FUJITSU SEMICONDUCTOR
DATA SHEET

DS06-70105-3E

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 achive. 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.

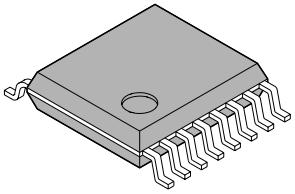
*: Advanced Standard macro base Technology of PLL with RF system On LSI-New Technology

■ 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

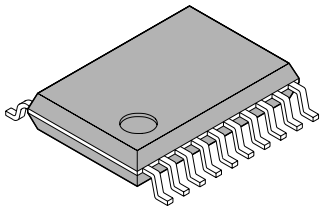
■ PACKAGES

16-pin Plastic SSOP



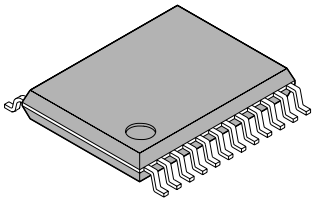
(FPT-16P-M05)

20-pin Plastic SSOP



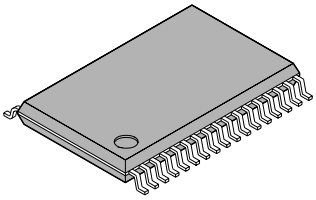
(FPT-20P-M03)

24-pin Plastic SSOP



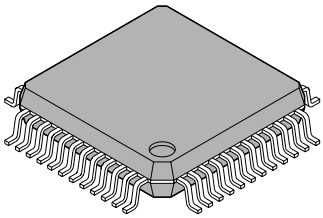
(FPT-24P-M03)

34-pin Plastic SSOP



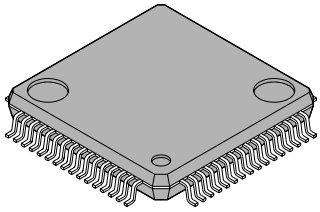
(FPT-34P-M03)

48-pin Plastic LQFP



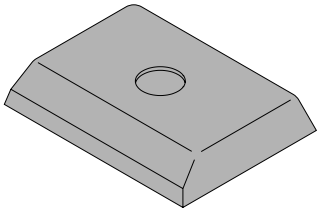
(FPT-48P-M05)

64-pin Plastic LQFP

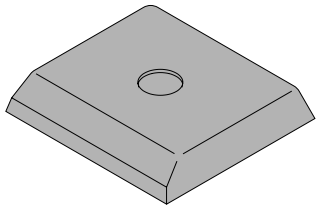


(FPT-64P-M03)

16-pad Plastic BCC

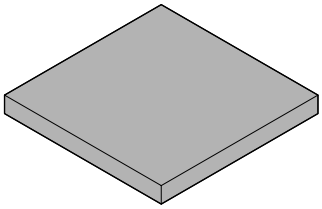


(LCC-16P-M02)



(LCC-16P-M03)

48-pad Plastic BCC



(LCC-48P-M02)

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

■ 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	Ta	–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.

■ 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 -2π 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_{CC}	I_{CC}	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 μA(Max.)

Note: Refer to macro specification book.

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^{nd} 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_P = 40 dB	3.6 V	19.0 mA	CDMA
		G_P = 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.

■ 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 V, Ta = –25 °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 PMODLO = –20 dBm I/Q : sin, cos wave 5.25 kHz VBB = 1.0 V 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	%		PMODLO = –20 dBm I/Q : PN9
Amplitude error	Aerr	—	—	—	%		
Phase error	Perr	—	1.5	—	deg		
Adjacent cannel leakage power	ACP	—	–65 *1	–60 *1	dB		
		—	–73 *2	–68 *2	dB		
TXout1-2 isolation	ISOout	—	30	—	dB	—	
Power supply current	I_{CC}	—	35	—	mA	—	

*1:50 kHz offset

*2:100 kHz offset

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

■ 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.

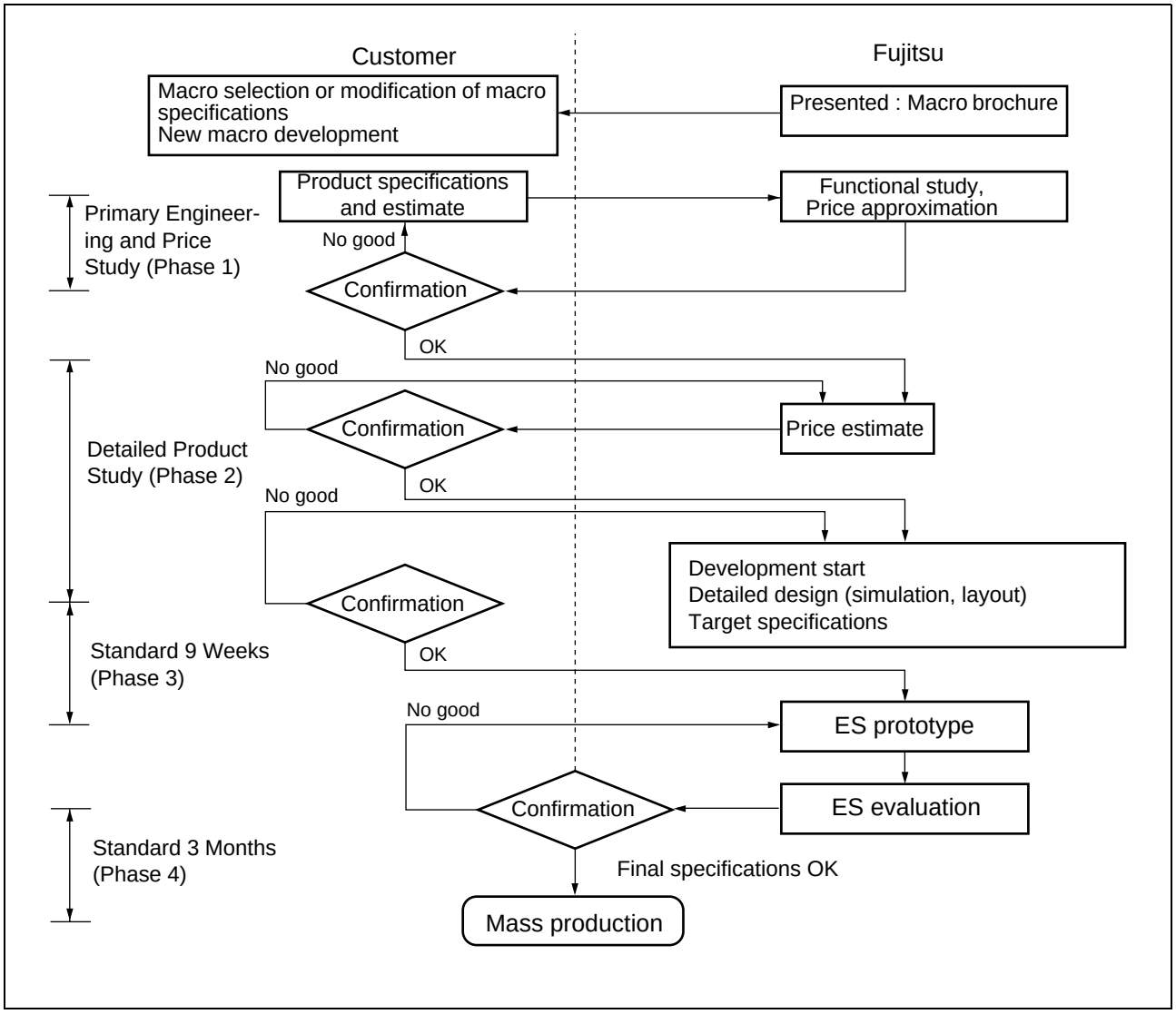
(3) Development Start (Phase 3)

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.

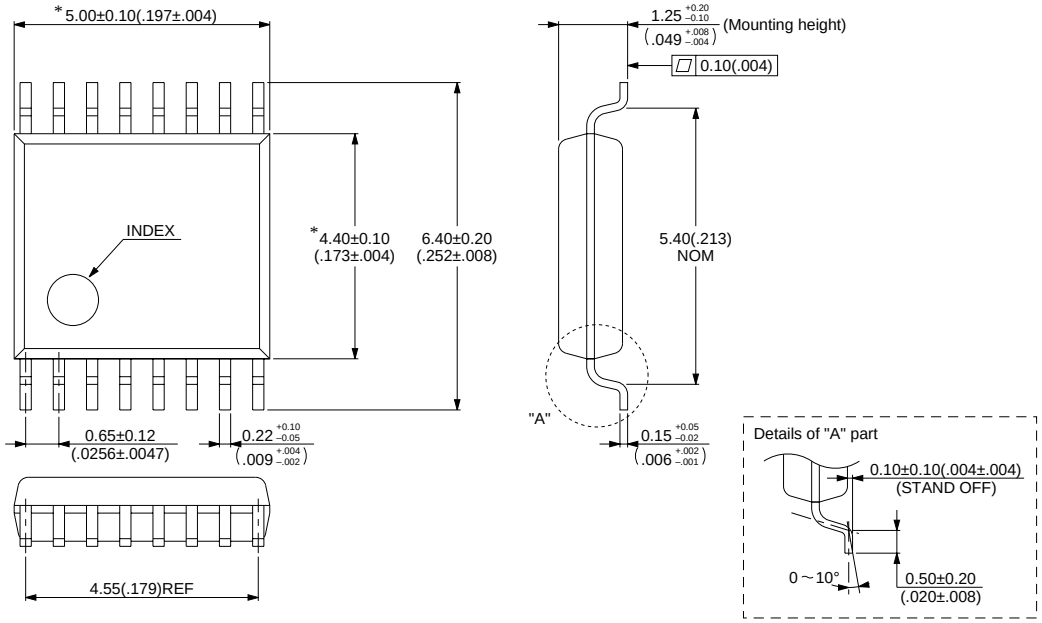
- Development Flow



■ PACKAGE DIMENSIONS

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

*:These dimensions do not include resin protrusion.



Dimension in mm (inches)

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

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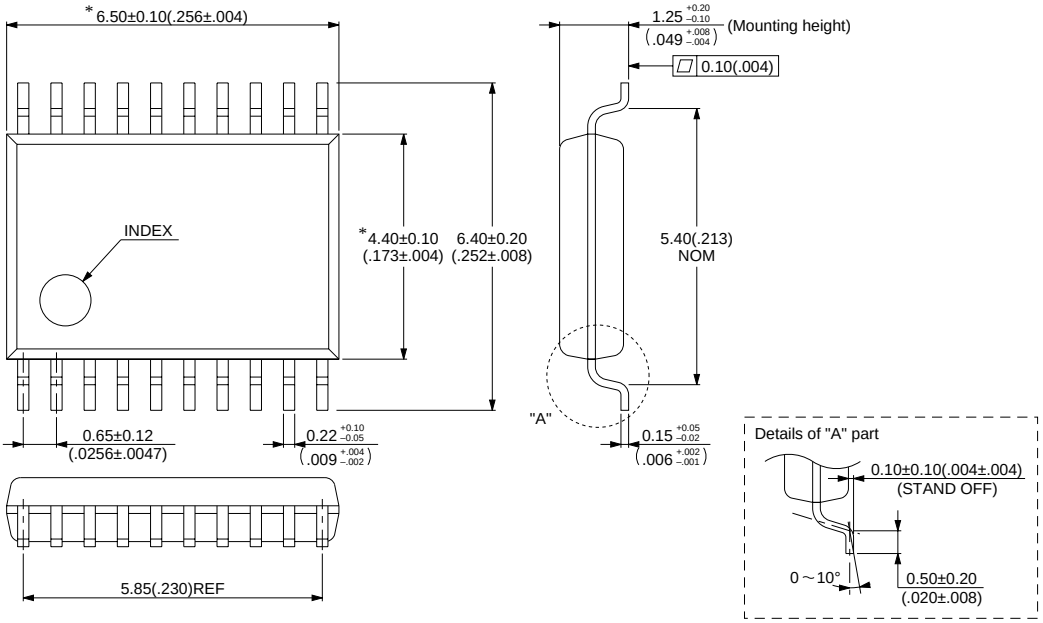

Dimension in mm (inches)

24-pin Plastic SSOP
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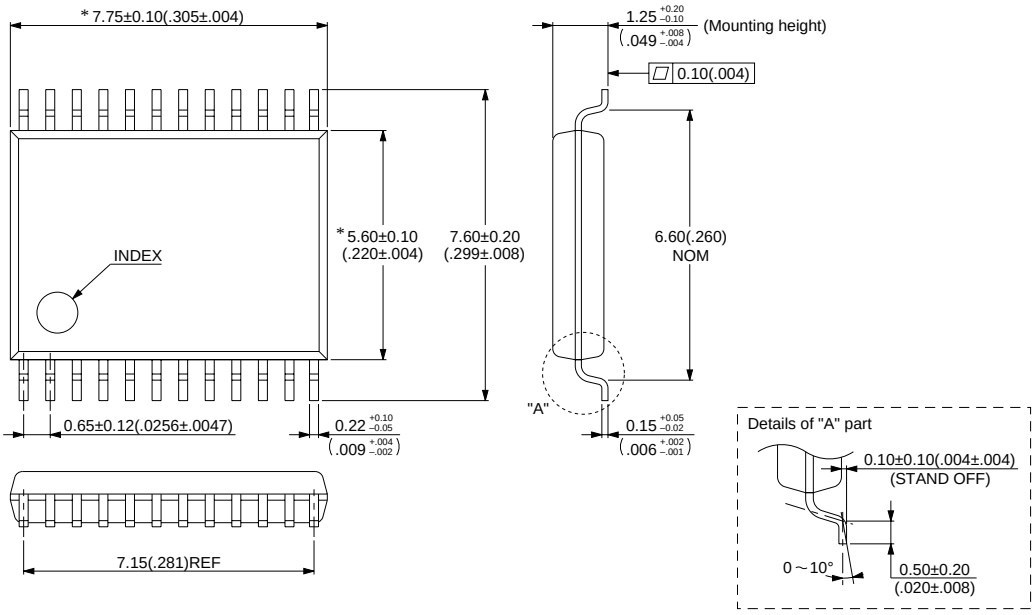

Dimension in mm (inches)

34-pin Plastic SSOP
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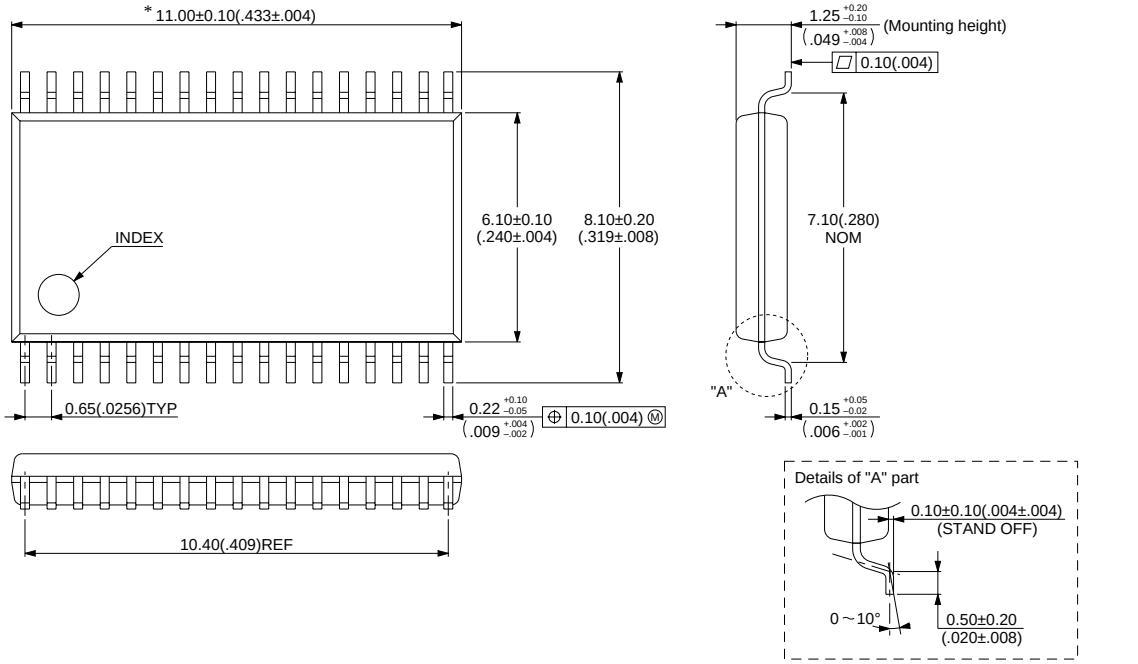
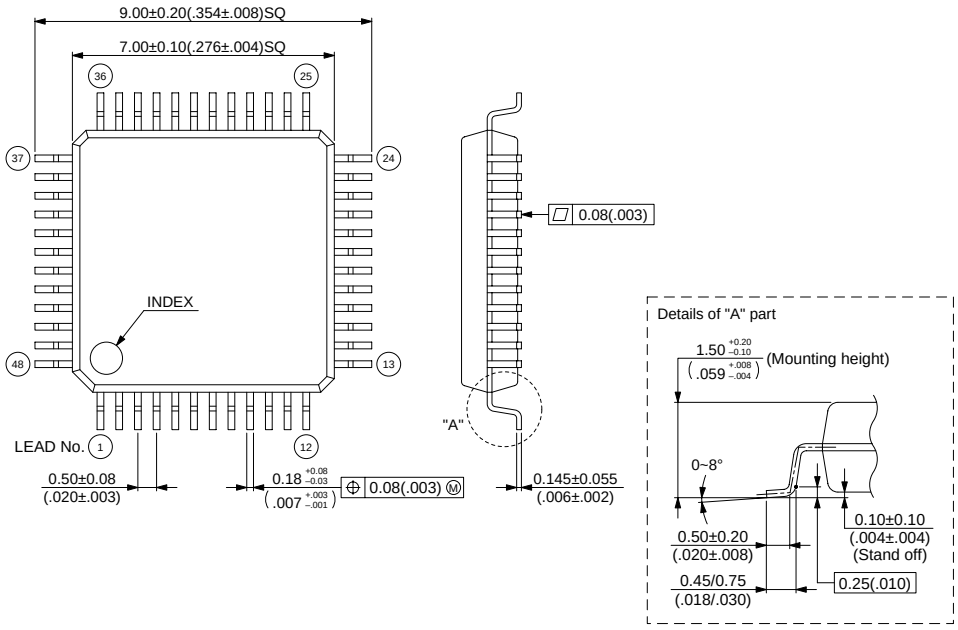


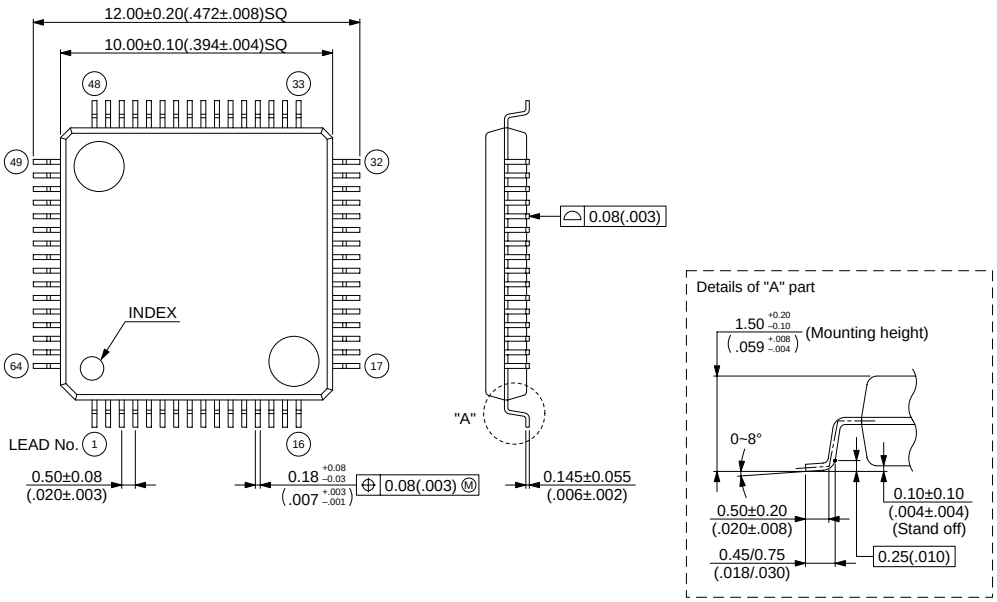
Dimension in mm (inches)

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



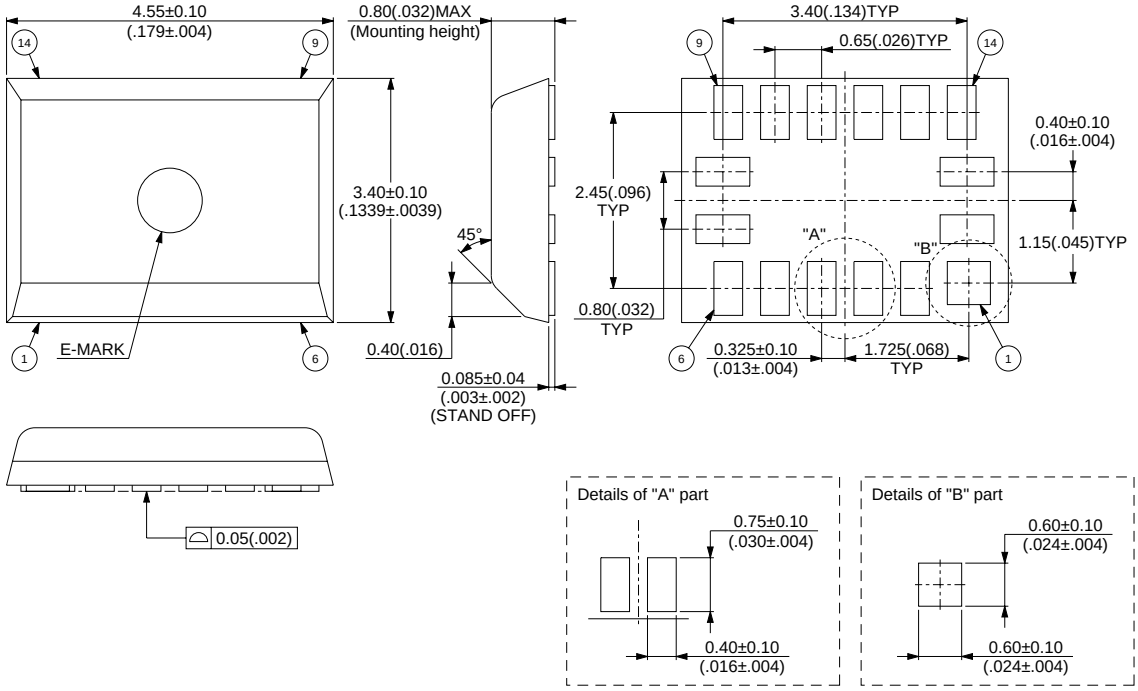
Dimension in mm (inches)

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



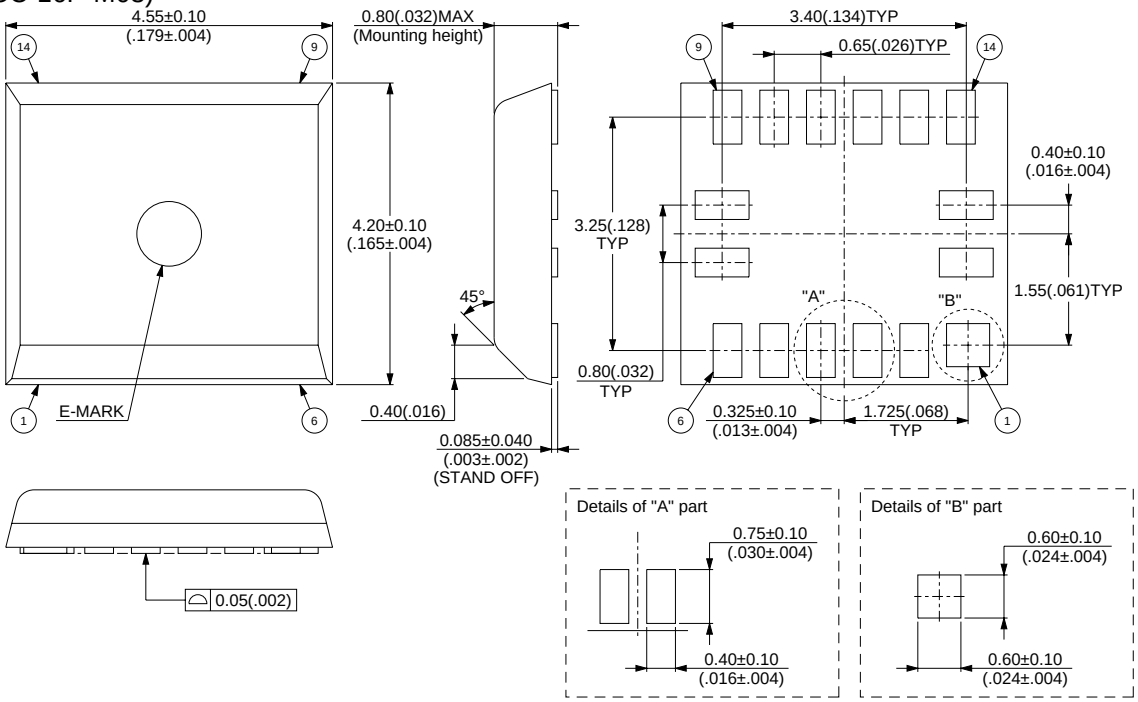
Dimension in mm (inches)

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



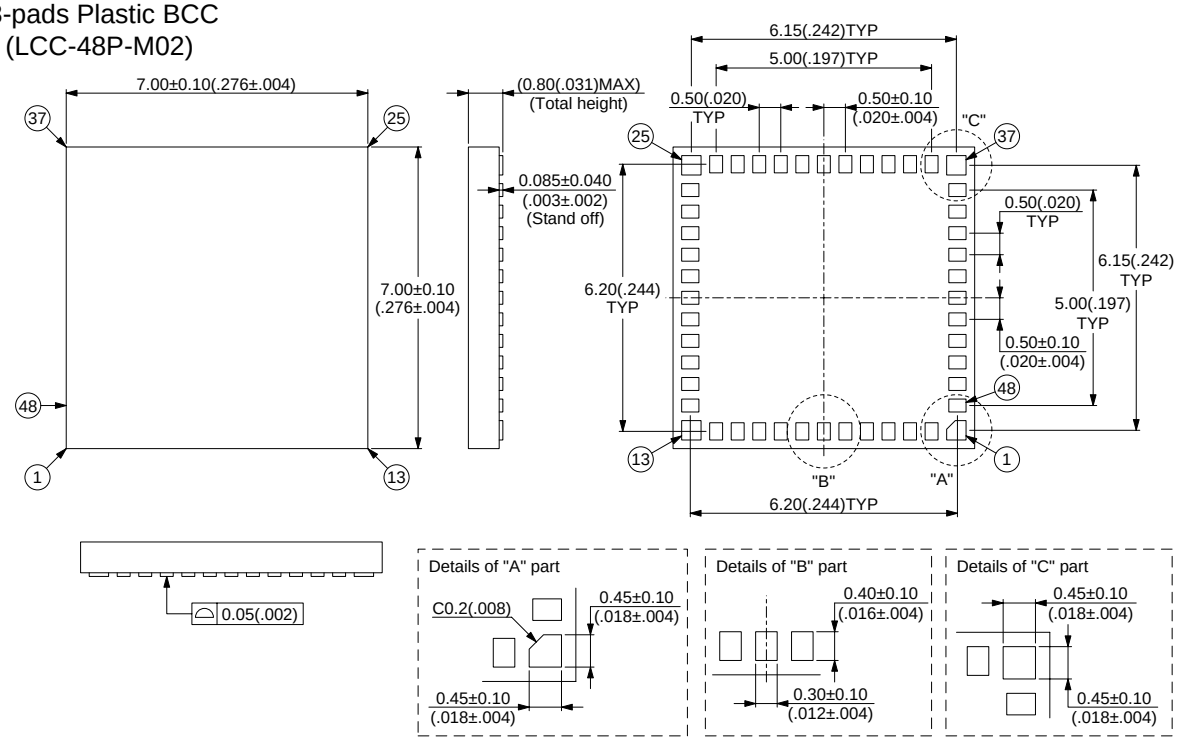
Dimension in mm (inches)

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



Dimension in mm (inches)

48-pads Plastic BCC
(LCC-48P-M02)



Dimension in mm (inches)

■ ASTRO-NT REQUEST SHEET (Example)

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

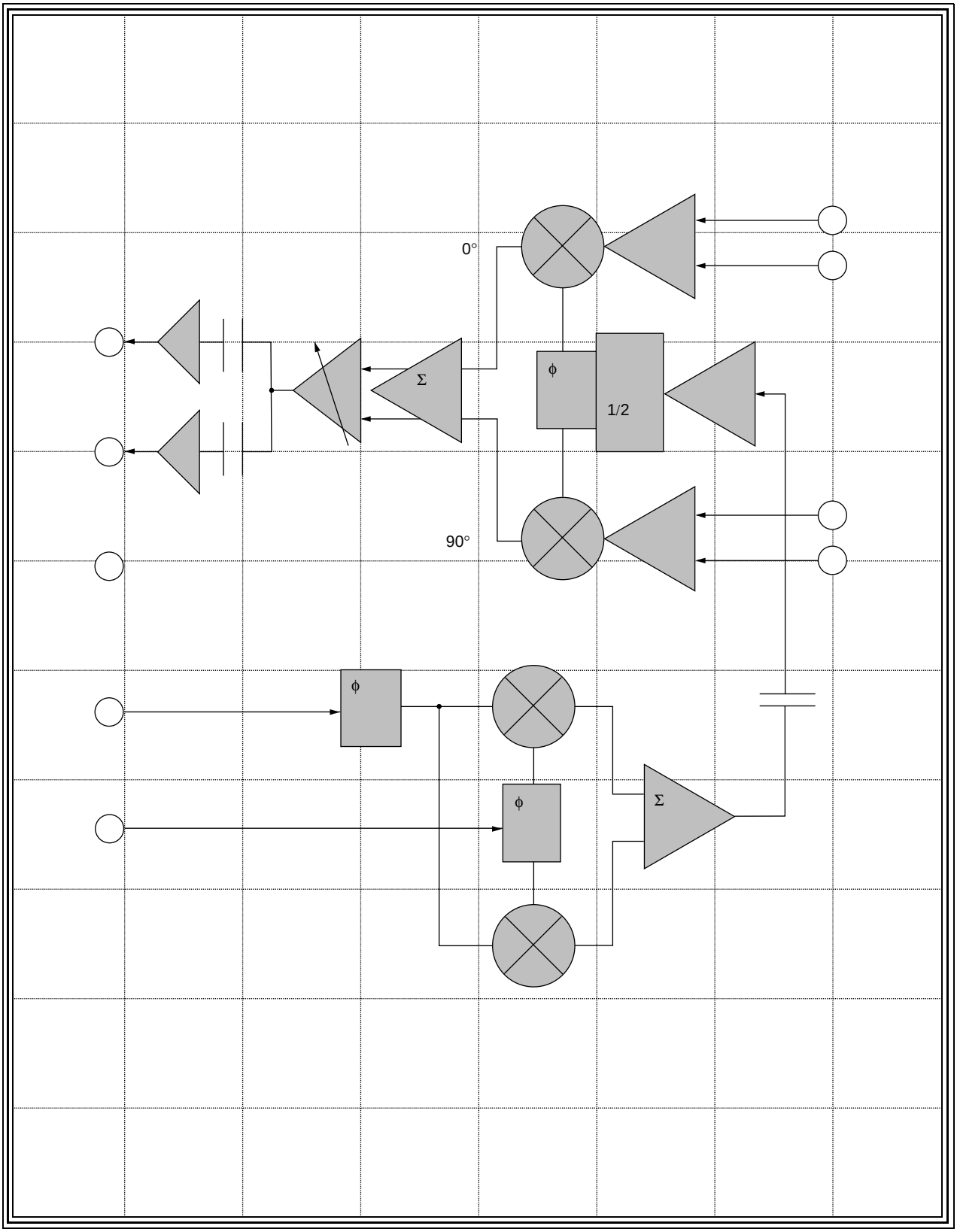
Macro name (*1)	Use current specifications	Modification requested (*2)
RV001AMP	×	
RV002MIX		×
RV001QMOD		×

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

Block diagram (Example)



■ ASTRO-NT REQUEST SHEET

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

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

MEMO

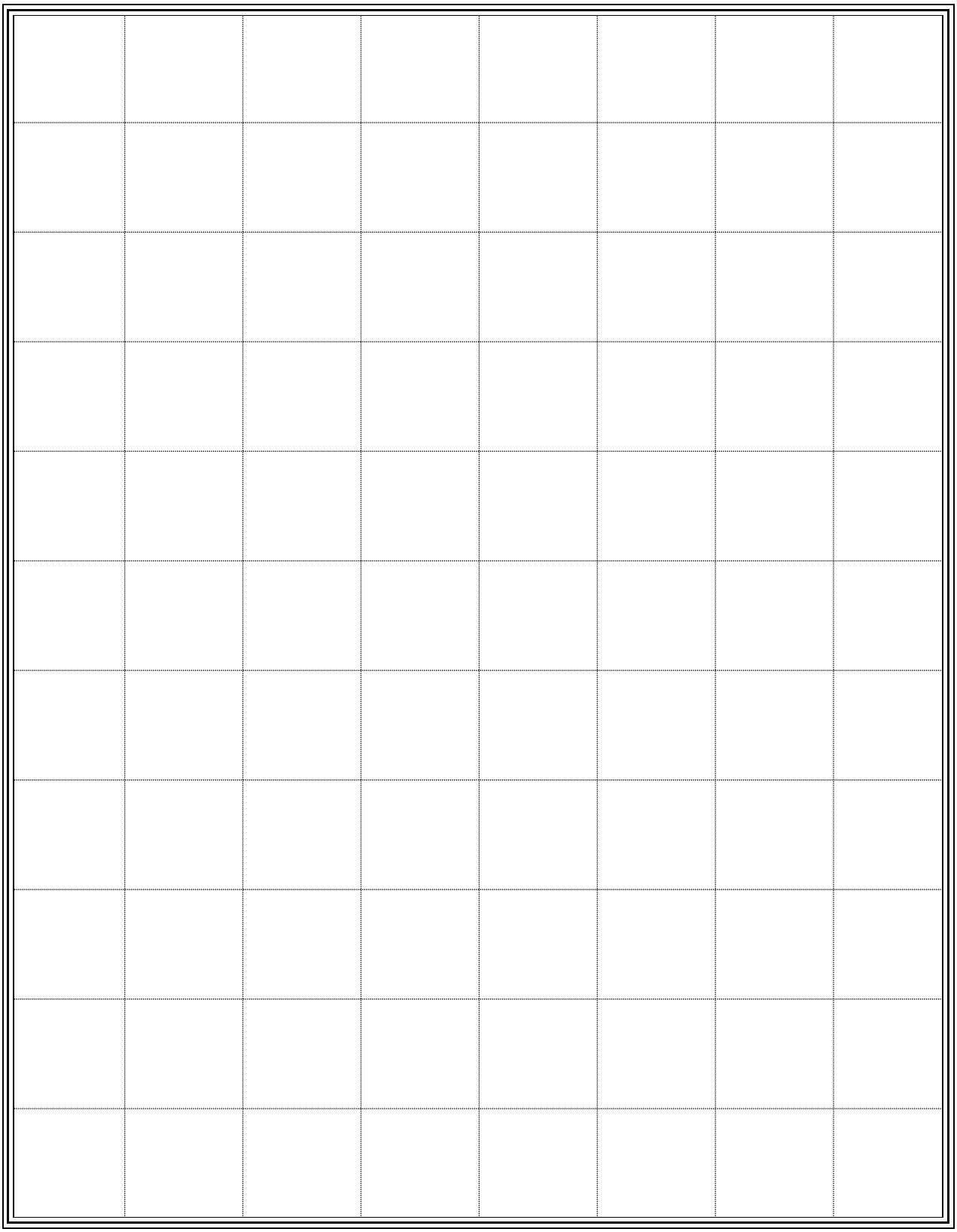
*:Please fill in the macro name of the macro brochure.

*:Please fill in the demand on an attached spec seat.

Macro name:

Function Block	Parameter	Symbol	Target Value			Unit	Comment/Condition
			Min.	Typ.	Max.		

Block diagram



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F9905

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