

*Semicustom*

Bi-CMOS

**ASTRO-NT****(for RF front-end LSI-Based on PLL, Analog Macro)**

# MB15G000 Series

## ■ DESCRIPTION

The ASTRO-NT\* is a new technology to correspond to the demand of high performance RF LSI. The technology stands on a macro concept and create a custom LSI ideal for use in high frequency front-end circuit such as VCO, amplifier, mixer and I/Q modulator devices.

The chip can be built by combining macros, in accordance with user's demand function and characteristic. FUJITSU prepares standard RF macros. They are well finished in design and layout to fulfil good performance by function that a master slice method can not achieve. It is possible to modify RF macro in response to user's demand.

This LSI series uses FUJITSU's latest BiCMOS process technology for low current consumption. In addition, many types of packages are available that makes it possible to find a proper size package for different circuit integration levels.

ASTRO-NT is ideal for applications with RF or IF signal, particularly mobile communication devices operating such as PDC, PHS, GSM, DCS, PCS and so on.

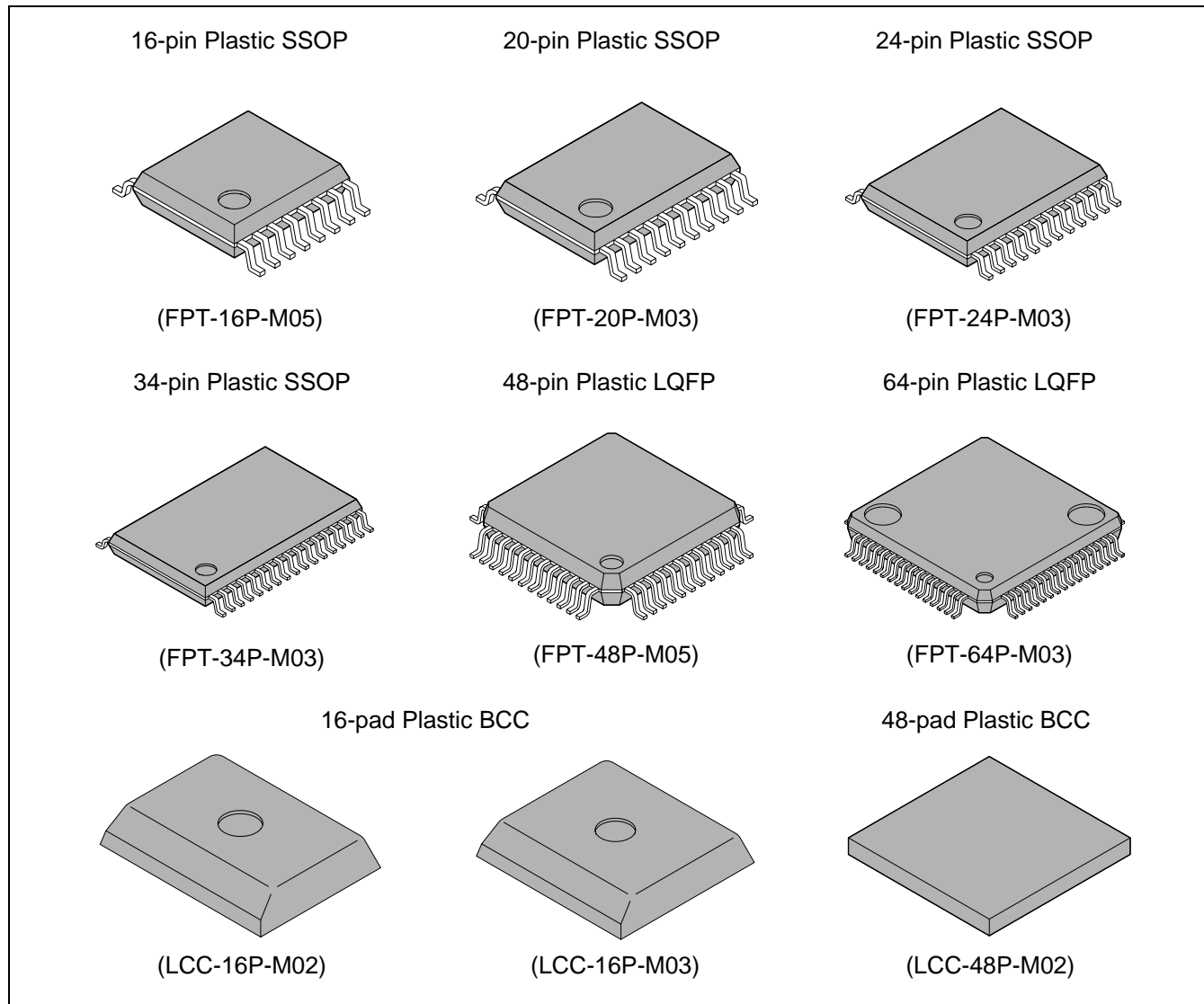
\*: Advanced Standard macro base Technology of PLL with RF system On LSI-New Technology

## ■ FEATURES

- High operating frequency: to 3.0 GHz (max)
- Supply voltage: 2.5 to 5.5 V
- Standard RF macro
- Low power consumption
- Package line up –Many types of package are available.  
SSOP-16, SSOP-20, SSOP-24, SSOP-34, BCC-16, BCC-48, LQFP-48, LQFP-64,
- Operating temperature: –40 to +85°C
- Fujitsu's latest BiCMOS process technology

# MB15G000 Series

## ■ PACKAGES



| Number of pins and name of package | Package Code | Size (mm)         |
|------------------------------------|--------------|-------------------|
| 16-pin Plastic SSOP                | FPT-16P-M05  | 6.4 × 5.0 × 1.25  |
| 20-pin Plastic SSOP                | FPT-20P-M03  | 6.4 × 6.5 × 1.25  |
| 24-pin Plastic SSOP                | FPT-24P-M03  | 7.6 × 7.75 × 1.25 |
| 34-pin Plastic SSOP                | FPT-34P-M03  | 8.1 × 11.0 × 1.25 |
| 48-pin Plastic LQFP                | FPT-48P-M05  | 9.0 × 9.0 × 1.5   |
| 64-pin Plastic LQFP                | FPT-64P-M03  | 12.0 × 12.0 × 1.5 |
| 16-pad Plastic BCC                 | LCC-16P-M02  | 3.4 × 4.55 × 0.8  |
|                                    | LCC-16P-M03  | 4.2 × 4.55 × 0.8  |
| 48-pad Plastic BCC                 | LCC-48P-M02  | 7.0 × 7.0 × 0.8   |

# MB15G000 Series

## ■ ABSOLUTE MAXIMUM RATINGS

| Parameter               | Symbol      | Rating |                | Unit |
|-------------------------|-------------|--------|----------------|------|
|                         |             | Min.   | Max.           |      |
| Power supply voltage *1 | $V_{CC}$ *2 | -0.5   | 4.0            | V    |
|                         | $V_{CC}$ *3 | -0.5   | 6.0            | V    |
| Input voltage *1        | $V_{IN}$    | -0.5   | $V_{CC} + 0.5$ | V    |
| Output current          | $I_{out}$   | -10    | 10             | mA   |
| Storage temperature     | $T_{stg}$   | -55    | +125           | °C   |

\*1:Voltage values are based on GND = 0 V

\*2:Using 3V macro specifications

\*3:Using 5V macro specifications

WARNING: Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

## ■ RECOMMENDED OPERATING CONDITIONS

| Parameter               | Symbol         | Value |      |          | Unit |
|-------------------------|----------------|-------|------|----------|------|
|                         |                | Min.  | Typ. | Max.     |      |
| Power supply voltage *1 | $V_{CC}$ *2,*3 | 2.7   | 3.0  | 3.3      | V    |
|                         | $V_{CC}$ *2,*4 | 4.5   | 5.0  | 5.5      | V    |
|                         | GND            | —     | 0    | —        | V    |
| Input voltage           | $V_{IN}$       | GND   | —    | $V_{CC}$ | V    |
| Operating temperature   | $T_a$          | -40   | —    | +85      | °C   |

\*1:Voltage values are based on GND = 0 V

\*2:The range of operating voltage should be defined depends on circuit configuration.

For models not using standard 3V or 5V specifications, maximum ratings and recommended operating conditions are set according to circuit use.

\*3:Using 3V macro specifications

\*4:Using 5V macro specifications

WARNING: The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated within these ranges.

Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representatives beforehand.

# MB15G000 Series

## ■ MACRO DESCRIPTIONS

### 1. Prescaler

Divides the reference frequency by any given value and outputs the resulting frequency. Choice of two -modulus or fixed output mode.

### 2. PLL

#### • Phase comparator

The phase comparator has a phase detection range of  $-2\pi$  to  $+2\pi$ , and is designed to eliminate blind spots in phase comparison by output of a margin-of-error signal to the charge pump even when the phase difference is zero. Phase comparator characteristics can also be tuned to the polarity of VCO.

#### • Counters

The divide ratios of the comparator-side counter and reference-side counter can be either programmable or fixed.

#### • Charge pump

The “H” level output voltage from the charge pump is determined by power supply voltage. Charge pump characteristics for the sending and receiving systems can be optimized for each specific application.

For example, when FM modulation is applied directly to the VCO signal, charge pump characteristic can be adjusted for lower speeds in order to reduce the sensitivity of the synthesizer loop so that output does not track the modulation.

#### • High speed lock-up circuit

This circuit is specially designed for faster lock-up speeds.

#### • Intermittent operation control circuit

This on-chip power-saving function reduces circuit current flow in standby status, enabling devices to operate with less power demand. A special circuit is built in to prevent excessive error signal from increasing lock-up delay during the transition from power-saving mode to operating mode.

#### • List of standard macros

| Type | V <sub>CC</sub> | I <sub>CC</sub> | Operating frequency | Prescaler divide ratio (M) | Comparator counter divide ratio (N) | Swallow counter divide ratio (A) | Reference counter divide ratio (R) |
|------|-----------------|-----------------|---------------------|----------------------------|-------------------------------------|----------------------------------|------------------------------------|
| PLL1 | 2.7 V           | 1.5 mA          | 0.5 GHz             | 8/9, 16/17                 | 5 to 2047                           | 0 to 255                         | 5 to 16383                         |
| PLL2 |                 | 2.0 mA          | 1.2 GHz             | 32/33, 64/65               |                                     |                                  |                                    |
| PLL3 |                 | 3.0 mA          | 2.0 GHz             |                            |                                     |                                  |                                    |
| PLL4 |                 | 3.5 mA          | 2.5 GHz             |                            |                                     |                                  |                                    |

Crystal oscillator input frequency: Up to 32 MHz

Standby mode current demand: 10  $\mu$ A(Max.)

Note: Refer to macro specification book.

# MB15G000 Series

## 3. RF Analog Macro List

| Circuit               | Function                                       |                        | Voltage | Current | Application Example |
|-----------------------|--|------------------------|---------|---------|---------------------|
| QMOD/QDEM             | 900 MHz QMOD + AGC                             |                        | 3.0 V   | 29.6 mA | PDC                 |
|                       | 1.9 GHz MOD + UpCONV (IF = 233 MHz)            |                        |         | 27.0 mA | PHS                 |
|                       | 0.9, 1.9 GHz Doubler + MOD UpCONV IF = 413 MHz |                        |         | 28.0 mA | GSM/DCS, PCS        |
|                       | 130 MHz Shifter QMOD                           |                        |         | 7.7 mA  | CDMA                |
|                       | 85 MHz Shifter + QDEM                          |                        |         | 7.8 mA  | CDMA                |
|                       | Offset Mix + QMOD + AGC (900 MHz)              |                        | 2.9 V   | 39.0 mA | PDC                 |
|                       | VCO + QMOD + AGC (200 MHz)                     |                        | 3.0 V   | 22.0 mA | CDMA                |
| 2 <sup>nd</sup> Mixer | Lo = 250 MHz, IF = 10.8 MHz 2nd Mixer          |                        |         | 3.5 mA  | PHS                 |
|                       | Lo = 130 MHz, IF = 450 kHz 2nd Mixer           |                        |         | 3.0 mA  | PDC                 |
|                       | 400 MHz IF AMP + 2nd Mixer                     |                        |         | 5.0 mA  | GSM/DCS, PCS        |
|                       | 800 MHz, 1.9 GHz UpCONV                        |                        |         | 10.2 mA | CDMA                |
| Buf AMP/VCO           | 1.3-1.6 GHz Local Buffer AMP                   |                        |         | 3.0 mA  | GSM/DCS, PCS        |
|                       | 400 MHz VCO + VCO Buffer                       |                        |         | 5.0 mA  | GSM/DCS, PCS        |
|                       | 260 MHz VCO (Tx)                               |                        |         | 3.0 mA  | CDMA                |
|                       | 170 MHz VCO (Rx)                               |                        |         | 1.6 mA  | CDMA                |
| Lim AMP/RSSI          | 450 KHz LimAMP/RSSI                            |                        | 3.0 V   | 2.0 mA  | PDC                 |
|                       | 10.8 MHz LimAMP/RSSI                           |                        |         | 2.0 mA  | PHS                 |
| AGC AMP               | 130 MHz AGC                                    | G <sub>P</sub> = 40 dB | 3.6 V   | 19.0 mA | CDMA                |
|                       |  | G <sub>P</sub> = 55 dB |         | 4.9 mA  |                     |
|                       | 850 MHz, 19 GHz AGC + Power driver             |                        | 3.0 V   | 38.5 mA | CDMA                |

Note: Circuit format and other details can be adjusted to meet customer requirements.

Refer to macro specification book.

# MB15G000 Series

## ■ MACRO BROCHURE

A macro brochure is available for the convenience of customers using standard FUJITSU macros in Astro-NT development. Astro-NT can be arranged in a variety of configurations using combinations of macros. Customer may select the macros that suit their particular requirements for specifications and characteristics.

Also, standard macros may be modified to meet more detailed customer requirements.

The macro brochure includes sample applications and electrical characteristics of macros.

- Macro Brochure (Sample Macro Electrical Characteristics)  
RV001QMOD (900 MHz Doubler QMOD + AGC)

( $V_{CC} = 3.0 \text{ V}$ ,  $T_a = -25 \text{ }^{\circ}\text{C}$ )

| Parameter                              | Symbol | Target Value |        |        | Unit | Comment/Condition             |  |
|--|--------|--------------|--------|--------|------|-------------------------------|--|
|  |        | Min.         | Typ.   | Max.   |      |                               |  |
| Lo input frequency                     | fMODLO | 870          | 948    | 960    | MHz  | —                             |  |
| Lo input level                         | PMODLO | −23          | −20    | −15    | dBm  | —                             |  |
| I/Q input frequency                    | fBB    | DC           | —      | 0.5    | MHz  | —                             |  |
| I/Q input amplitude                    | VBB    | 0.5          | 1.0    | 1.2    | Vpp  | Single ended input            |  |
| I/Q offset voltage                     | VOS    | 1.4          | 1.5    | 1.6    | V    | External offset voltage value |  |
| I/Q offset current                     | IOS    | —            | 10     | 20     | μA   | —                             |  |
| AGCcnt input voltage                   | AGCcnt | 0.7          | —      | 2.5    | V    | —                             |  |
| SSB maximum output level               | Pout1  | −1.0         | 2.0    | —      | dBm  | AGCcnt = 2.5 V                | fMODLO = 948 MHz<br>PMODLO = −20 dBm<br>I/Q : sin, cos wave<br>5.25 kHz<br>VBB = 1.0 V<br>Single ended |
| SSB minimum output level               | Pout2  | −32          | —      | —      | dBm  | AGCcnt = 1.1 V                |  |
|  |        | —            | —      | −32    | dBm  | AGCcnt = 0.7 V                |  |
| Carrier leakage                        | CL     | —            | —      | −30    | dBc  | AGCcnt = 0.7 to 2.5V          |  |
| Image rejection                        | IR     | —            | —      | −30    | dBc  |                               |  |
| Third order intermodulation distortion | IM     | —            | —      | −35    | dBc  |                               |  |
| Vector error                           | EVM    | —            | 3.0    | 5      | %    |                               |  |
| Amplitude error                        | Aerr   | —            | —      | —      | %    | PMODLO = −20 dBm<br>I/Q : PN9 |  |
| Phase error                            | Perr   | —            | 1.5    | —      | deg  |                               |  |
| Adjacent channel leakage power         | ACP    | —            | −65 *1 | −60 *1 | dB   |                               |  |
|  |        | —            | −73 *2 | −68 *2 | dB   |                               |  |
| TXout1-2 isolation                     | ISOout | —            | 30     | —      | dB   | —                             |  |
| Power supply current                   | Icc    | —            | 35     | —      | mA   | —                             |  |

\*1:50 kHz offset

\*2:100 kHz offset

\*:Macro brochures are available by contacting your Fujitsu marketing representative.

# MB15G000 Series

## ■ DEVELOPMENT FLOW

Products are developed through the following processes. The illustration below shows the development flow.

### (1) Customer Request (Phase 1)

The customer selects an existing macro from the Fujitsu Macro Brochure, for the purpose of producing a system block in a specific design. If the desired macro does not exist, the customer may request Fujitsu to modify an existing macro.

### (2) Functional Study and Price Approximation (Phase 2)

Based on the customer request, Fujitsu and the customer make an initial study of feasibility. An initial price estimate is also made.

### (3) Development Start (Phase 3)

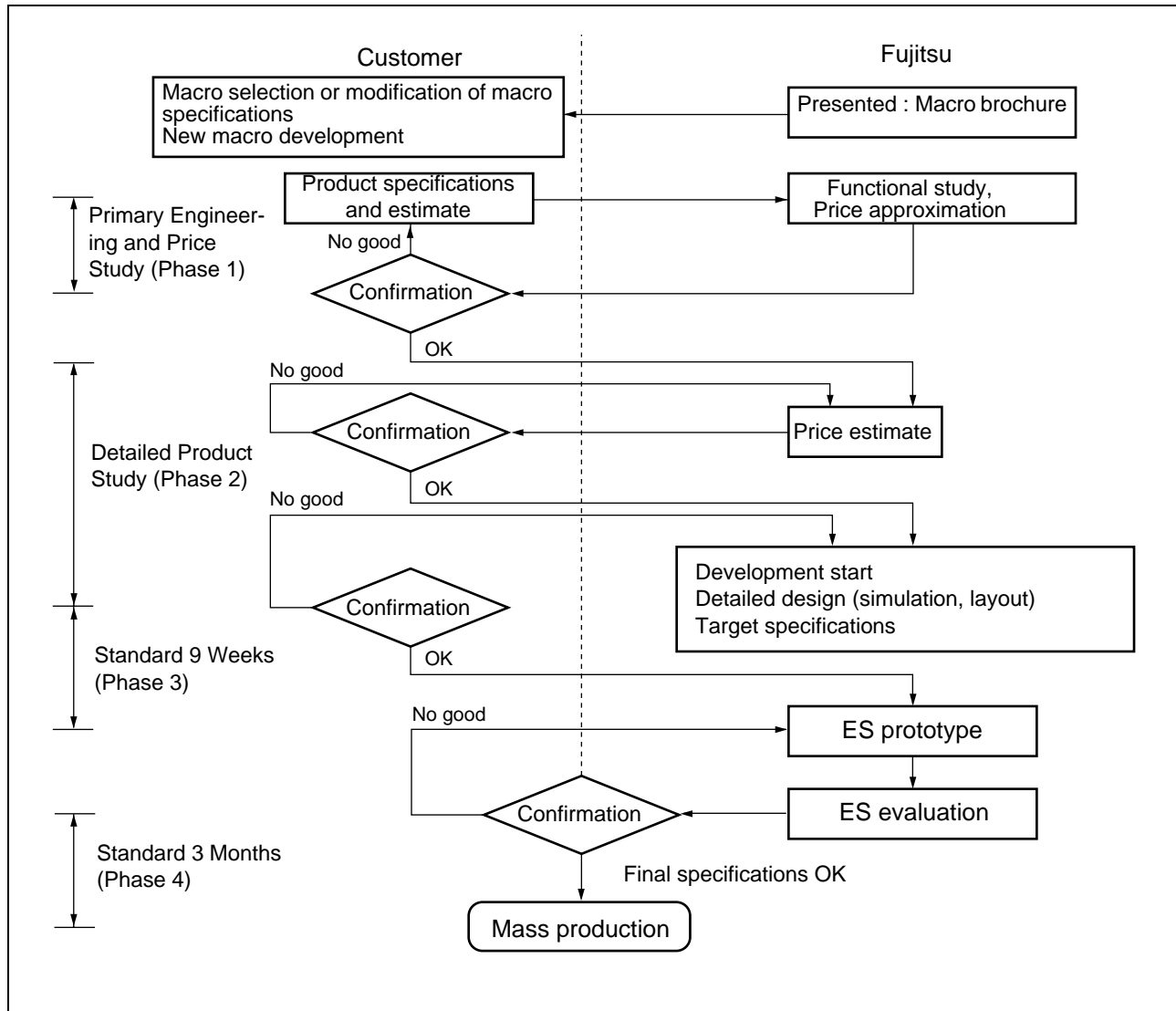
Based on the results of the primary study, and with the approval of the customer, Fujitsu starts the development process. Detailed investigation is made including circuit study and simulation of circuit characteristics, a layout is created, and provisional delivery characteristics (target specifications) are drawn up. The development schedule, development costs, and price estimate are prepared.

### (4) Prototyping and Mass Production

Based on the provisional delivery specifications approved by the customer, the LSI is designed and prototyped. The standard time for ES prototyping is approximately nine weeks. Fujitsu and the customer jointly evaluate the ES based on the provisional specifications. If no problems are found, final delivery specifications are approved and development is completed. The next step, transition to mass production and delivery, requires a standard interval of approximately three months.

# MB15G000 Series

## • Development Flow



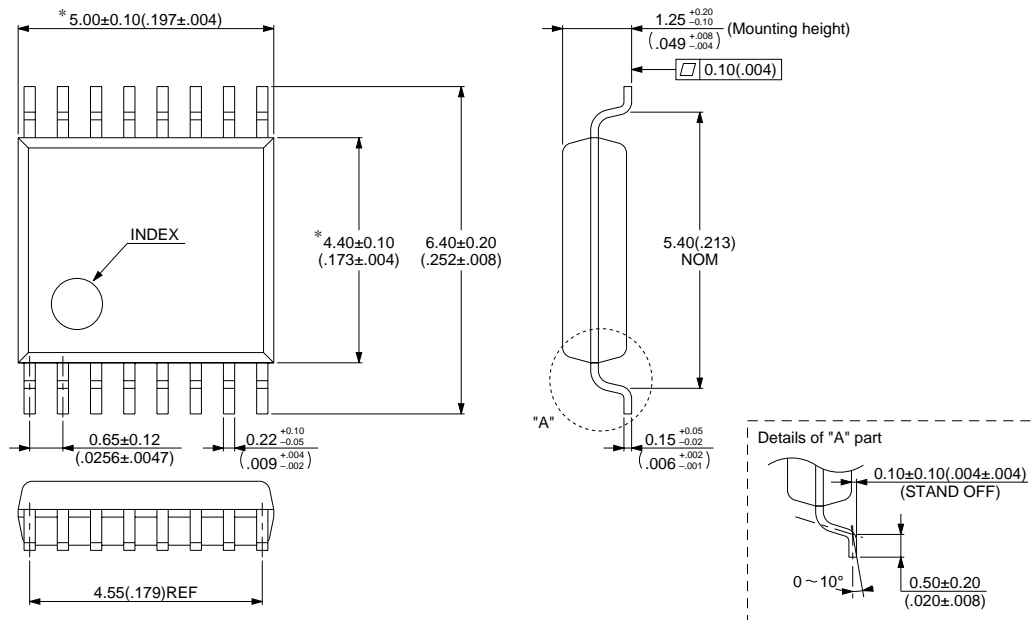


# MB15G000 Series

## ■ PACKAGE DIMENSIONS

16-pin Plastic SSOP  
(FPT-16P-M05)

\*:These dimensions do not include resin protrusion.

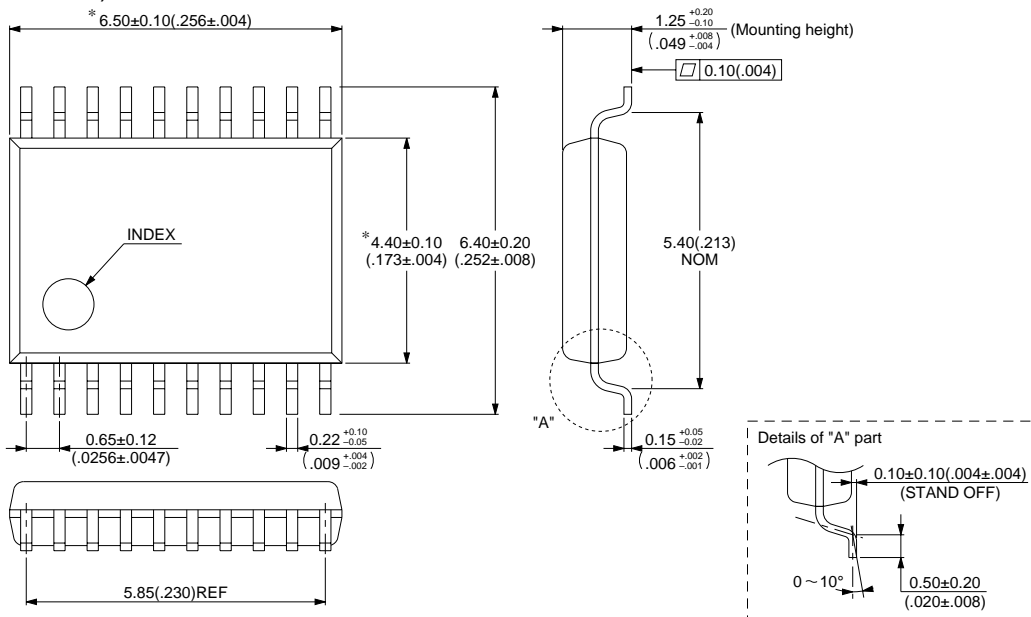


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Dimension in mm (inches)

20-pin Plastic SSOP  
(FPT-20P-M03)

\*:These dimensions do not include resin protrusion.



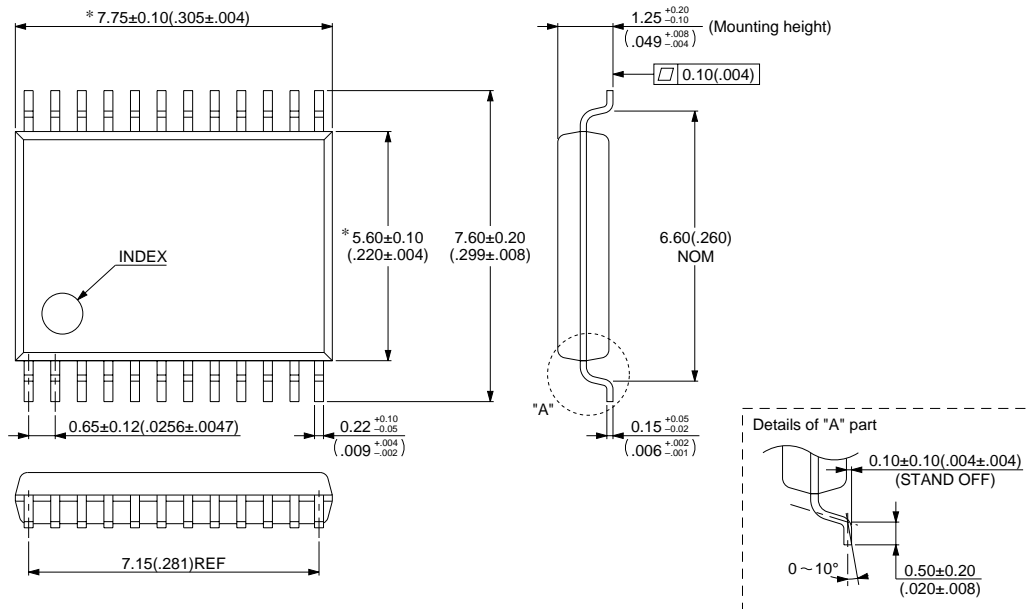
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Dimension in mm (inches)

# MB15G000 Series

## 24-pin Plastic SSOP (FPT-24P-M03)

\*:These dimensions do not include resin protrusion.

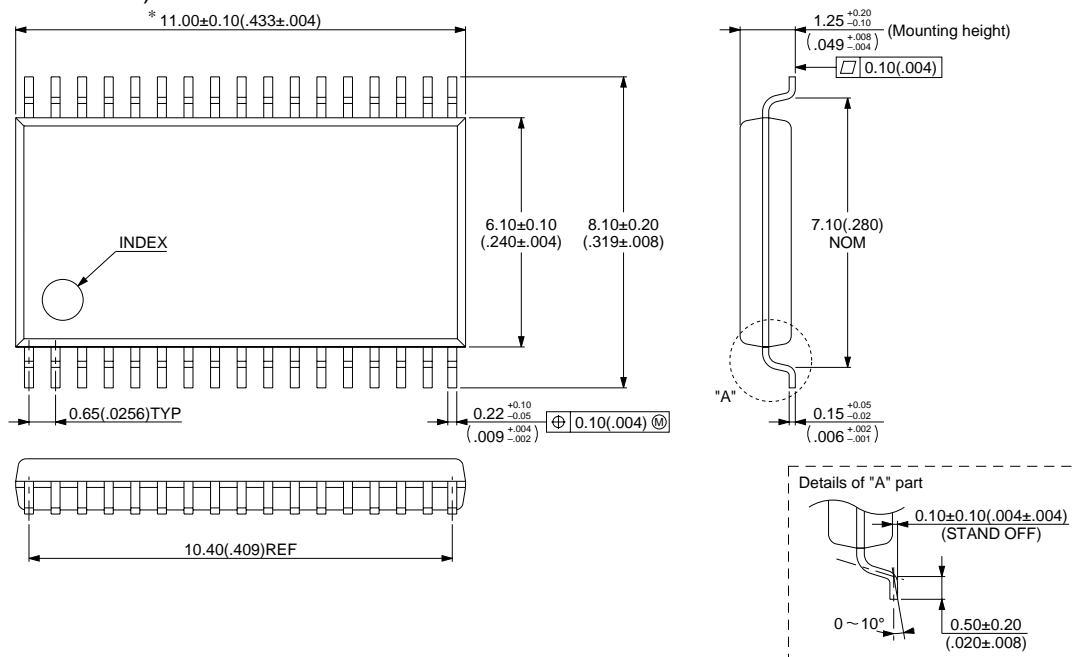


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Dimension in mm (inches)

## 34-pin Plastic SSOP (FPT-34P-M03)

\*:These dimensions do not include resin protrusion.

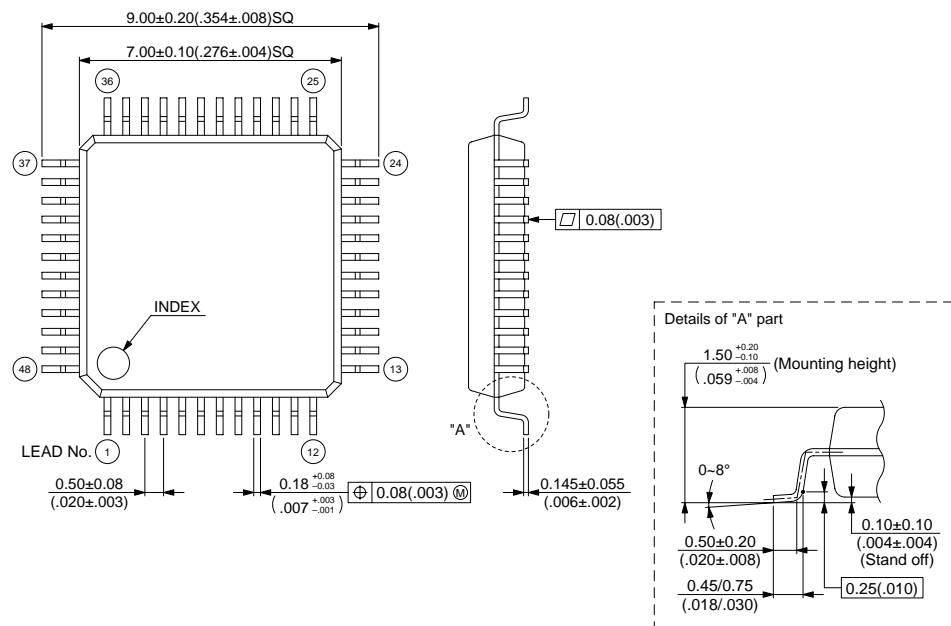


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Dimension in mm (inches)

# MB15G000 Series

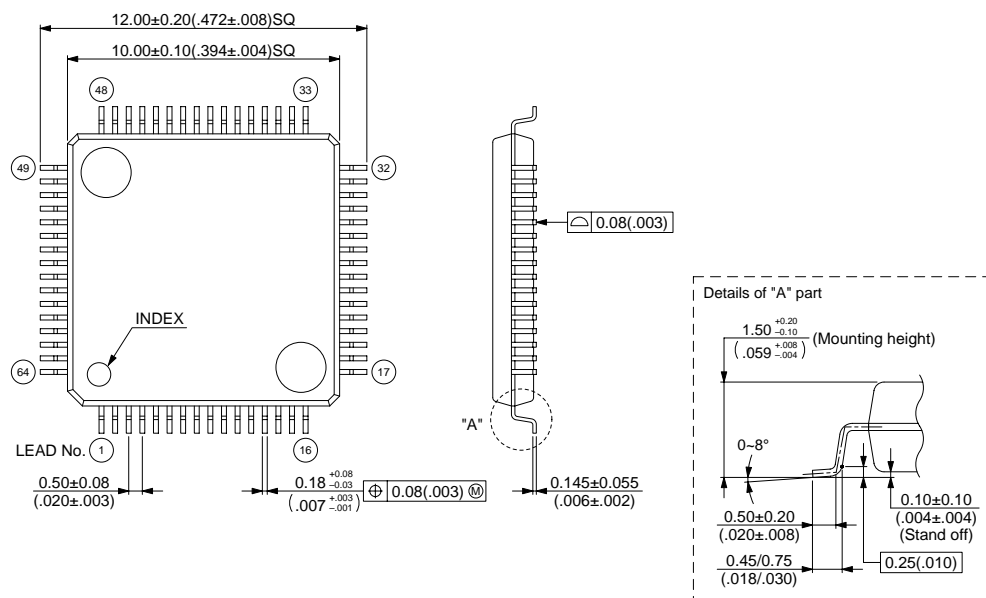
## 48-pin Plastic LQFP (FPT-48P-M05)



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Dimension in mm (inches)

## 64-pin Plastic LQFP (FPT-64P-M03)

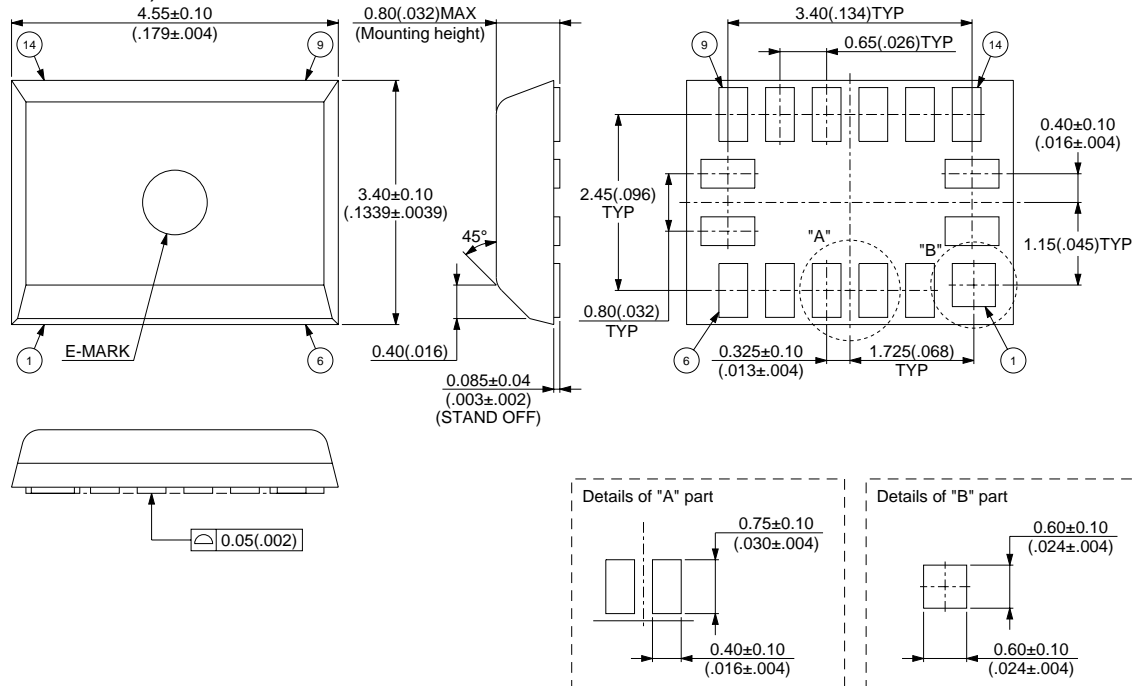


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Dimension in mm (inches)

# MB15G000 Series

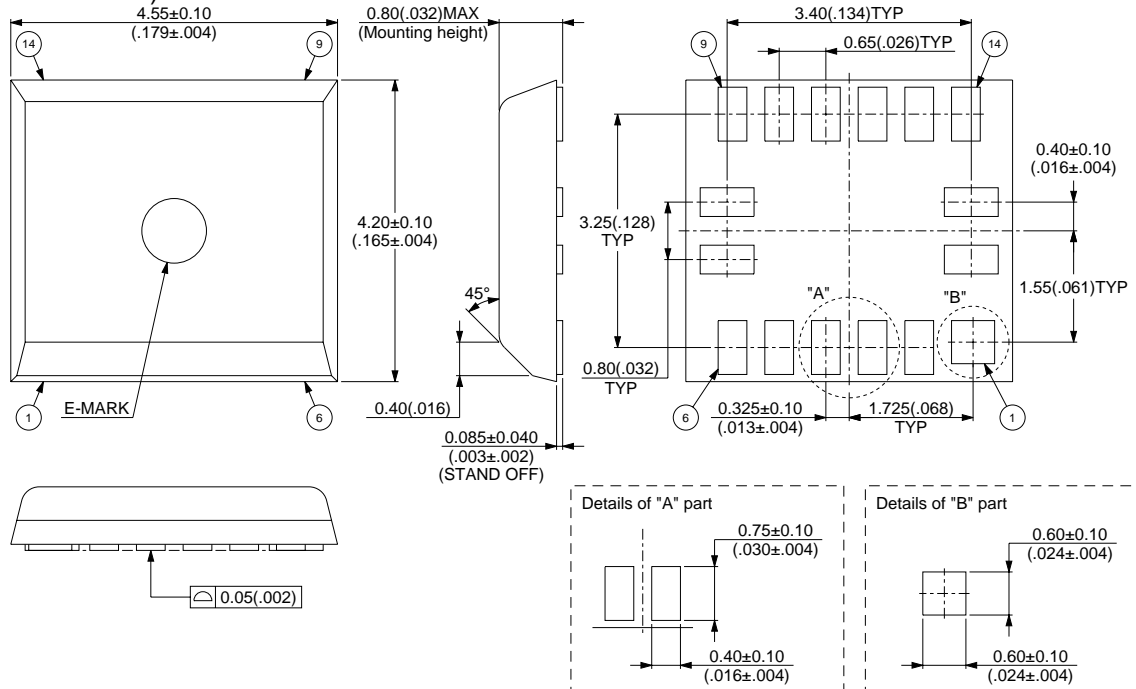
## 16-pads Plastic BCC (LCC-16P-M02)



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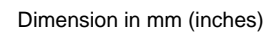
Dimension in mm (inches)

## 16-pads Plastic BCC (LCC-16P-M03)



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Dimension in mm (inches)



# MB15G000 Series

## ■ ASTRO-NT REQUEST SHEET (Example)

|               |   |         |
|---------------|---|---------|
| Customer name | : |         |
| Application   | : |         |
| Time          | : | ES; CS; |
| Quantity      | : |         |

| Macro name (*1) | Use current specifications | Modification requested (*2) |
|-----------------|----------------------------|-----------------------------|
| RV001AMP        | ×                          |                             |
| RV002MIX        |                            | ×                           |
| RV001QMOD       |                            | ×                           |

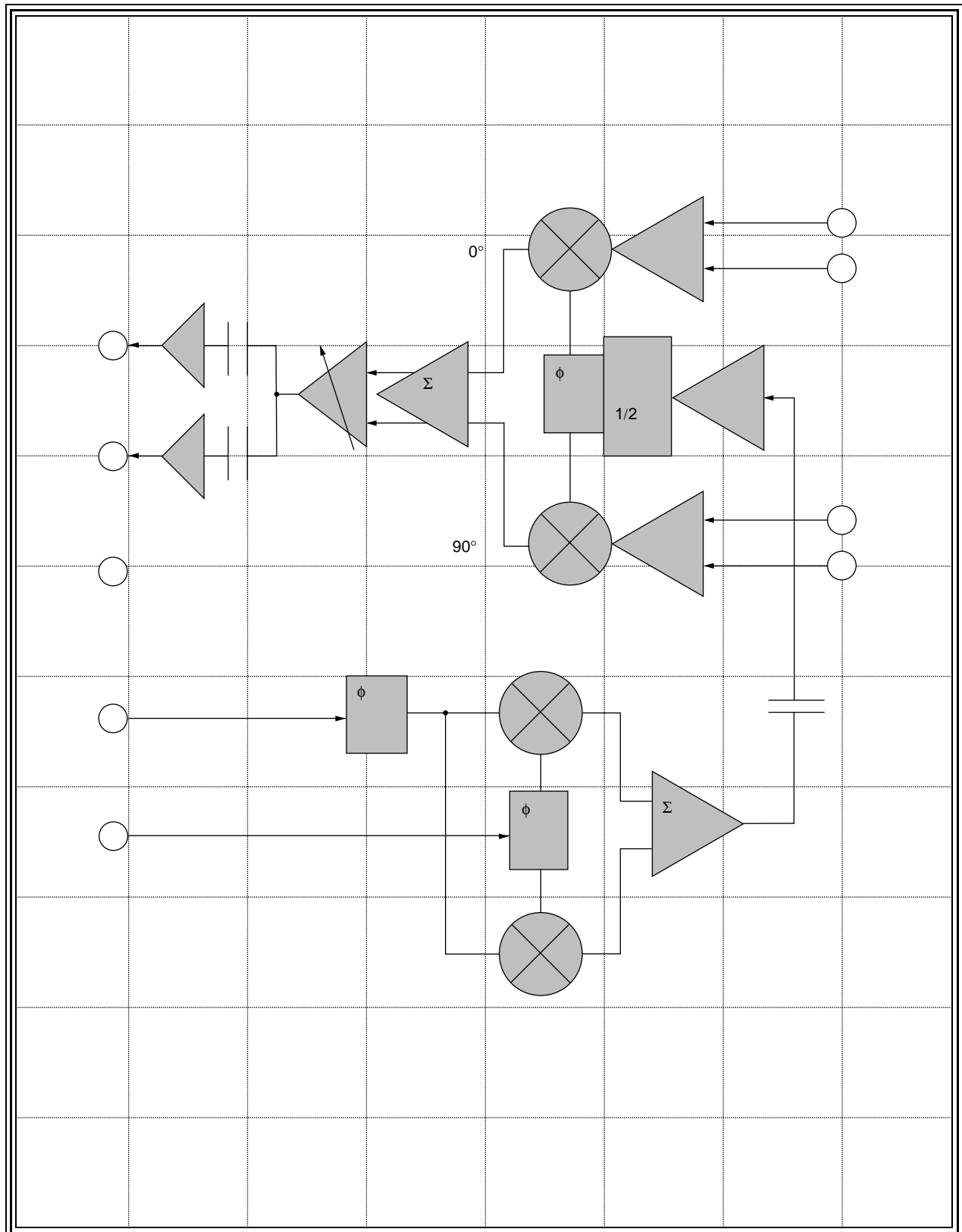
If Modification is Requested:

Macro name : RV002MIX, RV001QMOD

| Function Block | Parameter                | Symbol | Target Value |      |      | Unit | Comment/Condition |
|----------------|--------------------------|--------|--------------|------|------|------|-------------------|
|                |                          |        | Min.         | Typ. | Max. |      |                   |
| RV002 MIX      | Gaim                     | Gv     |              | 30   |      | dB   |                   |
| RV001 QMOD     | SSB maximum output level | Pout1  | -2           | 2    |      | dBm  | AGCcnt = 2.0 V    |

# MB15G000 Series

Block diagram (Example)



# MB15G000 Series

■ ASTRO-NT REQUEST SHEET

Customer name :  
Application :  
Time :ES; CS;  
Quantity :

| Macro name (*1) | Use current specifications | Modification requested (*2) |
|-----------------|----------------------------|-----------------------------|
|                 |                            |                             |
|                 |                            |                             |
|                 |                            |                             |
|                 |                            |                             |
|                 |                            |                             |
|                 |                            |                             |
|                 |                            |                             |
|                 |                            |                             |

MEMO

\*:Please fill in the macro name of the macro brochure.  
\*:Please fill in the demand on an attached spec seat.



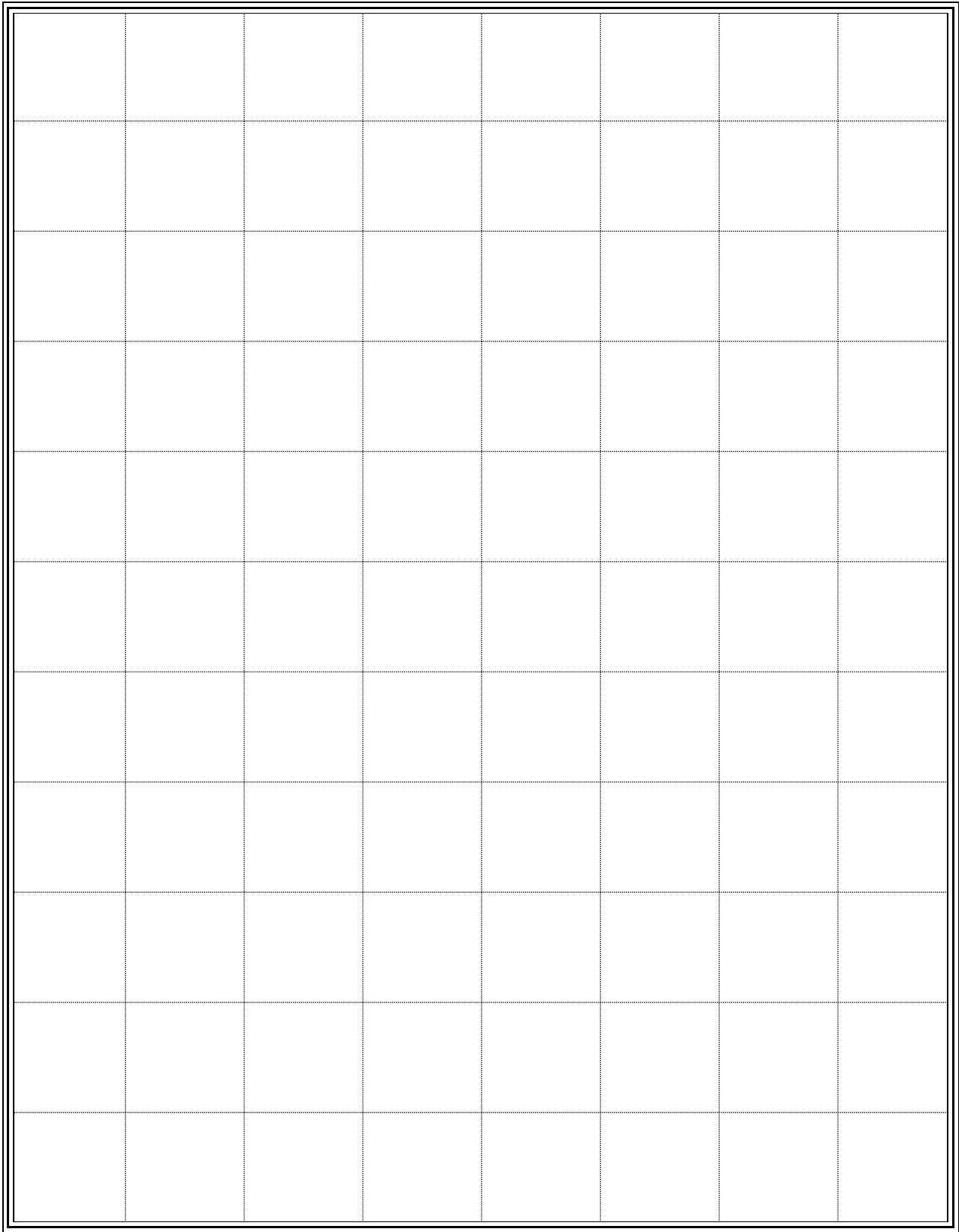
MB15G000 Series

Macro name: \_\_\_\_\_

| Function<br>Block | Parameter | Symbol | Target Value |      |      | Unit | Comment/Condition |
|-------------------|-----------|--------|--------------|------|------|------|-------------------|
|                   |           |        | Min.         | Typ. | Max. |      |                   |
|                   |           |        |              |      |      |      |                   |
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# MB15G000 Series

Block diagram



# MB15G000 Series

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