Accel Low Power Mode

	ACCEL_UI_AVG	000	001	010	011	100	101
	Averages	2	4	8	16	32	64
	Noise (mg-rms)	6.2	4.4	3.1	2.2	1.56	1.1
ACCEL_ODR	ODR (Hz)	Power consumption, Idd (uA)					
1111	1.5625	4.4	4.4	4.5	4.7	5.2	6.1
1110	3.125	4.8	4.9	5.1	5.5	6.4	8.2
1101	6.25	5.5	5.7	6.1	7	8.8	12.5
1100	12.5	6.9	7.4	8.3	10.1	13.7	20.9
1011	25	9.8	10.7	12.5	16.1	23.3	37.8
1010	50	15.6	17.4	21	28.2	42.7	71.6
1001	100	27.2	30.8	38	52.5	81.3	139.1
1000	200	50.5	58	72	101	159	NA
0111	400	97	111	140	NA	NA	NA

Table 4. ICM-42670-P Accel Low Power Mode

3.8 MEMS SELF TEST

Unlike ICM-20602, ICM-42670-P gyro/accel self-test procedure is hard coded in build in DMP. User does not need to write their own self-test procedure software.

Please refer to TDK App Note “AN-000258 ICM-42607x and ICM-42670x DMP Mode Accel and Gyro Self-Test” for information on how to perform the ICM-42670-P self-test.

3.9 INTELLIGENT MOTION FUNCTION

In addition to the ICM-20602 “wakeup on motion,” ICM-42670-P has many more intelligent motion functions.

APEX (Advanced Pedometer and Event Detection – neXt gen) in ICM-42670-P includes Pedometer, Tilt Detection, Low-g Detection, Freefall Detection, Wake on Motion, and Significant Motion Detection.

By using ICM-42670-P, user can expand their smart application with less software development effort. Because the intelligent motion functions run on ICM-42670-P DMP, user product device power consumption will be lower than running the functions on device AP.

TDK App Note “AN-000271 ICM-42607x ICM-42670x APEX Motion Function Desc Usage” has detailed instructions for APEX.

4 SOFTWARE DRIVERS FOR ICM-20602 AND ICM-42670-P

ICM-20602 and ICM-42670-P register maps are completely different, so their software drivers must be different.

Please contact TDK for ICM-42670-P software driver.

5 REVISION HISTORY

REVISION DATE	REVISION	DESCRIPTION
05/27/2021	1.0	Initial Release

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